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Article

The Effect of Agile Workspace and Remote Working on Experiences of Privacy, Crowding and Satisfaction

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Abstract: Occupant density is an important and basic metric of space use efficiency. It affects user experience of privacy, crowding and satisfaction. The effect of agile working has been two fold. Firstly, offices have an increasing range of workspace settings such as break out space, collaborative space and contemplative space in contrast to the traditional workspace settings of assigned desks and formal meeting rooms. Secondly, office workers have become increasingly mobile as they are able to work from a greater variety of locations both in and out of their main place of work. This study asks whether workers who occupy agile workspaces and those with greater mobility experience privacy differently from workers with more conventional offices and work patterns. The experience of privacy can be considered in terms of retreat from people, control of information flow and control of interactions. Our results show that agile workspaces improve the ability to control information compared with open plan offices. It was also found that highly mobile workers are more sensitive to the negative effects of interacting with people. From this a taxonomy of offices is defined in terms of the features that contribute to the experience of privacy.

Keywords: occupant density; privacy; crowding; offices; agile working

1. Introduction

An increase in agile workspace and remote working has changed the way that work is done and offices configured. However, little is known about how these changes affect the experience of privacy, crowding and satisfaction. Experiences of privacy are diverse; it can be thought of in terms of the desire for withdrawal, control of information flow and control of interactions [1]. These are important health and wellbeing issues for building occupants [2,3]. Understanding how agile workspaces and remote working affects occupants' experience is therefore of utmost importance.

There is little peer reviewed coverage of agile working. In commercial literature the term is used to describe a variety of concepts including an individual's mode of working (an agile worker) and also a type of office design (agile workspace or agile offices), see Table 1. There is a range of alternative words that are of importance and describe overlapping concepts. To avoid confusion, this study uses the term agile workspace to describe a particular type of office design. This study uses the term "remote worker" and "mobile worker" synonymously to describe people who work in places other than their assigned desk space. Finally when talking of both mobile workers and agile workspace together the term agile working will be used.

Traditionally open plan and cellular offices are composed of uniform assigned workstations, formal meeting rooms and support space. In contrast agile offices have a variety of additional work settings such as shared desks, informal meeting space, collaborative space, break out space and contemplative space [4–7]. These alternative work settings have developed from the hive, den, cell and clubroom patterns of work identified by Duffy [8]. Agile workspaces often facilitate working from unassigned desks, desk sharing is common and there are a variety of available work settings to choose from [9]; however, this is not always the case. Although agile workspaces could consist of cellular or open plan offices they generally tend to be open plan. These unique aspects suggest that these new ways of working need to be examined.

In tandem with agile workspace has come the remote, or mobile, worker. Mobile workers have greater flexibility in where they work because of the use of mobile communications and computing. Generally the mobile worker has an office building that acts as a base but also works from a variety of other locations such as their home, cafes and other offices [10]. Mobile workers can be found in traditional offices not just agile workspaces. They are defined by the degree to which they work from locations other than their main offices. Their specific categorization for this study will be explained in more detail further on.

The move towards agile working is in part driven by a need to intensify space use and in part from a drive towards greater collaboration and interaction of the workforce [11]. Its benefits for collaboration and interactions have been explored elsewhere [12,13]. Given the apparent benefits for collaboration, there is a tendency to focus on the trade-off between interaction and privacy and assume that the intensification of space naturally leads to poorer privacy. However, there are features of agile workspaces that support both increased privacy and improved collaboration. The aim of this study was

to focus on perceptions of privacy, crowding and satisfaction to better understand the effect of agile working on this trade-off.

Table 1. Overview of terminology used in commercial literature.

| Term | Definition |
|----------------------------------|---|
| Agile working | Working in different ways especially without a fixed desk [9]. |
| Workstation setting | A word for the various places to work in an agile workspace. As in agile workspace has “a greater variety of workstation settings” [4]. |
| Workstyle | The arrangement and set up of the office, encompassing the different ways of working [4]. |
| Mobile working Remote working | Working in different locations, as in “technology enabled mobile working” [9]. |
| Co-working | Different organisation working in the same building [9]. |
| Activity based working | Choosing workstation setting according to the work activity carried out at any one time [5,9]. |
| Flexible working | Having flexibility of when to work [9]. |

Studying privacy and collaboration are just two ways of understanding how spatial constraints affect occupant relationships. To understand how space affects occupant relationships it is necessary to characterise key features of the building environment. This is often done in terms of occupant density, partly because it is a key measure of space utilisation. At its simplest, a definition of density is a measure of “a number of units in a given area”, where the area is defined by a fixed length or more tangible limits such as the walls of an office [14]. However, occupant density is not the only way to characterise the spatial environment.

There have been a number of studies that have looked into the effects of density in general and particularly for office spaces. Each of these offer slightly different approaches to characterising the spatial environment according to how it affects interaction between people. Lee [15] compared typologies of office: enclosed private, shared private, open plan with high cubicles, open plan with low cubicles and open plan without partitions. Leaman and Bordass [16] conclude that it is the number of people in a work group that is important for productivity. Kupritz [17] compares open plan offices with and without partitions. Sundstrom *et al.* [18] studied nine physical parameters: number of enclosed sides, workstations in room, private office, distance to nearest workstation, workstations visible, workstations within 25 ft (7.6 m), floorspace allowance, distance to common entrance and finally a person’s visibility to supervisor. Fried *et al.* [19] measured the number of co-workers within a 15 ft (4.6 m) radius. Valins and Baum [20] looked at two different typologies of student resident, comparing 17-room corridors with 3-room suites. This range of approaches indicates that the experience of the spatial environment and its effect on occupant relations cannot be understood using simple metrics of units per given area; instead typologies and features of space should be used instead or as well.

An important effect of spatial constraints is the experience of privacy. Sundstrom and Sundstrom [1] define three separate components to the common concept of privacy: retreat from people, control over

information and regulation of interaction. As well as using this conceptual breakdown of privacy Kupritz [17] separates the properties of buildings into field characteristics and barriers. The former, such as corridors, break out spaces and neighbouring desks, intrude on privacy. The latter, such as partitions and doors, are moderators of privacy. These privacy factors and feature types are a useful structure with which to conceptualise spatial experience.

Crowding is another way to describe the effect of occupant density and spatial typology. It is used to describe circumstances and consequences where social stimulation becomes stressful. Baum and Epstein [21] explain the phenomena by using models of attentional capacity. They suggest that overload due to excessive noise, information or the need to make decisions can lead to stress and require coping mechanisms such as withdrawal. The concept of crowding is similar to the need for retreat from people, identified by Sundstrom and Sundstrom [1]. In their study of college dormitories Valins and Baum [20] showed that people who experience crowding retreat from social contact. Interestingly this suggests that too much interaction can encourage withdrawal because people experience social overload.

One way to measure occupant density, the number of people in a given room, has a particular effect on occupant experience. Leaman and Bordass [16] associate this with negative consequences because it leads to lack of environmental control for three reasons. Firstly because it is difficult to consistently map system zones with prevailing environmental conditions and occupant activity. Secondly occupants must consider many more people when taking decisions about their environment. Lastly long distance effects such as glare or distant noise are harder for individuals to deal with. This view associates density with the effect it has on occupant control of building systems.

The variety of different approaches show that there is no simple, unified way of thinking about spatial constraints and density (Table 2). Different studies each highlight different aspects of the density problem whether it be crowding, privacy, satisfaction or environmental control. Each of these could be moderated by the mobility of the worker. This study tries to understand the effect that emerging trends in agile working are having on experiences of privacy, crowding and satisfaction. The categories in Table 2 were used to frame the hypotheses and develop the questionnaire. Henceforth, we formulate hypotheses about how mobile working and agile workspaces moderate the different aspects of the experience of privacy and crowding.

Hypotheses:

H1: Compared with open plan, occupants of agile workspace will experience:

H1A: less need for retreat;

H1B: less need to control information;

H1C: the same need to control interactions.

H2: Workers with increased mobility will experience:

H2A: reduced sensation of crowding and therefore a reduced need for retreat;

H2B: the same need for information control;

H2C: reduced need for control of interactions.

Table 2. The different ways occupant density and spatial constraints are experienced.

| Experience of Densification in Offices | Factors | Practical Measures to Improve Experience |
|---|--|---|
| | Desire to retreat | Contemplative space |
| Privacy | Desire to control information | Provide a way to stop being overheard or block out distractions |
| | Desire to control interaction | Do not disturb signals |
| Crowding | Number of people that a person encounters | Reconfigure buildings so encounters are more selective |
| Large groups | Building environments for large groups: poor system zoning, group decision making, party to long range effects | Reconfigure building so work groups and environmental zones are smaller |

2. Methods

2.1. Participants and Buildings

The purpose of this study is to investigate the effects of agile working on the experience of privacy, crowding and satisfaction. For this it is necessary to compare agile workspaces and mobile workers with more traditional modes, such as workers who do all their work from the same desk and those in either a private or open plan office. To accomplish this, three different typologies of office were chosen for the study: traditional cellular offices, with assigned seating, formal meeting rooms and a number of small open offices; traditional open plan, with assigned seating, formal meeting rooms and a small number of uniform break out spaces; and agile open plan workspace with assigned seating, formal meeting rooms and a large number of varied break out spaces.

Buildings C and D were both mixed cellular offices and small open plan rooms; for brevity they have been referred to as cellular. Their spaces ranged from private offices to rooms with more than 11 people in them. Across buildings C and D a third of the participants were in offices of greater than 11 people. Buildings A and E were both open plan, with formal meeting rooms and one or two small tables for break out. Buildings F and G were open plan with assigned desks but they also had a large number of varied meeting spaces in addition to formal meeting space. Building F had a large expanse of open comfy seating that was away from workstations, it also had a number of break out spaces closer to workstations containing sofas, chairs and tables. Building G had a variety of booths close to workstations and some touch down desks that could be used instead of a person's primary workstation (although these were increasingly being used by new starters). Office B was a small building with an underused main room and three smaller offices, it had predominately unassigned seating; because it didn't fit easily into either of the three types it was left out of the typology analysis.

The study was part of a larger post occupancy evaluation of seven buildings in London and Reading between June and September 2014 [22]. At each building, ambient conditions were monitored using data loggers for a week. At the end of the week a survey was sent out to all occupants. One section of the survey was about attitudes to and experience of crowding and privacy. Participants for this study came from all seven of the buildings surveyed; $N = 179$ people answered the survey; this comprised

$N = 62$ male, $N = 114$ female and $N = 3$ no gender chosen, all of them were 18 years of age or older. Not all participants answered all questions but because analysis was between participants incomplete cases were retained. Response rates were about $20\% \pm 5\%$ except for two outliers of 2% and 77%. It should be noted that these investigations are about differences between typologies not the performance of individual buildings, therefore the sample size is considered more important than the response rate. The sample size in this case was large enough to provide statistical differences between the three typologies being compared.

The seven office buildings varied in character; some were newly fitted out, others were not. All involved desk based work; this consisted of design, administrative and academic type work. Three buildings were at universities and contained academics and administrators, three were building design consultancies, one was a charity (Table 3). Occupant density varied between $7 \text{ m}^2/\text{per}$ and $14 \text{ m}^2/\text{per}$ Net Internal Area (NIA) while the local density varied between $3 \text{ m}^2/\text{per}$ and $6 \text{ m}^2/\text{per}$. Occupant density was calculated by taking the net internal area of the floor plate and the number of workstations [4,23]. Local density is taken by sampling a small number of workstations and taking only the immediate space around the workstations required for seating and access.

Ethics approval was obtained from the University of Reading. Each participant gave informed consent. At the beginning of the survey participants were fully briefed about the purpose of the questions and how their data would be handled. They consented and were informed they could withdraw at any time. For completing the survey, participants were rewarded with a snack of their choosing.

Table 3. Overview of the studied buildings showing office type and occupant density.

| Building | Response Rate N (%) | Occupier | Typology | Plan | Work Stations Per room | Occupant Density (NIA) | Local Density |
|----------|---------------------|----------|-----------|---------|------------------------|------------------------|---------------|
| A | 11 (22%) | Design | Open plan | Shallow | 49 | 7.5 | 5.2 |
| B | 10 (77%) | Academic | Open plan | Shallow | 9 | 8.3 | 5.9 |
| C | 54 (20%) | Academic | Cellular | Shallow | Varies | Varies | Varies |
| D | 30 (16%) | Academic | Cellular | Shallow | Varies | Varies | Varies |
| E | 10 (20%) | Design | Open plan | Shallow | 17 | 14.2 | 5.7 |
| F | 25 (2%) | Charity | Agile | Deep | 687 | 7.3 | 5.9 |
| G | 39 (26%) | Design | Agile | Shallow | 50 | 6.9 | 3.6 |

2.2. Questionnaire Development

The questions were designed to probe the different facets of privacy and crowding. Questions 1 to 8 were about how the office supported different types of activity. Questions 9 to 11 were about occupant experience of their work area. Question 12 was about overall satisfaction with layout. Questions 13 to 15 were about occupant behaviour. After this there were three open questions, then demographic questions (Table 4).

Table 4. Survey questions developed for this study.

| No. | Question | Possible Responses |
|-----|---|---|
| 1 | In general how do your current work arrangements support being able to have confidential conversations? | |
| 2 | In general how do your current work arrangements support working alone? | |
| 3 | In general how do your current work arrangements support working without visual or acoustic distractions? | |
| 4 | In general how do your current work arrangements support being aware of what colleagues are doing? | Not at all/A little/Moderately/ |
| 5 | In general how do your current work arrangements support unplanned interactions with colleagues? | Quite a bit/Extremely |
| 6 | In general how do your current work arrangements support being able to work with confidential documents? | |
| 7 | In general how do your current work arrangements support getting away from colleagues? | |
| 8 | In general how do your current work arrangements support controlling who comes to talk to you? | |
| 9 | Rate your personal work area: private? | |
| 10 | Rate your personal work area: too close to colleagues? | Not at all/A little/Moderately/ |
| 11 | Rate your personal work area: crowded? | Quite a bit/Extremely |
| 12 | During the last week how satisfied were you with the layout? | Dissatisfied/A little dissatisfied/Neither/ A little satisfied/Satisfied |
| 13 | How often do you try to shut off or get away from your colleagues at work? | Not at all/Less than once a week/Once or twice a week/Once or twice a day/ |
| 14 | How often do you need to block out visual and acoustic distractions? | Many times a day/Throughout the day |
| 15 | How often would you like to control who talks to you? | |
| 16 | What do you do to manage these issues? | |
| 17 | What conditions, or features, of your office cause these problems? | Open response |
| 18 | What conditions, or features, of your office improve these problems? | |
| 19 | Please enter your age? | 18–24/25–34/35–44/45–54/55–64/65+ |
| 20 | Please enter your gender? | Male/Female |
| 21 | When were you in the building this week? | Monday/Tuesday/Wednesday/Thursday/ Friday |
| 22 | Where else do you work? | At home/At other offices/At cafes and other ad hoc places/While on the move/Other |
| 23 | How many people do you share an office with? | Private office/2–4/5–10/11+ |

2.3. Analysis

The answers to questions 1 to 15 were translated into a numerical score. For questions 1 to 11, 1 = Not at all, 5 = Extremely; for question 12, 1 = Dissatisfied, 5 = Satisfied; for question 13 to 15, 1 = Not at all, 6 = Throughout the day. Average scores for each typology were then compared using ANOVA. Often the scores for the agile workspaces were either similar to open plan offices or cellular offices. Where they are similar to one and not the other this has been highlighted.

The degree of mobile working of each participant was characterized in two ways. First by the number of days, that week, that the participant had been at the office. This was translated into a number between 1 and 5 which could be used in a linear regression model. Fifteen linear regression models were tested to compare questions 1 to 15 with the number of days at the office. This was used to see whether people who were in the office more had different attitudes and experience than people who came in less.

The second way to characterize occupant mobility was by the number of different places a participant worked other than their main office. There were five different alternative locations to choose from, as detailed above. This was translated into a number between 0 and 5 according to the number of other places the participant worked at during the week of the study. Once again, 15 linear regression models were tested to compare questions 1 to 15 with the number of different places worked at. This could be used to see if people who worked in a greater number of locations had different attitudes and experience of their space.

3. Results

3.1. Building Overview

Looking collectively at all the offices, generally they were thought to be good for interaction and not so good for privacy (Figure 1). People reported that their office space supported interaction and awareness of colleagues. Offices were reasonably supportive of confidential conversations, confidential documents and working alone. They were not so good at reducing visual and acoustic distractions and being able to get away from colleagues. They were particularly bad for controlling interactions.

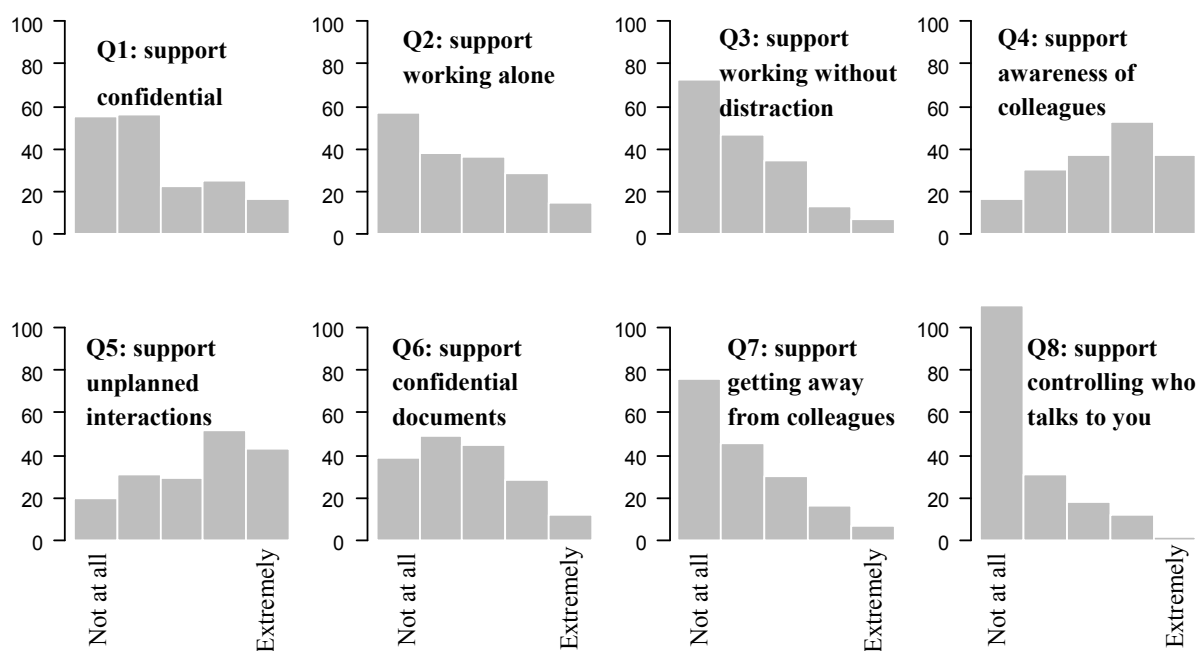


Figure 1. The degree to which all offices supported different behaviours. Overall the offices were thought to be good for interaction and not so good for privacy.

Participants had a mixed opinion of their work area (Figure 2); they thought it was neither private nor too crowded. Their concept of privacy was not opposite to crowdedness; most people rated their work area both unprivate and uncrowded. Neither did participants think they were too close to colleagues. Linear regression models confirm that people's response for too close, crowded and satisfaction with layout were all highly correlated, however, their perception of privacy was independent of these three responses. This suggests that whereas the perception of crowding is closely related to the number of people in a place the perception of privacy is not.

Figure 3 shows the frequency with which participants would like to carry out different types of privacy behaviour. People feel that they do not need to get away from colleagues as often as they would like to block visual distractions and control who comes up to them. The need for retreat is felt less strongly than the need to control distractions and interactions.

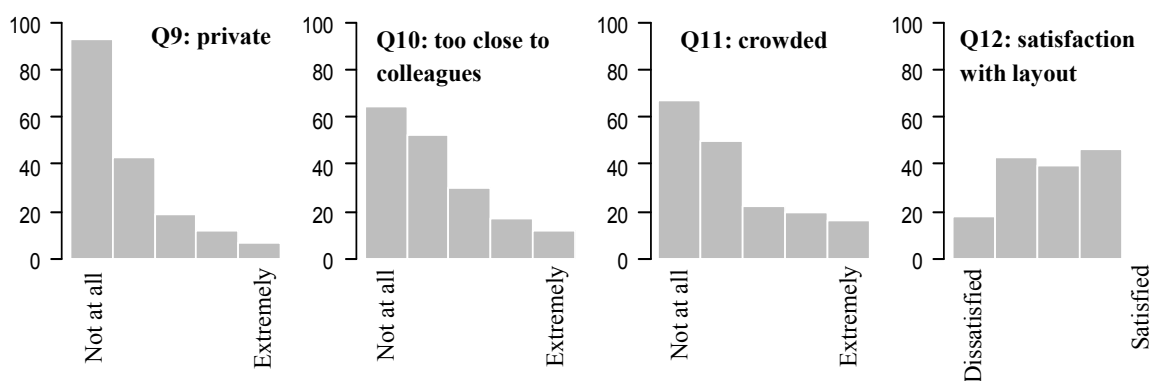


Figure 2. How participants across all offices felt about their personal work area. There is high correlation between crowdedness, feeling that people are too close and satisfaction.

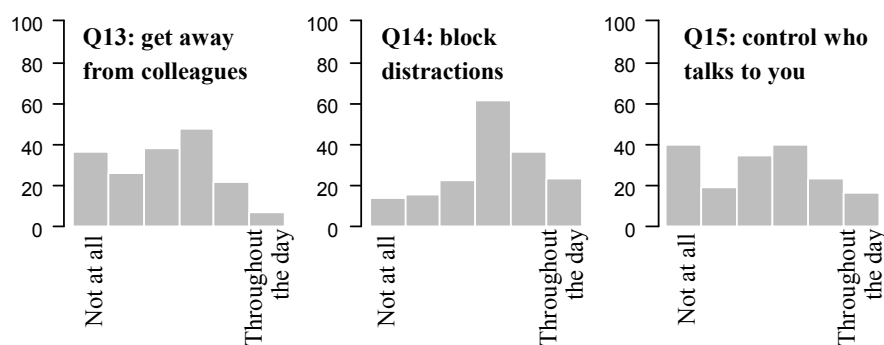


Figure 3. How often participants from all offices need to carry out privacy behaviours.

3.2. Office Typologies

Table 5 shows the different responses to questions 1 to 15 for the three different office typologies. For each question an ANOVA test was done to see if the averages were different for different typologies. Scores are highlighted in grey when one score was different from the other two; the two similar scores are highlighted, while the odd one out is not highlighted. A p -value of <0.1 was used instead of 0.05 because several tests were just short of the 0.05 significance level and the purpose of the highlighting is to show the similarity and differences between typologies as well as the significance of individual results.

Table 5. An overview of questions 1 to 15 about the experience of privacy, crowding and satisfaction (1 = Not at all, 5 = Extremely or Many times a day). Scores are highlighted where they are statistically similar to each other and different from the other score. SD: Standard deviation; MSE: Mean Square Error.

| Question | Type of Office | | | F-test | MSE | p-value | |
|--|--|--|---------------------|---------------------|--------------------|---------|-------|
| | Cellular and Small Office | Open Plan | Agile Workspace | | | | |
| In general how do your work arrangements support | confidential conversations | $M = 2.31$ ($SD = 1.41$) 95% $CI = 0.26$ | 2.00 (0.83) 0.32 | 2.71 (1.28) 0.28 | $F(2, 163) = 2.88$ | 1.68 | 0.06 |
| | working alone | 2.59 (1.51) 0.28 | 2.05 (0.94) 0.36 | 2.58 (1.11) 0.24 | $F(2, 162) = 1.47$ | 1.69 | 0.23 |
| | working without visual and acoustic distractions | 2.17 (1.84) 0.22 | 1.52 (0.87) 0.33 | 2.13 (1.12) 0.25 | $F(2, 162) = 2.88$ | 1.25 | 0.06 |
| | awareness of colleagues | 3.10 (1.33) 0.25 | 3.57 (1.21) 0.46 | 3.70 (1.09) 0.24 | $F(2, 161) = 4.55$ | 1.48 | 0.01 |
| | unplanned interactions | 3.02(1.39) 0.26 | 3.48 (0.93) 0.35 | 3.76 (1.24) 0.27 | $F(2, 162) = 5.88$ | 1.62 | 0.003 |
| | working with confidential documents | 2.62 (1.37) 0.25 | 2.05 (0.92) 0.35 | 2.74 (1.03) 0.23 | $F(2, 161) = 2.63$ | 1.41 | 0.07 |
| | getting away from colleague | 2.07 (1.33) 0.25 | 1.57 (0.75) 0.28 | 2.16 (1.01) 0.22 | $F(2, 162) = 2.09$ | 1.32 | 0.13 |
| | controlling interactions | 1.83 (1.18) 0.22 | 1.40 (0.68) 0.26 | 1.48 (0.81) 0.18 | $F(2, 160) = 2.8$ | 0.99 | 0.06 |
| | private | 2.17 (1.37) 0.25 | 1.43 (0.68) 0.26 | 1.58 (0.73) 0.16 | $F(2, 161) = 6.99$ | 1.17 | 0.001 |
| | too close to colleagues | 2.26 (1.31) 0.24 | 1.90 (1.09) 0.41 | 2.13 (1.06) 0.23 | $F(2, 162) = 0.76$ | 1.41 | 0.47 |
| | crowded | 2.33(1.45) 0.27 | 1.90 (1.34) 0.50 | 2.18 (1.08) 0.24 | $F(2, 162) = 0.93$ | 1.68 | 0.40 |
| | satisfaction with layout | 2.49 (1.00) 0.19 | 2.88 (1.02) 0.39 | 3.20 (0.93) 0.20 | $F(2, 137) = 7.62$ | 0.95 | 0.001 |
| | try to get away | 2.96 (1.45) 0.27 | 3.05 (1.40) 0.53 | 3.16 (1.48) 0.33 | $F(2, 165) = 0.32$ | 2.08 | 0.73 |
| | need to block visual and acoustic distractions | 3.96 (1.49) 0.28 | 3.90 (1.30) 0.49 | 3.85 (1.41) 0.31 | $F(2, 163) = 0.1$ | 2.03 | 0.90 |
| | like to control who talks to you | 3.58 (1.58) 0.29 | 2.67 (1.53) 0.58 | 2.87 (1.66) 0.36 | $F(2, 162) = 4.78$ | 2.52 | 0.01 |

The table shows when agile workspaces had a similar score to cellular offices and when they had a similar score to traditional open plan. Overall it can be seen that agile workspaces are unique. They are similar to cellular offices for questions related to control of information (Q: 1, 3, 6, 14). They were similar to traditional open plan offices for questions related to control of interactions with colleagues

(Q: 4, 5, 8, 15). All types of office were roughly the same in terms of retreat from colleagues (Q: 2, 7, 10, 13).

Agile workspaces were felt to be particularly good for having confidential conversations and as good as cellular offices for working with confidential documents. They were also considered to be as good as cellular offices for working without visual and acoustic distractions. However, they were considered less private than cellular offices. Interestingly people in open plan offices felt less desire to control who talks to them than people in cellular offices.

Overall all types of office were roughly the same in terms of retreat from colleagues (Q: 2, 7, 10, 13), which is counter to H1A. Agile workspaces are perceived as better than open plan offices for control of information (Q: 1, 3, 6, 14); this supports H1B. They were perceived as similar to traditional open plan offices for control of interactions with colleagues (Q: 4, 5, 8, 15), which supports H1C.

3.3. Time Spent in Office

People who come into the office fewer times in a week generally rate the features of their office the same as those who come in more during the week (Q: 1–12). Linear regression models between the time spent in the office (1–5 days) and these questions (1 = Not at all, 5 = Extremely) had no significance.

However, as seen in Figure 4, linear regression models between the time spent in the office (1–5 days) and the need for privacy behaviours (1 = Not at all, 6 = Throughout the day) show some correlation. Mobile workers have different requirements for different privacy behaviours (Q: 13–15). The mobility of the worker does not affect the need to get away from colleagues (H2A), neither does it affect how often they wish to block acoustic and visual distractions (H2B). However, there is a clear correlation between mobility and the degree to which control of interactions is needed (H2C) (Table 6). These results show that the less a person is in the office, the more they want to control who approaches and interacts with them. This result goes against H2A, supports H2B, and suggests an opposite effect than predicted by H2C. This suggests that mobile workers find it difficult to adapt to the office when they are there.

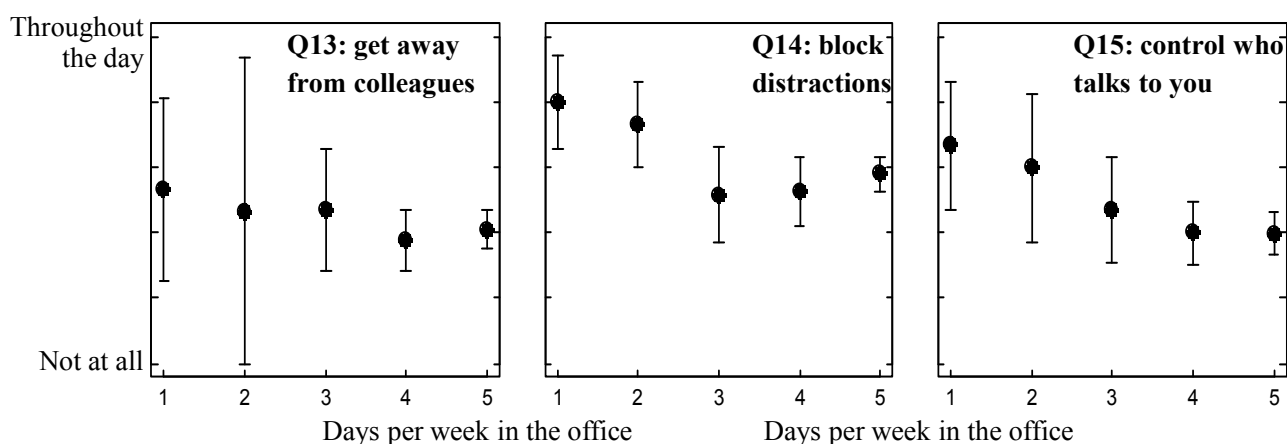


Figure 4. How the need to carry out privacy behaviours changes for people who spend a different number of days in the office each week. People who spend less time in the office feel a greater need to control interactions.

Table 6. Summary of regression model between the number of days in the office and the need to carry out privacy behaviours, a_0 is the model intercept; a_1 is the model gradient.

| | Measure | a_0 | a_1 | p -value | R^2 |
|------------------|--------------------------------|-------|-------|------------|-------|
| How often do you | get away from colleagues | 3.59 | 0.12 | 0.31 | 0.007 |
| | need to block out distractions | 4.40 | −0.12 | 0.28 | 0.008 |
| | like to control interactions | 2.30 | −0.27 | 0.03 | 0.03 |

3.4. Number of Alternative Work Locations

People who worked in a greater variety of (non-office) locations rate the features of their office the same as those who come in more during the week (Q: 1–12). Linear regression models between this measure of mobility (0–5 other places worked at during the week) and measures of experience of privacy and crowding (1 = Not at all, 5 = Extremely) have no significance.

However, as Figure 5 shows, people who work elsewhere do have different requirements for privacy behaviours (Q: 13–15). This was confirmed by testing the linear correlation between measure of mobility (0–5 other places worked at during the week) and privacy behaviours (1 = Not at all, 6 = Throughout the day). There is a significant correlation between mobile working and the desire to get away from colleagues and control interactions (H2A and H2C). There is not a strong correlation between mobile working and wanting to block distractions (H2B) (Table 7). This supports H2B, and suggests an opposite effect than that predicted by H2A and H2C. This suggests that mobile workers experience differently the perceptions of interactions but not the perception of distractions from environmental stimuli.

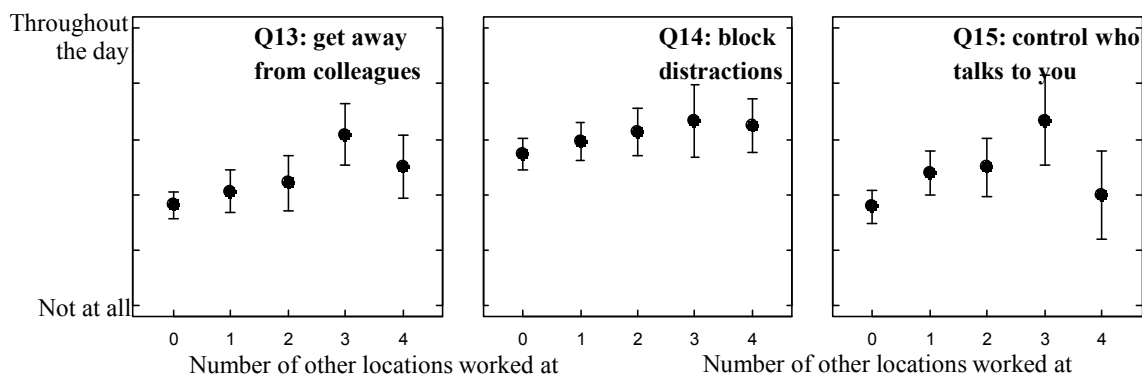


Figure 5. How the need to carry out privacy behaviours changes for people who work in different numbers of places. People who spend less time in the office feel a greater need to control interactions.

Table 7. Summary of regression model between the number of alternative work locations and the need to carry out privacy behaviours.

| | Measure | a_0 | a_1 | p -value | R^2 |
|------------------|--------------------------------|-------|-------|------------|-------|
| How often do you | get away from colleagues | 2.80 | 0.28 | 0.01 | 0.04 |
| | need to block out distractions | 3.77 | 0.17 | 0.10 | 0.02 |
| | like to control interactions | 2.90 | 0.33 | 0.004 | 0.05 |

3.5. Possible Co-Correlations

A linear regression model showed that there is a highly significant negative correlation between the two measures of worker mobility ($p < 0.001$). An ANOVA showed that different typologies had no significant difference in mean days in the office ($F(2, 137) = 0.7$, $MSE = 0.76$, p -value = 0.50) and a nearly significant difference between the mean number of other places worked ($F(2, 215) = 2.0$, $MSE = 0.94$, p -value = 0.14).

Age, gender and work role were investigated to see if they had a significant effect on any of the averages recorded. They all showed an effect on Q8, while age also had an effect on Q9. Gender and work role had no significant effect on the number of days in the office but both had a significant effect on the number of other places the person worked at. Age had no significant effect either on days in the office or other places worked at.

3.6. Field Characteristics and Barriers

3.6.1. Field Characteristics that Exacerbate Problems

Participants were asked what conditions and features of their offices caused privacy and crowding problems. Environmental noise was reported as a problem, in particular external vehicular traffic and a lack of background noise to mask activity in the office. Noise from neighbouring areas was also a problem, including: toilets, corridors, tea points, break out space and reception areas.

Forms of communications were a problem. Too many phone calls bothered some people. People shouting across the office was mentioned, as were people with particularly loud voices. Finally some people felt that work cultures, interactions and “friendly offices” contributed to a lack of privacy.

Finally, particular building features were seen as problematic, including, lack of sound insulation and sound absorption material, the co-location of different types of work activities, lack of space for private conversations and the size of desks. Sight lines were another problem mentioned: looking away from the group meant that one’s computer screen was overlooked, looking into the group meant one was distracted by goings on.

3.6.2. Field Characteristics that Improve the Problem

Having somewhere else to go such as high-sided seating and quiet rooms improved the situation. Also the ability to signal to colleagues when distractions were unwelcome.

3.6.3. Coping Mechanisms

There were many different coping mechanisms. These included changing one’s environment, either by altering it such as using blinds or closing windows or moving to another space entirely; signalling to other people that interruptions were not wanted, either by telling people directly or using headphones; changing oneself, by going out for a walk to taking a break, making oneself “just concentrate harder”, or taking calls away from their usual workstation; finally people schedule work time so that difficult work was done during quiet times, such as the early morning or evening or in a quiet place such as at home.

Not all these mechanisms can always be employed though. Open door policies were reported as problematic. In some offices it is frowned upon to listen to music through headphones. Other people identified a lack of alternative space to work from. All of these stopped people employing their preferred coping mechanism.

3.6.4. Comparing Features across Typologies

Table 8 compares the presence and relevance of different features across the three office typologies. They are categorized according to those that worsen building performance, those that improve building performance and the techniques used to manage reduced privacy. Their relevance to the different office typologies studied has been recorded on the right hand side of the table. This was judged by the researcher from their knowledge of the buildings studied and the participant's responses to the open questions. The greater the number of stars a feature is given the more relevant it is considered for a particular typology.

Table 8. Features that affect the perception of privacy and crowding and their relevance to different office typologies.

| Features | Relevance of Feature to Type of Office | | |
|--|--|-----------|-------|
| | Cellular | Open plan | Agile |
| Poor field characteristics | | | |
| External vehicular noise | ** | ** | ** |
| Lack of masking noise | ** | * | * |
| Internal noises: toilets, corridors, tea points, break out space, reception area and co-location of different types of work activities | * | ** | ** |
| Communication methods: loud voices, shouting, phone calls, overly friendly | * | ** | ** |
| Physical characteristics: sound insulation and absorption material. A lack of space for private conversations. Size of desks. Sight lines. | * | ** | * |
| Good field characteristics | | | |
| Alternative locations to work from | * | * | ** |
| Methods to signal when privacy is needed (alternative locations, signage) | ** | * | ** |
| High sided seating on meeting areas | * | * | ** |
| Coping mechanisms | | | |
| Changing the environment (opening and closing windows, blinds and doors) | ** | * | * |
| Changing oneself (taking a break, taking phone calls out of the office) | ** | * | *** |
| Signalling need for privacy | ** | * | ** |
| Scheduling work for specific times (such as end or beginning of the day) | ** | ** | ** |

Note: Relevance to the different office typologies: * Low, ** Medium, *** High.

The responses suggest that some of the features distinguish between typologies. These are items such as communication methods that is a problem for the open plan and the agile space but not for cellular offices. Another such feature is having high-sided seats in meeting areas and alternative work locations. These features can contribute to the definition of typologies (in this case cellular offices and agile workspace respectively). Other features are equally relevant to all typologies. These are items such as external vehicular noise and scheduling work for specific times of the day. The features that

are equally relevant to all typologies can be used to open up sub-typologies of offices. For instance, open plan offices with external vehicular noise is a different sub-typology from open plan offices without external vehicular noise.

4. Discussion

This study raises a variety of points about agile working. It has shown that agile workspace is a distinct typology; the experience of which is different from both traditional open plan and cellular offices. These typologies are defined by characteristic features that are unique to them. There is also a range of typology crossing features that can be used to define sub-typologies. In addition to the findings about typologies it has been shown that mobile workers actually have a greater desire for privacy than their less mobile colleagues. Taken together these results suggest that to understand the experience of privacy and crowding it is necessary to go beyond a simple measure of density. Instead a detailed understanding of features, typologies and users is required.

Mobile working was predicted to not change occupants' need for information control while reducing their need for control of interactions and their need to retreat from co-workers. This seemed plausible because worker mobility would provide opportunities for the latter two. The hypothesis held for the need for information control. However, contrary to what was expected, mobile workers have an increased need for control of interaction and need to retreat. This suggests that mobile workers tend to feel the negative effects of density more than stationary workers. This could be because those who work at the office less often find it difficult to adjust to the high levels of interaction that occur in offices, or that their fleeting appearances encourage a greater number of disturbances. If this is the case it would have important impacts for how offices should be designed. Offices where mobile working is encouraged may wish to improve methods for controlling interactions.

However, the causation could be opposite, and people who have a worse experience of privacy may be driven to work away from their office more. This behaviour was reported a number of times in the open response question, when people described working at home and outside office hours as one way that they managed privacy issues. It is a serious problem if distraction and lack of privacy are forcing people out of their place of work.

It should be noted though that the R^2 correlation coefficients of the regression model were low. So even though there was a significant relationship found, the results here should be used with some caution. They can only be said to apply over large groups of occupants and there may be other, as yet unknown, factors that could confound the relationship observed here.

Another weakness is the measure of worker mobility used here. Firstly most of the people surveyed had assigned desks therefore their mobility is not as high as it could be. Secondly for the people surveyed their mobility varied with a range of other factors therefore it is possible that findings may be attributable to a co-factor such as job role or organization type. Future investigations should prioritize inclusion of highly mobile workers to further test their experience of density and ensure other factors are more tightly controlled.

The results here support the idea that agile workspaces are a distinct typology separate from traditional open plan and cellular offices. The experience of privacy and crowding for their occupants has some aspects of both open plan and cellular offices. They are similar to cellular offices because

they improve the ability to work with private documents and free from visual and acoustic distraction; both of these are forms of information control. They are similar to open plan offices because they improve awareness of colleagues and enable signalling to control unplanned interactions; these are both forms of interaction control. Finally they are about the same as both cellular and open plan in the degree to which occupants can get away from colleagues when greater focus is needed. Although for many questions about getting away from colleagues agile workspaces are rated better than either cellular or open plan offices, the difference is not quite significant. In summary it would seem that agile workspaces are similar to open plan regarding their control over interactions, similar to cellular in terms of control of information and almost unique in terms of their ability to provide quiet places away from colleagues. Apart from the lack of significance in one of these conclusions, the results confirm the hypotheses (H1) about the agile workplace typology.

Agile workspaces are perceived as different because they have distinctive features that the two conventional typologies do not. They make it easy to leave one's desk to make phone calls and have small meetings. Combined with specially designed furniture this results in less noise and disturbance for those engaged in solitary work. They also provide somewhere else to go to work as required. This not only allows people to avoid sources of distraction but sends a clear signal that they do not wish to be disturbed. It is these features that make the experience of agile workspaces different from the other typologies.

A weakness of this study is the applicability of typological profiling, drawn from a sample of just six buildings. In the typological analysis there were only two buildings for each type. This gives a reasonable possibility that some other unique factors may be able to explain the differences seen between the offices. In addition the cellular offices studied here had some open plan elements; although they did appear to offer their occupants a distinctly different experience. However, it is remarkable that generally the two conventional typologies formed extreme cases, and agile workspaces were similar to either one or the other. There was no score where agile workspace was the odd one out and the other two types had similar scores. It would be remarkable if there was another underlying factor that behaved in this way across all six buildings.

This work also shows that the division of privacy into three primary elements (of information control, interaction control and withdrawal) is useful and supports analysis and understanding. However, it should be considered whether the category of information control could be further split down into distractions from the real world (environmental noises and movement) and the virtual world of computers (emails, electronic alerts and notifications). Some of the features of agile workspace cut across all three of these primary elements; for example having an alternative location to work from, can provide both a place to withdraw to and allow control of interactions. While some features of agile workspaces, such as high-backed chairs, help to control information flow but don't necessarily allow for improved control of interaction or need for withdrawal. Agile workspace are composed of a number of unique features, each of these affects a different element of privacy; when combined these features set agile workspace apart from conventional offices.

Having agile space doesn't change the density of workstations or the features of the immediate vicinities of people's desks. It changes an area remote to where people work, it changes how people work. That this can have an effect on experiences of privacy and crowding shows that a density metric is not sufficient to understand privacy requirements. To fully understand a person's experience of a

spatially constrained office it is necessary to understand the configuration of an office and what it enables them to do.

There will always be financial pressure to increase occupant density. Generally this is considered a bad thing for people's experience. Nobody likes the idea of being crammed into a building, closer and closer to one's neighbour. However, it has been shown that this all-important space efficiency metric is not the only factor that is important for privacy, crowding and satisfaction. By understanding important and salient design features it may be possible to alleviate some of the negative consequences of density while still reaping the benefits.

5. Conclusions

This study has answered the specific hypotheses and it has also contributed to knowledge about the relationship between measurements of density, spatial constraints and feelings of privacy, crowdedness and satisfaction. The experience of privacy and crowding in agile workspaces is distinct. They are similar to cellular offices when considering the perception of information control, whereas they are similar to open plan offices when considering the control of interaction. This suggests that agile workspaces renegotiate the trade-off between interaction and privacy. They improve interaction, as documented elsewhere, and improve aspects of privacy. They do this because they offer features (such as a variety of space) that can be used for either private work or collaborative endeavours.

Occupants with increased mobility were found to have an increased desire for privacy. This was counter to what was expected. It suggests that either privacy issues are pushing people to work out of the office or that increased mobility increases the need for privacy in the office. Both of these suggest that privacy and mobility are intimately linked and that design for mobile workers should take greater account of crowding and privacy issues, especially the need for control of interactions. However, the measures of worker mobility used in this case could be improved.

It is very interesting that agile workspaces improve privacy but mobile working makes it worse. This suggests that to get the best out of agile workspaces close attention should be paid to the improvement of privacy in the office. Firstly to ensure that agile workspaces do not encourage counterproductive over-mobility and secondly to ensure that possible negative side effects of mobile working are alleviated.

This work reiterates that density metrics are not the only important factor for understanding the experience of privacy and crowding. Typologies and features of the office are also important. Here we have shown that using agile workspaces affects certain aspects of the experience of privacy and crowding. Specifically it affects the perception of information control but not interaction control, when compared with open plan. This suggests that designers can use specific interventions, such as ensuring space for private conversations and alternative space to work from, to reduce some of the negative experiences associated with density.

The study began by highlighting the different ways to characterize the experience of density and spatial constraints on interaction. The strong correlation between feeling crowded, thinking yourself too close to colleagues and satisfaction with layout supports the notion that crowding is the same as the need for withdrawal, and this is but one element of an occupant's need for privacy. Being able to break

down these separate components of the privacy experience and respond to them through novel approaches will enable designers to resolve the age-old trade-off between privacy and openness.

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Author Contributions

The study is based on Trevor Keeling's EngD research work. Trevor Keeling was responsible for the research design, data collection and analyses. Derek Clements-Croome and Etienne Roesch provided invaluable guidance and supervision respectively, throughout the research.

Conflicts of Interest

The authors declare no conflict of interest.

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