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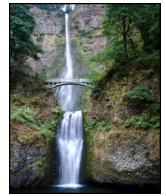
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The End of Sitting: How middle-aged employees use and experience a new activity-inducing office over time



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ABSTRACT

Rietveld-Architecture-Art-Affordances acknowledged the public health concern of sitting too much and developed The End of Sitting—a workspace without chairs that provides a variety of supported standing positions. In the current study middle-aged office workers were to use the End of Sitting for one hour per week over a ten-week period. Over time, participants reduced their changes between locations in one session while working, yet they still worked in different locations and postures at the final work sessions. In addition, we found that the self-reported office task performance (concentration, quality of work, productivity), mood (energized, well-being, pleasantness) and postural comfort were not negatively affected by working in this new office environment compared to their conventional workplace. This indicates that the End of Sitting should be taken seriously as an alternative office for regular office workers.

1. Introduction

Many office workers spend the majority of their working hours sitting, often in prolonged unbroken bouts (e.g., Buckley et al., 2015; Parry & Straker, 2013). In response to the evidence on the adverse health consequences of extended sitting (e.g., Biswas et al., 2015), recent public health recommendations state the importance of reducing sedentary time and promoting regular changes in posture (e.g., Buckley et al., 2015).

Studio RAAAF (Rietveld-Architecture-Art-Affordances) acknowledged that the typical office design with its chairs and desks solicits sedentary behavior and therefore, created an activity-inducing work environment. As the name of the studio indicates, RAAAF is inspired by Gibson's concept of affordances. Gibson (1979/1986) introduced this concept to refer to the possibilities for action in a certain environment. Consequently, RAAAF conceives of architectural intervention as the creation of affordances—with their rock-like sculpture, called “The End of Sitting” (EoS), they created a variety of possibilities for supported standing (see Fig. 1; see also Rietveld, 2016). Moreover, each location was designed to offer only temporary comfort to induce frequent postural changes. Ever since the introduction of this new office landscape, several empirical studies have tested its potential benefits (Caljouw, De Vries, & Withagen, 2017; Renaud, Huysmans, Speklé, van der Beek, & van der Ploeg, 2017; Withagen & Caljouw, 2016). In the first observational study of the use of this workspace, Withagen and Caljouw

(2016) indeed observed that most participants (83%) adopted more than one non-sitting posture at different locations when they worked in the EoS for 75 min. Contrary, in a conventional office, all but one participant worked sitting on the same chair for the whole work session. Interestingly, after working in the EoS, participants reported that even though their legs felt more tired, they also felt more energetic than after working in the regular office.

Although these results seem promising, the study of Withagen and Caljouw (2016) had two important limitations. First, the participants in that study were relatively young ($M = 21.7$, $SD = 3.0$), rendering it hard to generalize their findings to typical office workers. Second, the participants worked in the landscape for only 75 min. Hence, the postural changes and movements through the EoS that were observed in their study may simply reflect exploratory behavior to search for an optimal spot and may thus be a novelty effect. In the current study, we aim to overcome both limitations—we observed how middle-aged office workers used and experienced the EoS over a longer period of time. Although the office workers were to work in a smaller cut-out version of the original landscape, this cut-out also affords one to work in many different postures, allowing us to examine the behavior and experience of middle-aged office workers. Specifically, we explored the following research questions: How often do employees change location in EoS? Which locations do they use? How do they experience working in EoS? And most importantly, how do the office workers change in their use and experience of this new office environment over time?

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Fig. 1. The End of Sitting original (left) and cut-out (right).

2. Method

2.1. Participants

Eighteen regular office workers (8 males and 10 females) with an age range from 23 to 64 years old were recruited from the organizations that use the open-plan office where the EoS is placed. Participants had no assigned desk and no prior experience with working in the EoS. Four persons dropped out in the first weeks for organizational reasons (not because of physical inconvenience). The remaining participants ($M_{age} = 45.5$ years, $SD_{age} = 14.2$; $M_{height} = 1.78$ m, $SD_{height} = 0.07$; $M_{weight} = 74$ kg, $SD_{weight} = 15.2$) reported that they worked at the office on average 30.5 h (SD 7.5) per week and spent on average 11.4 h (SD 2.2) per day sitting. The majority (83%) reported that they spent at least 30 min of moderate activity five days per week. All participants volunteered and signed informed consent. The study was approved by the institutional ethical board.

2.2. Study design and data collection

The End of Sitting-Cut Out, $1.8 \times 11.5 \times 2.10$ m, was placed in an office with chairs and desks around it. The desks in the entire office were flexibly used by different workers at different times. For a period of 10 weeks participants were to work an hour every week in the EoS—they were asked not to use it at any other time during the week. Before the first work session participants were introduced to the landscape and explored the landscape for a few minutes. We restricted the number of participants working in the EoS at the same time to a maximum of three.

Participants completed a questionnaire before and after the first, fourth, seventh, and tenth EoS sessions to evaluate the work experience of, the conventional desk (where they had just worked) and the EoS, respectively. The questionnaire (see Fig. 2) was inspired by a validated questionnaire (Helander & Zhang, 1997) that aimed to do justice to the distinction that is made between comfort (well-being and aesthetics) and discomfort (biomechanics and fatigue) and included items that were similarly scored in a previous study on the EoS (Withagen & Caljouw, 2016).

Two video cameras recorded all work sessions. Observer XT Version 11.5 (Noldus Information Technology, Wageningen, The Netherlands) was used to code the adopted location in 15 s intervals (see Fig. 5 for the 10 categories). To determine whether the observations were sufficiently reliable, four observers all coded the same randomly selected session for each participant (10% of the entire dataset). The computed Cohen's kappa between the scores of one of the authors and the other three observers demonstrated that the inter-rated reliability was good (between 0.989 and 0.998).

An additional observation session of 1 h evaluated how workers used the space around the EoS. They were asked to work at the desks and not in the EoS. Every 15s the adopted location was coded (i.e. sit at a certain desk, changed to another desk, not at a desk or outside observation space).

I was able to concentrate well when working in the office space

strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
1	2	3	4	5
6	7	8	9	

My work productivity was good

strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
1	2	3	4	5
6	7	8	9	

The quality of my work was good

strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
1	2	3	4	5
6	7	8	9	

I found it pleasant to work in the office space

strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
1	2	3	4	5
6	7	8	9	

I have worked in a comfortable body posture

strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
1	2	3	4	5
6	7	8	9	

The workplace supports my well-being

strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
1	2	3	4	5
6	7	8	9	

I feel energetic after working in the office space

strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
1	2	3	4	5
6	7	8	9	

I think the design of the office space is beautiful

strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
1	2	3	4	5
6	7	8	9	

My legs got tired when working

strongly disagree	disagree	neither agree nor disagree	agree	strongly agree
1	2	3	4	5
6	7	8	9	

Fig. 2. The translated work experience questionnaire (original in Dutch). Participants encircled a number to score each item.

3. Results

A Friedman test on the number of location changes within the EoS with Session as a factor revealed a significant effect ($\chi^2(9) = 18.03$, $p = .03$). A follow-up stepwise step-down procedure indicated that participants changed location significantly less in session 10 than in session 1 (see Fig. 3). In all sessions, half or less than half of the participants moved out of the EoS at least one time to get a coffee, visit the toilet, etc. A Friedman test revealed no significant difference between sessions in the number of transfers to a location outside the EoS ($\chi^2(9) = 6.69$, $p = .67$). When working for an hour at a desk in this

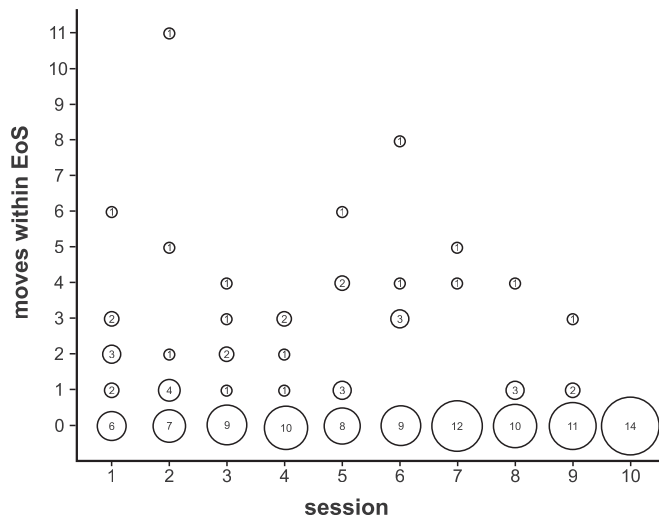


Fig. 3. The size and number in the circles indicate the number of participants with a certain number of relocations within the EoS per session.

office, people spent on average 99% (range 92–100%) of their time sitting at the same desk. One office worker spent 15 s sitting at another desk. Six workers left their desks for a short while during the session.

The fact that hardly any of the participants switched locations during the final work sessions does not necessarily imply that the participants found their favorite location in the landscape, and that all of the switches observed in earlier sessions were just explorations of the landscape. Indeed, participants might still work at different locations at different sessions. To test whether this happens, we counted the total number of locations that participants worked at in the beginning (sessions 2–4), the middle (sessions 5–7), and the end (sessions 8–10) of the ten-week period. We decided to group these sessions together because the questionnaires were filled in at the end of these experimental phases, allowing us to compare the experiences and the number of locations used. Session 1 was not included in this analysis. Fig. 4 displays how many locations of the EoS were used in the different experimental phases. A Friedman test with Time (beginning, middle, and end sessions) as a factor revealed no significant differences ($\chi^2(2) = 0.8, p = .67$). Hence, although the participants hardly switched within a work session at the end of the ten-week period, they still worked at different locations in the final work sessions.

Fig. 5 depicts the percentage of time and the number of participants who worked at the different locations in each of the experimental

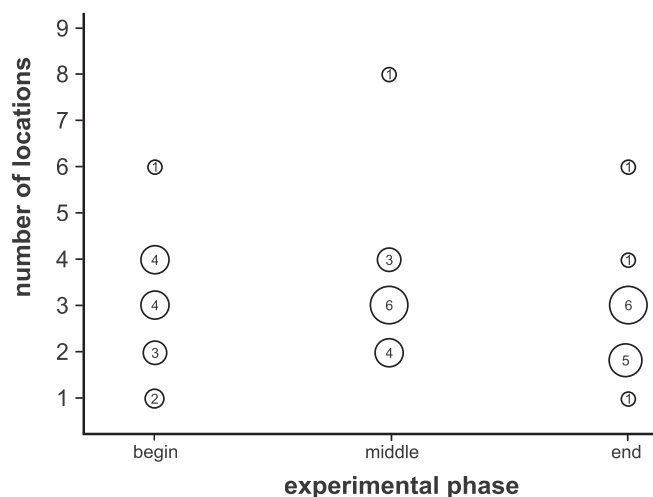


Fig. 4. The size and number in the circles indicate the number of participants who used a certain number of locations within the EoS per experimental phase.

phases. It reveals that in all sessions the locations 2, 3, 4 and 5 were hardly used or not at all.

Table 1 presents the work experience questionnaire outcomes. To test whether there were differences between the regular office and the EoS, we compared the scores on each item in sessions 1, 4, 7, and 10. Wilcoxon signed-rank tests indicated a significant difference between the EoS and the conventional workplace for the perceived tiredness of the legs in each of the four sessions ($z_s > 2.37, p_s < .05$). Only in the initial session a significant difference between the workspaces was revealed for energy level ($z = -2.406, p = .016$). People felt more energized after working in the EoS. This difference was no longer significant in the subsequent sessions. On all of the other items, no significant differences between the workplaces were found. Friedman tests on the gain scores after working in the EoS compared to a regular workplace revealed only a significant difference between the four sessions for the item “I found it pleasant to work in the office space” ($\chi^2(3) = 11.05, p < .05$). A follow-up stepwise step-down procedure indicated that the gain score was higher in session 4 compared to session 7 and session 1. Apparently, compared with a conventional workspace with chairs and desks, we found no negative effects on perceived task performance and mental state while working in the EoS.

4. Discussion

The current study examined how office employees use and experience the End of Sitting while working there for one hour a week over a ten-week period. In an earlier study (Withagen & Caljouw, 2016), the authors observed that the vast majority of their relatively young participants changed locations in the EoS within a 75-min work session. In the present study, we examined whether these changes were not simply a reflection of exploring the landscape, and whether the employees with a mean age of 45.5 years used and experienced the landscape in a similar way as the young participants ($M = 21.7$ years) did in the previous study.

Arguably, the most interesting finding of the present study is that, although the sample size was relatively small, over time there is a significant decline in the number of location switches within a work session. In the final work sessions of the ten-week period, hardly any participant changed to another location in the EoS. This suggests that the switches previously observed by Withagen and Caljouw (2016) and also observed in the initial work period of this experiment, were indeed a reflection of exploring the landscape. Hence, the location switches that the designers of RAAAF intended to induce with their new office landscape extinguish over time, at least in the EoS cut out. However, interestingly, the participants in the present study did not have a favorite location that they continuously returned to in the final sessions. Indeed, even in these sessions, participants worked at different locations. Thus, although the EoS cut-out did not induce location switches within the work sessions of an hour, the landscape resulted in participants working in different postures at different sessions.

Another pertinent finding of the study is that several locations in the EoS were hardly used by the participants. Although Withagen and Caljouw (2016) found that some young participants spent some time in locations that afford a more reclined posture (e.g. lying on their belly or back or curled-up with the buttocks on a sloped surface and the feet braced against the opposite wall), these locations were rarely used in the present experiment. Instead, locations with trunk and buttocks support were preferred. Incidentally, the locations that support upright standing with trunk support were previously found to increase energy expenditure and heart rate compared to sitting on a chair (Caljouw et al., 2017). In line with the findings of Withagen and Caljouw (2016), scores on the work experience questionnaire indicated no significant reduction in levels of concentration, quality of work, or productivity when working in the EoS. Future studies should use more objective measures for productivity and quality of work to affirm the questionnaire self-reports. Although the reported postural comfort was not

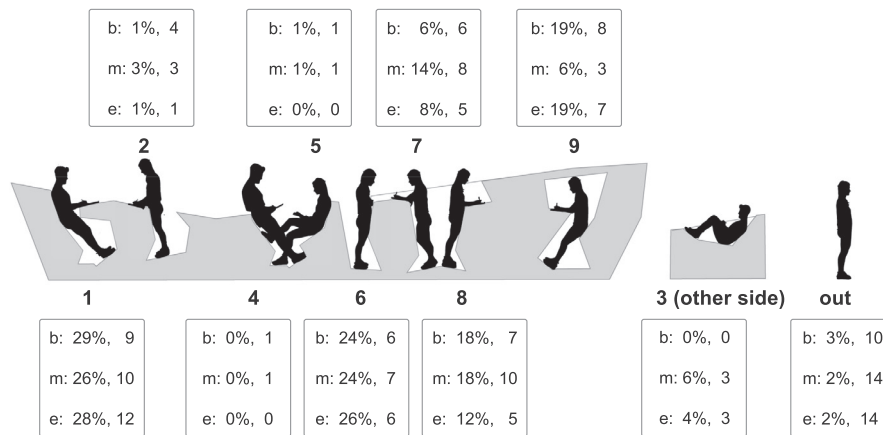


Fig. 5. A side view of the cut-out with the percentage time and number of participants who worked at the different locations in each of the experimental phases (b: begin, m: middle, e: end).

Table 1
Medians (and 25th and 75th percentiles) of participants’ scores on the 9-point Likert scale for each item in both office spaces for the four sessions.

	Session 1 (n = 14)		Session 4 (n = 13)		Session 7 (n = 14)		Session 10 (n = 14)	
	regular	EoS	regular	EoS	regular	EoS	regular	EoS
Concentration	7 (5.75–7)	7(6–8)	7(4–7.5)	7(6.5–7.5)	7(6–7.2)	7(7–8)	7(5.75–7)	7(6–7)
Productivity	7(6.75–7.25)	7(6–7.25)	6(5–7.5)	7(7–8)	7(6–7.3)	7(7–8)	7(6.5–7)	7(6–7)
Quality	7(7–7.25)	7(7–8)	7(5–8)	7(7–7)	7(6.75–7.25)	8(7–8)	7(6.75–7.25)	7(6–7)
Pleasant	7 (6–8)	7(4–7)	5(3.5–7)	7(5–8)	7(6–7)	6.5(5–7)	7(6–7)	6.5(5–7)
Wellbeing	6.5 (5–7.25)	7 (5–7)	6(4–7)	6(4.5–7)	6.5(5.75–7)	6(4–7.25)	6(5–7)	6(4–7)
Energy	5 (4–5)	7(5–7.25)	4(3–6.5)	6(4.5–7)	5.5(5–7)	7(4.75–7)	5.5(5–7)	6.6(5–7)
Design	4 (3–4.25)	5.5 (3.75–7)	6(4.5–7)	6(4.5–7)	5(3.75–6)	6(4–7)	5.5(4–6)	5.5(4–7)
Tired legs	3 (1–4)	5 (3–7)	3(2–3)	6(4–7)	3(2–3)	5.5(3–7.25)	3(3–3)	6.5(4–7.25)
Posture	7(6–7)	5.5 (4–7)	7(5–7.5)	6(4–7)	7(6–7.3)	6(4–7.25)	6.5(6–7)	7(4–7)

significantly reduced when working in the EoS, participants reported having more fatigued legs. The reported discomfort in the legs suggests that concerns related to prolonged standing in EoS should be taken seriously. Previously, young adults reported that they found it more pleasurable to work in the EoS and that it contributed to their well-being and energy level compared to a conventional workspace (Withagen & Caljouw, 2016). In contrast, the scores on well-being, energy level and appreciations of the design were somewhat lower in the current study. Also, only after working in the new design for the first time, employees felt more energetic than the previous hour at their regular workplace. Perhaps a larger landscape filling the entire office space is aesthetically more impressive and energizing than the current cut-out. Another option is that the relatively young and physically fit adults who participated in the previous study are more open to an activity-inviting office environment than typical office workers. Yet, the fact that we did not find significant differences between the EoS and the regular workspace on all but two items of the questionnaire indicates that the EoS cut-out should also be seriously considered as an alternative office for regular office workers.

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