Stairway to Health: Fine-tuning a Feasible Stair Climbing Nudge and Exploring Residual Effects After Nudge Removal

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Abstract

Enhancing the use of stairs over elevators can have important health and sustainability benefits. Nudging – a libertarian behaviour change method – is a promising tool for promoting stair climbing. This study examined if a cheap and simple nudge could increase stair climbing among students and employees of Utrecht University and if the effect would persist for four weeks after nudge removal. The intervention included point-of-choice prompts, deterring posters, and salient green footsteps. A simple time-series design was conducted over 8 weeks and data were collected before, during, and after the intervention. Stair and elevator traffic was observed with the use of video footage. In total 1992 observations were made. Chi-square tests were applied to compare each study phase against baseline measures. Results showed that the baseline stair climbing rate (11.9%) had a statistically significant increase of 5.0% over the intervention period and that this effect remained stable during the four weeks after nudge removal. The modest effect produced by the intervention shows promise for promoting stair climbing at worksites. The residual effect is a first indication that the behaviour change triggered by the nudge is sustained. Future research is required to establish whether this long-lasting behaviour change is mediated by the formation of new stair climbing habits.

Keywords: Physical activity, Sustainability, Nudging, Observation, Stair climbing.

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In our modern sedentary world, only a third of the population meets the guideline of 30 minutes of moderate exercise per day (Hallal et al., 2012; Pate et al., 1995). Lack of exercising forms a risk factor for noncommunicable diseases (e.g., cardiovascular diseases, hypertension, diabetes mellitus), premature mortality, and decreased psychological well-being (WHO, 2017, 2018). Because most adults generally struggle to find time for exercising, recent focus has been placed on the promotion of an ‘active lifestyle’ (WHO, 2018). An active lifestyle is one in which casual opportunities for exercising are utilized (e.g., taking the bicycle instead of the car to work), resulting in bursts of movement that can accumulate up to sufficient activity levels throughout the day (Boreham et al., 2005). Since most adults spend approximately half of their waking hours at work or school (Dishman, Oldenburg, O’Neal, & Shephard, 1998), the work or study site is considered a key setting for promoting active lifestyles.

A feasible, low-key way to insert more activity into daily routine is via stair climbing. Regularly taking the stairs has been associated with a reduced blood pressure, weight loss, and increased cardiovascular fitness (Andersen et al., 2013; Boreham et al., 2005; Boreham, Wallace, & Nevill, 2000). The distinction between stair ascent and descent, however, is important to note; stair ascent requires three more times the energy expenditure compared to resting state (9.6 MET, equivalent to jogging) than stair descent (3.2 MET, equivalent to slow walking; Ainsworth et al., 1993; Teh & Aziz, 2002). Hence, only climbing up stairs is considered to be a vigorous activity, of which just seven minutes a day have been related to 62 percent less coronary deaths (Yu, Yarnell, Sweetnam, & Murray, 2003). Climbing down stairs has on the other hand a neglectable impact on health, as it does not require more energy than regular walking. The current study therefore only focusses on stair ascent.

Because for most people stair climbing is a regularly repeated behaviour in an unchanging context, it quickly stops requiring conscious thought and becomes automatic (Verplanken & Wood, 2006). Indeed, stair climbing has been shown to be habitual and mostly processed via peripheral routes of decision making (Bargh & Gollwitzer, 1994). In the current 'obesogenic' environment, however, elevators and escalators tempt people with an easier alternative to climbing stairs. Staircases are often – especially in buildings built in the 20th century – hidden and more difficult to locate than lazier alternatives (Engbers, 2007; Eves & Webb, 2006). By promoting elevator use over stair climbing, this type of infrastructure facilitates the formation of suboptimal habits. That is, when people repeatedly opt for the elevator rather than the stairs, cognitive associations form between the repeated behaviour and the context, so that eventually entering the building or elevator hall will automatically trigger elevator use (Aarts & Dijksterhuis, 2000a, 2000b; Wood, Tam, & Witt, 2005). The tendency of automatically choosing the elevator over the stairs is detrimental for two reasons: 1) taking the elevator equals a missed chance to gain health benefits, and 2) elevators consume up to 25 percent of the total energy usage in large buildings (Sachs, 2005; Liu, Qiao, & Chang, 2010), therefore adding to greenhouse gas emissions. As stairs form a healthy and sustainable alternative to elevators, their use in offices and educational buildings should be promoted.

The Use of Nudging

In order to change habitual, context dependent behaviour, modifying the environment is crucial (Engbers, 2007; Foster & Hillsdon, 2004). Traditional behaviour change methods – which focus on enhancing knowledge, skills, attitudes, and motivation – have repeatedly shown to be insufficient to engender true behaviour change (e.g., Rhodes & de Bruijn, 2013; Sheeran, 2002; Webb & Sheeran 2006). Although educational methods often establish intentions to change behaviour, these do not often convert to actual behaviour change (Webb & Sheeran, 2006). An explanation for this is provided by scientific developments on the dual system approach, introducing two systems that are believed to operate in the human mind: the automatic system (System 1) that works fast, associative, and unconsciously and the reflective system (System 2) that works slow, effortful, and consciously (Kahneman, 2012; Strack & Deutch, 2004). It has been found that humans rely on their automatic system for nearly 95% of the time (Baumeister, Bratslavsky, & Muraven, 2018; Kahneman, 2012), emphasizing that interventions should not only make use of educational methods appealing to rationality, but should also provide contextual changes that help to disrupt and redefine automatic, habitual behaviour (Egbers, 2007; Strack & Deutch, 2004; Wood et al., 2005).

Nudging is a promising tool for promoting stair climbing over elevator use. The beauty of nudging is that it alters the environment to steer human behaviour, making use of people's automatic tendencies rather than their rational system (Thaler & Sunstein, 2013). A nudge is described by Thaler and Sunstein (2013) as "any aspect of the choice architecture that alters people's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives". Another advantage of nudging is that it is a libertarian method of influencing behaviour; it does not prohibit or limit undesired behaviours. Hence, Thaler and Sunstein (2013) argue that influencing behaviour is inevitable as infrastructure cannot *not* exist, ergo this infrastructure might as well facilitate optimal rather than suboptimal behaviour.

Research on Stair Use Interventions

To date, several interventions aiming to increase stair use have been designed and studied. The traditional tactic is to place a point-of-choice prompt, which is a motivational message at the point where paths to the elevator or escalator and stairs divert (e.g., *'Stay healthy, take the stairs'*). Prompts are designed to make people consciously aware of the desired behaviour, without requiring too much attention (Kremers et al., 2006; Michie, Abraham, Whittington, McAteer, & Gupta, 2009). Point-of-choice prompts have repeatedly been effective in increasing stair use over escalator use in public spaces, such as shopping malls (Kerr, Eves, & Carroll, 2001a, 2001b), airports (Russell & Hutchinson, 2000), and train stations (Blamey, Mutrie, & Tom, 1995; for review see Kahn et al., 2002). However, within the setting of higher buildings, point-of-choice prompts often fail to increase stair use over elevator use (Eves & Webb, 2006). It has been suggested that motivational messages at the point-of-decision work when the required effort is low (i.e., taking one or two pairs of stairs), but that they are insufficient in motivating people to climb higher (Eves & Webb, 2006). Later research, nonetheless, demonstrated that when the messages are more health and caloric specific (e.g., '*Stair climbing burns more calories per minute than jogging*' or '*7 minutes of stair climbing per day protects your heart'*), they did manage to significantly increase stair climbing in several-story buildings (Eves, Webb, Griffin, & Chambers, 2012; Eves, Webb, & Mutrie, 2006; Webb & Eves, 2007). This illustrates that specific goal-related (i.e., 7 minutes a day) and outcome-related (i.e., a healthier heart or burned calories) messages have stronger motivational effects compared to their general counterparts. In their review, Eves and Webb (2006) conclude that point-of-choice prompts are promising tools for behaviour change but work optimally in combination with environmental manipulations.

Several studies found combined effects of point-of-choice prompts and different environmental manipulations, ranging between a 4.4% and 8.2% increase in stair climbing (e.g., Boutelle, Jeffery, Murray, & Schmitz, 2001; Engbers, 2007; Graham, Linde, Cousins, & Jeffery, 2013; Kerr, Yore, Ham, & Dietz, 2004; Rogers, Hazlewood, Marshall, Dalton, & Hertrich, 2010; Van Nieuw-Amerongen, Kremers, De Vries, & Kok, 2011). These interventions bundled a variety of manipulations to make staircases more accessible (e.g., removal of doors), aesthetically attractive (e.g., painted stairwell, artwork in stairwell), fun (e.g., music, feedback systems), and salient (e.g., glass doors, footsteps or twinkly lights leading to the staircase). Although they are generally proven effective in generating small effect sizes, the counter side of such multitude interventions is that their operationalization and implementation costs considerable amounts of time, workforce, and financial resources. Consequently, such interventions are unfeasible for most work and study sites. The challenge is therefore to develop an effective intervention that is cheap and easy to implement. Among all manipulations mentioned above, placing footsteps on the floor seems to be the sole method that meets both criteria.

Thus far, research on nudging with the use of footsteps is scarce and ambiguous. In one study, footsteps leading to trash bins reduced litter up till 46% (Hansen & Jespersen, 2013). Regarding stair use specifically, footsteps in combination with motivational posters have shown to be effective in increasing stair ascent with 6.3-8.7% (Weghorst, 2016). In another study, however, a comparable intervention only led to an increase in stair ascent during the first 2-week intervention phase, whereas this effect did not reappear during the second phase (Marshall, Bauman, Patch, Wilson, & Chen, 2002). A third study (Åvitsland et al., 2017) even found footsteps leading to the stairs to significantly decrease stair ascent with 4.9%. This ambivalence in study outcomes might be explained by variance in situational and sample characteristics; whereas in the two former studies (Marshall et al., 2002; Weghorst, 2016) staircases were difficult to locate and near the elevators, Åvitsland and colleagues (2017) studied a staircase clearly noticeable upon entering the building that was also further removed from the elevators. The distance between the stairs and the elevator has been shown to positively impact stair climbing (Zacharias & Ling, 2015). Baseline stair climbing was substantially higher in the Åvitsland study (89.6%) compared to in the other two studies (respectively 15.5% and 24.8%, Marshall et al., 2002; Weghorst, 2016). The samples' attitudes also reflected these behavioural differences: post-intervention questionnaires indicated that the nudge had been interpreted as patronizing in the study of Åvitsland and colleagues (2017), while it was met with curiosity in the study of Weghorst (2016). It is thus clear that both the study setting and the sample of the three studies strongly varied from one another, which might explain the differences in outcomes.

To recapitulate, research on the simple footstep nudge in combination with motivational messages is yet inconclusive. The dearth of compelling evidence on the effectiveness of this nudge underscores the importance of studying it further across different settings and populations. It could be that situational and sample characteristics moderate the nudging effect, so that nudging is only effective in stimulating stair climbing when certain conditions are met (e.g., low baseline stair climbing rates, stairs that are challenging to find, and a sample with an open attitude towards behaviour change initiatives). Hence, it is important to always tailor a nudge to the specific setting in which it is applied.

The Current Research

In this current study, a feasible intervention for promoting stair climbing is tested in a six-story university building, combining both motivational messages and footsteps making the staircase more salient. Two types of posters are used to convey the motivational messages: point-of-choice prompts stimulating stair climbing and deterring posters near the elevator buttons to discourage elevator use. Deterring posters have been shown to have an additive effect on top of the use of point-of-choice prompts in stimulating stair climbing (Russell & Hutchinson, 2000). The posters contain both a health- and sustainability-related message. Although decreasing energy consumption through diminished elevator use is an ambitious goal (i.e., *all* people usually occupying one elevator must switch to stair climbing for the elevator to remain unused), the sustainability messages is expected to add to environmental awareness, potentially generating effect in the long term. From a health perspective, stair climbing generates individual gain in terms of health benefits; each person choosing the stairs over the elevator can thus be considered a win. In contrast to previous studies (Marshall et al., 2002; Weghorst, 2016), current poster messages will be more specific in terms of caloric expenditure and the building's energy consumption, considering that specific messages have yielded larger positive results compared to general messages in past research (Eves et al., 2006, 2012; Webb & Eves, 2007).

The first aim of this study is to examine the effectiveness of the intervention in increasing stair ascent over elevator ascent. Despite ambiguity among previous studies, the nudge is expected to significantly increase stair climbing compared to baseline. This is because the current study setting contains more similarities to settings of studies in which footsteps in combination with posters were (initially) effective (Marshall et al., 2002; Weghorst, 2016), than to the setting in which the intervention was counter effective (Åvitsland et al., 2017). That is, the studied staircase is nearby the elevators, is hidden behind doors and appears to be scarcely used.

The second aim of this study is to research the long-term effectiveness of the intervention effect. Optimal would be if stair climbing, initially triggered by the nudge, evolves into an intrinsic habit that engenders sustained behaviour change and extends to a variety of settings (Aarts, & Dijksterhuis, 2000b). Although the examination of habitual changes does not fit within the scope of this study, it can be examined if stair climbing rates remain stable after removal of the intervention. A residual effect post intervention forms a first indication of sustained behaviour change. While several stair promoting nudges were found to have long-lasting effects, leading up to 3 months (Blamey et al., 1995; Kerr et al., 2004) and even two years (Graham et al., 2013), only two studies examined stair climbing post-intervention. In the first study (Marshall et al., 2002), the significant increase in stair ascent measured during the first intervention phase disappeared during a two-week follow-up phase. After the second phase – during which no effect was found – stair climbing even dropped below baseline. The second study (Åvitsland et al., 2017) found a significant decrease in stair ascent to return to baseline within three weeks post intervention. The current study will measure stair climbing during two post-intervention phases: the first week (T1) and the fourth week (T2) after the removal of the intervention. Based on previous findings – although interpreted with caution due to the scarcity of evidence – it is hypothesised that stair climbing will again decrease after nudge removal. However, whether this will return to or even drop below baseline, and whether this will differ for T1 and T2, will be examined exploratory.

Methods

Design and Procedure

The current study employed a simple time-series design, in which data were collected before, during, and after the implementation of the intervention (see Figure 1). One week of baseline measurements preceded a three-week intervention phase. The intervention was set up on Friday evening of week 1 and removed on Monday morning of week 5; both were times at which the building was relatively quiet. Two separate weeks of follow-up measures were completed: T1 immediately followed the intervention phase while T2 started three weeks after removal of the intervention.

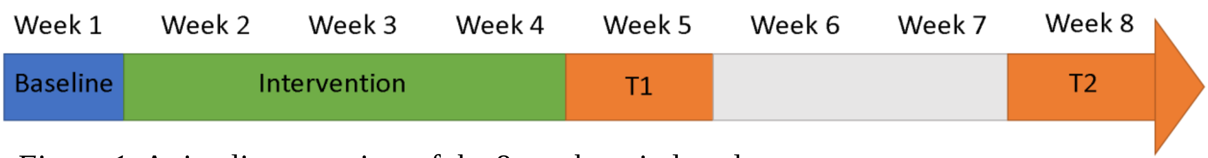

Figure 1. A timeline overview of the 8-week period study

Data collection started simultaneously with the beginning of the academic year. Week 1 of the study paralleled with the first lecture week in September 2018 and study week 8 with the last lecture week before the final exams that bring a close to the first period end October 2018. This planning was adopted to prevent any seasonal effects. That is, class schedules –

hence streams of people required to ascent the building for work or class at a given point in time – were expected to remain stable during the period of week 1 to 8.

Sample

The intervention was implemented and tested at the Androclus building, situated at Utrecht University Campus the Uithof. Permission for monitoring was granted by the faculty bureau of the building. The study sample existed of veterinary students, beta students, university employees (e.g., professors, researchers, supportive staff), and occasional visitors of the building. In total 1992 observations were made during the study. Due to collection of observational data only, no demographic information on participants could be specified. On the surface, however, the majority of participants seemed to be student and range within the young-adult age brackets (18-35 years). Moreover, both men and women appeared to be equally represented within the sample.

Setting

The Androclus building is a complex building made up of different departments. After passing the main entrance, people can breach out into different directions (i.e., left towards the canteen, right towards the study landscape, up one flight of stairs to the first floor, and straight towards the main part of the building). For a schematic overview of the building see Figure 2a. The main part of the building contains six stories of offices, classrooms, lecture halls, and practicum rooms. Concrete stairs in the entrance hall lead to the first floor only, where the largest lecture rooms can be found. To reach higher floors, the elevators or staircase in the main building must be used.

The intervention is placed on the ground floor of the main building. This floor is mainly a hallway with three elevators alongside each other, and adjacent to that two swing doors leading to a small lobby. Within this lobby two doors are found: one on the right leading to the staircase and one on the left opening to the leisure room and bar of the veterinarian student organisation. Thus, whereas the elevators are readily available when entering the hallway, the staircase is only accessible by passing through two doors. The intervention site can be reached from two sides: 1.) from the front, continuing from the entrance hall (i.e., past the concrete stairs) and 2.) from the back, where an employee-only entrance provides access to the building and where a hall leads to practicum rooms.

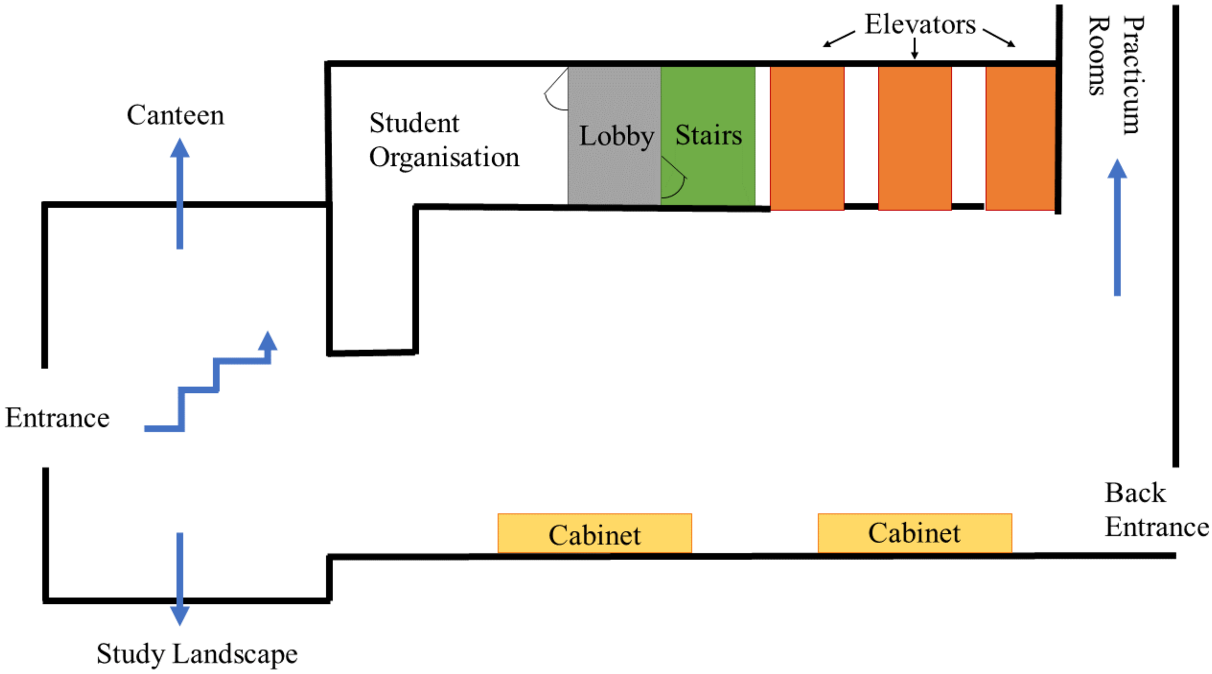

Figure 2a. A schematic overview of the ground floor of the Androclus building

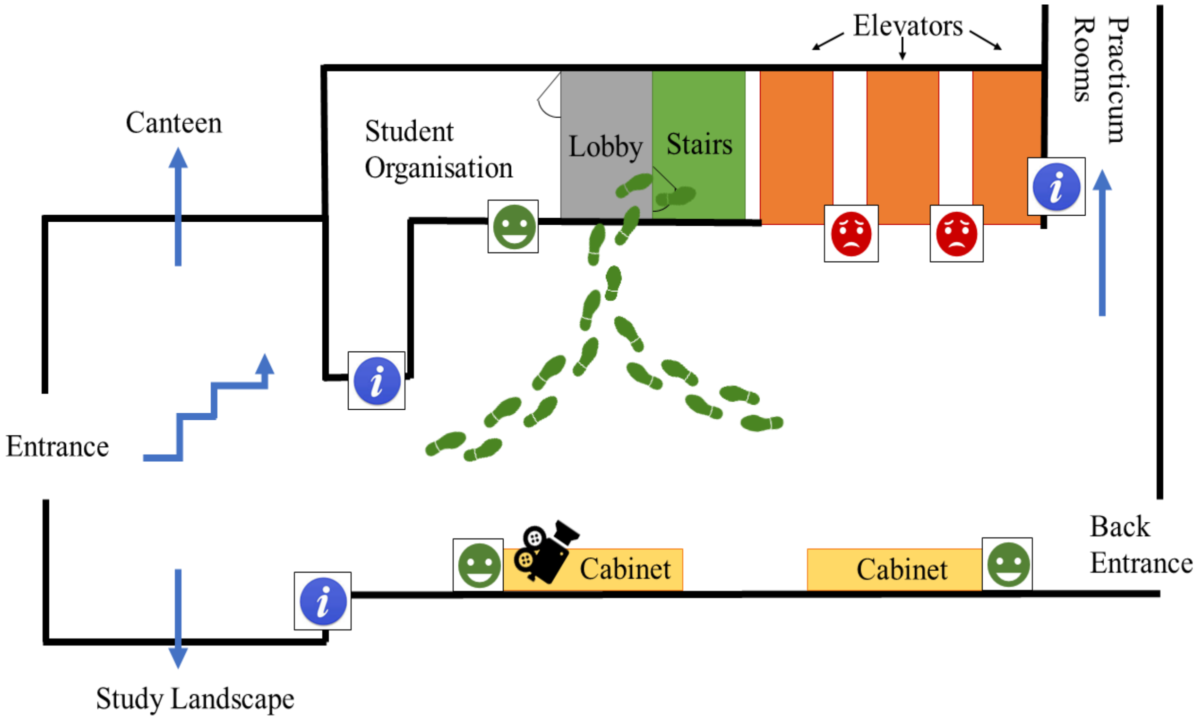

Figure 2b. A schematic overview of the ground floor of the Androclus building with the implementation of the intervention; [i] = warning signs that videos are made for research purposes, [camera] = the fish-eye camera, [smiley] = point-of-choice prompt poster, and [sad face] = deterring poster

Observations

Data was collected through observation. A Sony Exmor R StedayShot 11.0 Megapixel camera was used to obtain video footage that could be used to score large streams of people more reliably due to pause and replay functions. The fish-eye lens of this camera had a 170-degree angle that captured the entire intervention site and was placed on the cabinet on the right side of the hallway (see Figure 2b). For privacy purposes, the resulting videos were blurred to avoid recognizability on person level. This was done by smearing some Vaseline on the plastic casing of the camera, a method which was tested thoroughly before the start of the data collection. In addition, a warning email was send out two weeks prior to the study, in which students and employees of the building were informed about the filming for research purposes and reassured that the videos would not allow person recognition. The same message was displayed on three signs that were hung near the entrances of the intervention site during observation days (see Figure 2b). Finally, the recorded videos were saved on an encrypted USB stick, and backed up on an encrypted server. Internet transfer proceeded via an encrypted connection. The study obeyed the privacy protocol (see Appendix A) used by Weghorst (2016), which was approved by Ron Mast and Jeroen Benjamins.

Data was collected on Mondays and Thursdays. Due to limited camera battery and memory capacity, only the busiest times of the day were filmed: 30-minutes filming periods centred around each new lecture round, respectively at 9.00, 11.00, 13.15 and 15.15 o'clock (i.e., 15 minutes before and after the start of the lecture round). Because the early mornings were noticed to be the busiest time of the day (i.e., employees ascending for the start of a workday), the first filming round lasted 45 rather than 30 minutes (from 8.30 to 9.15 o'clock). In total, 27 hours of video material was obtained.

Scoring stair and elevator ascent was done by hand. All videos were scored by the same researcher and deleted afterwards (this was a requirement of building facility management to be allowed to film in the first place). Participants with a clear reason for taking the elevator (e.g., carrying a heavy load, being physically incapable of stair climbing) were excluded from counting. Elevator traffic was properly visible on the videos and therefore easily scorable; scoring stair traffic was more cumbersome, as stair climbers had to pass through the lobby first to access the staircase. Glass windows in the swing doors allowed sight on movement in the lobby; it was properly detectable whether people entered the doors to the left (to the student organisation room and bar) or the right (to the staircase). The only difficulty occurred when large numbers of people accumulated in the lobby, blocking the sight on the staircase doors. Overall, this only happened during the early afternoon (13.00-13.30), when students were spending their break at their student organisation's leisure room.

In such case, a scoring rule was applied consistently throughout the study: when people entered a lobby too crowded for scoring, it was assumed they visited the student organisation, not took the stairs. Whereas application of this rule might result in underestimation of stair climbing, this potential measurement error will be consistent among all study phases. Furthermore, close attention was paid to people leaving the student organisation's leisure room, crossing the lobby and entering the staircase, which was counted as stair climbing. Finally, it was noted when people already awaiting the elevator changed their minds and took the stairs instead.

Intervention

Green footsteps. 28 green footsteps were placed on the floor leading towards the staircase to increase its salience (see Figure 3). The colour green was chosen because it generally elicits positive reactions in people and has been found to have a relaxing and comforting effect (Kaya & Epps, 2004). The footsteps were each 20 centimetres long and 7 centimetres wide. They were placed in a walking pattern, at circa 20 centimetres distance from one another.

Figure 3. Photographs of the intervention site prior and post implementation

Posters. Two types of A3-sized posters were used: a point-of-choice prompt to motivate stair use and a deterring message to discourage elevator use (see Figure 4). The point-of-choice prompt contained the message: "*Take the stairs! With stair climbing you burn more calories per minute than with jogging & you help to protect the environment."* The message was formulated both in Dutch and English. Additively, a green, smiling emoticon was portrayed on top of the poster to enforce the motivational message. Research has indicated that emoticons are functional in communicating injunctive social norms and stimulating behaviour accordingly (Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007). Three point-of-choice prompts were placed at eye-height, at spots where they would easily catch people's attention when entering upon the intervention site (see Figure 2b). A fourth point-of-choice prompt was hung in the stairwell on the first floor to motivate further stair climbing. The deterring posters were similar in lay-out, portraying a red, sad-looking emoticon and the message: "*Rather take the stairs! On average 1 elevator uses up as much electricity as 2 households. Take care of the environment & your health*." Two deterring posters were hung in between the three elevators at waist-height (informational signs at high-height impeded higher placement).

Figure 4. A point-of-choice prompt (left) containing a positive formulated message for motivating stair climbing and a deterring poster (right) containing a negative formulated message for discouraging elevator use

Data Analyses

Frequencies of stair and elevator ascent were counted and percentages per study phase were calculated. Chi-square tests were applied to evaluate the differences between stair and elevator ascent, by comparing each subsequent study phase against baseline rates. To analyse the data, the statistical computer program IBM Statistics 24 was used and a significance level of $p < .05$ was applied. To test if total elevator use decreased – in the face of energy preservation for sustainability purposes – the degree of elevator use per person was calculated for each study phase by dividing frequencies of elevator ascent with the total amount of observations.

Results

Throughout the 6-week data collection period 1992 observations were made in total, with an average of 166 observations per day. Table 1 provides a complete overview on stair ascent per study phase.

Table 1

Percentages of stair ascent and difference compared to baseline per study phase

Study phase	**Stair ascent (%)**	**Difference compared to baseline (%)**
Baseline	11.9 (*n* = 319)	-
Intervention week 1	12.1 (*n* = 339)	0.2
Intervention week 2	22.0 (*n* = 322)	10.1*
Intervention week 3	17.0 (*n* = 342)	5.1
Total intervention	16.9 (*n* = 1003)	5.0*
Follow-up T1	16.0 (*n* = 375)	4.1
Follow-up T2	16.6 (*n* = 295)	4.7
Total intervention + Follow-ups	16.7 (*n* = 1673)	4.8*

* $p < .05$

At baseline 11.9% of people took the stairs rather than the elevator when ascending the building. When compared to baseline, the intervention did not establish a significant increase in stair climbing during the first week (0.2%, χ^2 (1) = 0.01, p = .943). During the second intervention week, however, a significant increase of 10.1% in stair use compared to baseline was found (χ^2 (1) = 11.67, p = .001). This increase compared to baseline reduced during the third intervention week to 5.1%, which approached, but did not reach significance (χ^2 (1) = 3.39, p = .066). The average of 16.9% stair ascent during the total intervention period, signifying a 5.0% increase in stair ascent compared to baseline, did reach significance due to its greater power (χ^2 (1) = 4.63, p = .034). When comparing subsequent intervention phases, stair use significantly augmented in week 2 compared to week 1 (9.9%, χ^2 (1) = 11.63, p = .001) and did not significantly decrease in week 3 compared to week 2 (-5.0%, χ^2 (1) = 2.75, p = .098).

After removal of the intervention, 16.0% stair ascent was measured during the first follow-up phase (T1). Although the increase in stair climbing compared to baseline was not significant (4.1%, χ^2 (1) = 2.38, p = .123), neither was the decrease of T1 compared to the third intervention week (-1.0%, χ^2 (1) = 0.12, p = .729) nor compared to the total intervention period (-0.9%, χ^2 (1) < 0.01, p = .948). Comparable results were found for T2 measures: with a stair climbing percentage of 16.6%, no significant increase compared to baseline was found (4.7%, χ^2 (1) = 2.78, p = .095), nor a significant decrease compared to week 3 (-0.4%, χ^2 (1) = 0.01, p = .907) or compared to the total intervention period (-0.3%, χ^2 (1) = 0.04, p = .848). Stair climbing rates between the two follow-up measurements did not significantly differ from one another (0.6%, χ^2 (1) = 0.05, p = .832). When combined, the entire intervention period plus the two follow-up measures showed a stair climbing percentage of 16.7%, which indicates a significant increase compared to baseline (4.8%, χ^2 (1) = 4.55, p = .033).

Further Observations

The amount of people in the waiting area for the elevators that noticeably changed their minds and took the stairs instead were respectively: 1 during baseline, 1 during the first intervention week, 3 during the second intervention week, 3 during the third intervention week, 2 during T1, and 3 during T2. Variety in total elevator use per person was also low between study phases, being 0.54 at baseline, 0.54 at intervention week 1, 0.51 at intervention week 2, 0.52 at intervention week 3, 0.50 at T1, and 0.54 at T2.

Discussion

It is apparent from the literature that enhanced stair climbing is desirable for both health and sustainability purposes (e.g., Andersen et al., 2013; Boreham et al., 2005; Sachs, 2005; Liu et al., 2010). Elevators in several-story buildings, however, offer a less effortful alternative to stair climbing that appeals to human’s automatic, peripheral routes of decision making and facilitates suboptimal habits of elevator use rather than stair climbing (Bargh &

Gollwitzer, 1994). The current study examined if a simple, cheap, and easy to implement intervention (i.e., salient footsteps on the floor leading to the staircase in combination with point-of-choice prompts and deterring posters) can help to break these suboptimal habits and increase stair climbing over elevator use. The second aim of the study is to investigate if the found effect persists up till four weeks post intervention.

Results showed that succeeding baseline measurements, stair climbing remained stable during the first intervention week, after which it increased with respectively 10.1% and 5.1% compared to baseline during week 2 and 3. The growth compared to baseline was significant for the second intervention week, whereas insignificant for the third. Yet, the overall increase of 5.0% during the entire intervention period *did* prove significant. This contrariety in significance between the two study phases could be allocated to variance in statistical power. During the final intervention week 342 observations were made, whereas this was nearly tripled for the entire intervention period. This difference in total observations, hence statistical power, can explain why nearly the same percentage of increase was significant for the entire intervention period whereas not for the third intervention week. Similarly, this explains why the stair climbing increase for the entire intervention period plus the follow-up measures (4.8%) was significant, whereas the increases found at T1 (4.1%) and T2 (4.9%) were not. Comparable studies, with larger amounts of observations (1000-5000 per study phase), indeed found percentages as small as 4.0-5.0% to be significant (Åvitsland et al., 2017; Van Nieuw-Amerongen et al., 2011; Weghorst, 2016). Following this premise, it can be assumed that the stair climbing increases found during intervention week 3, T1, and T2 would have been significant if more observations had been made, for instance if data had been collected for more than 2 days per week. Therefore, it should be noted that future studies should carefully consider the number of observations needed to achieve sufficient statistical power.

Despite the lower statistical power compared to that of similar studies, the first hypothesis – in which it was expected that the applied nudge would significantly increase stair climbing compared to baseline – can be confirmed. The overall intervention yielded a significant stair climbing increase of 5.0%. It is important to keep in mind that certain situational aspects might moderate the effect of the nudge, which could explain the arbitrary findings in prior research (Åvitsland et al., 2017; Marshall et al., 2002; Weghorst, 2016). The current study setting met all the requirements for high elevator use rather than stair climbing: the staircase was difficult to locate and its entry was near the elevators (Åvitsland et al., 2017; Zacharias & Ling, 2015). Indeed, the current baseline rate of 11.9% has been the lowest measured in research on this particular nudge thus far, creating an optimal setting for intervening as there is substantial room for growth. Similarly, the characteristics of the sample can be thought to influence the nudging outcomes. Although demographic details of participants were not available in this study, notable was during observations that the majority of stair ascenders were of relatively older age and closer resembled university employees rather than students. Possible is that students are less concerned with health and sustainability than employees, or that they manage to exercise more regularly due to their flexible schedules and are therefore less occupied with accumulating activity throughout the day (Dishman et al., 1998). Hence, it could be that the current nudge would generate even larger effects in office buildings, where the sample would mainly exist of employees with sedentary lifestyles. To determine the conditions under which the nudge would optimally work, future research should further explore the situational and sample characteristics that might moderate the nudging effect on stair climbing.

Contrary to other studies (e.g., Åvitsland et al., 2017; Van Nieuw-Amerongen et al., 2011; Weghorst, 2016), the current nudge did not generate an effect immediately, inasmuch as the stair climbing rates only started to rise *after* the first intervention week. This delayed effect diverges from the general premise that the suddenness of contextual changes helps to disrupt and redetermine habitual behaviour (Davis & Knowles, 1999; Wood et al., 2005). It could be that exposure to the intervention needs to accumulate for it to surpass a certain behavioural threshold. Stair climbing behaviour is mainly habitual and therefore difficult to influence (Bargh, & Gollwitzer, 1994). The low occurrence of people changing their minds after seeing the deterring posters supports the premise that stair climbing versus elevator use is a predetermined decision made upon entering the setting (Verplanken & Wood, 2006; Wood et al., 2005). The intervention is believed to mainly work below the level of conscious thought, by utilizing people's automatic tendencies to follow paths which are the most salient and by enhancing general awareness of the stair alternative through point-of-choice prompts (Kremers et al., 2006; Michie et al., 2009). This "soft" way of influencing behaviour could require more time to sink in and only gradually affect people's cognitive and behavioural schemes. Also possible is that some participants initially experienced reactance – a negative emotional reaction to the usurpation of freedom and the feeling of being persuaded (Knowles & Riner, 2007) – that might have gradually faded into acceptance over the course of the first intervention week. During intervention week 1, some footsteps were teared loose and redirected from the staircase towards the student organisation's leisure room (this was rectified shortly after and remained just during the rest of the intervention). Although this verifies that the intervention was noticed from the start, it also indicates that at least part of the sample was not fully accepting of the attempts to modify their behaviour. Future research should closer examine attitudes and cognitions regarding the intervention with the use of self-report measures.

The second hypothesis – in which it was expected that stair climbing rates would drop again after nudge removal – was not confirmed. Contrary to expectations, the reductions in stair climbing measured during T1 and T2 were insignificant; neither stair climbing percentage reduced more than 1.0% compared to either the final intervention week or the entire intervention period. These findings indicate that the nudging effect persisted for at least four weeks after nudge removal. Although carefully – as little evidence is yet available to support these findings – it can be speculated that the majority of participants that started stair climbing throughout the intervention kept opting for stair use over elevator use after the intervention was gone. Future studies should help to determine if this residual effect truly reflects the *same* individuals committing to stair climbing during and after the intervention, and if so, whether this long-term effect is mediated by the development of new stair climbing habits.

To recapitulate, the applied intervention triggered a significant increase of 5.0% compared to baseline, an effect that hardly decreased in the four weeks post intervention. A consequence of reporting in percentages rather than in absolute numbers is that the actual impact of the intervention strongly depends on the sample size. In the studied setting, where an average of 166 people per day ascended the building, these numbers translate to approximately 8 people more a day opting for stair use rather than elevator use. It may be obvious that these numbers are not sufficient to cut down elevator use and hence energy consumption, which is confirmed by the unchanging levels of elevator use per person found in the study. From a health perspective, however, each individual climbing stairs more frequently can be considered a gain, especially when this behaviour evolves into a habit that extends to other settings as well (Aarts & Dijksterhuis, 2000a, 2000b). Considering that comparable increase percentages have been found in studies with larger amount of observations (Åvitsland et al., 2017; Van Nieuw-Amerongen et al., 2011; Weghorst, 2016), it can be reasonably assumed that the effect of 5.0% found in the current study would have a substantial impact on health and possibly even sustainability in busier buildings with at least thousands of people ascending there daily.

Limitations and Strengths

Besides the aforementioned confined statistical power, some other limitations deserve comment. First, it was only observed *if* people went up the stairs, but not up to where they went. It is therefore undeterminable if ascenders took the stairs only up to the first floor, or whether they climbed higher. Advanced technologies such as movement or pressure sensors could provide such information in future research.

Second, use of the concrete stairs in the entrance hall leading up to the first floor was not measured, as it did not fit within the scope of this study. Since people are mostly willing to climb stairs to the first floor (Eves & Webb, 2006), and given that this staircase was in plain sight upon entering the building, it is safe to assume that these stairs are being used more frequently than the observed staircase. Not including observations on these specific stairs might have led to underrated stair climbing percentages. However, this is likely to have been the case for both initial stair climbing behaviour (i.e., baseline) and stair climbing behaviour during and after the intervention. Even though the nudge was applied near a different staircase (i.e., the studied setting), it is likely to have had a spill-over effect on use of the concrete stairs through increased awareness and possible habit formations. Thus, the possibility of underestimated stair climbing rates is believed to have influenced all study faces and hence to have had limited effect on the final conclusions drawn.

Third, the signs and preceding email warning about the filming for research purposes might have caused participants to behave more desirable than usual through awareness of being observed. On the other hand, the fish eye camera was barely noticeable on the cabinet and at all times placed subtly when no person was watching. Compared to other studies, in which the camera or observants were more notable (e.g., Åvitsland et al., 2017; Weghorst, 2016), and in which the collection of questionnaire data during the study could have added to awareness (Weghorst, 2016), data collection within the current study has been relatively discrete.

Fourth, despite fitting the measurements within the first university period, natural changes over time that might influence the dependent variable can never be fully controlled for. The weather for instance, shifted from warm to chilly over the course of the 8-week study period. Since during dark, cold, and wet periods people are less inclined to be physically active (Tucker & Gilliland, 2007), these weather changes might have contributed to a natural decline in stair climbing as the study progressed, which in turn could have led to an underestimated intervention effect. Also, the T2 measure preceded the exam week, which might explain why the building was less occupied that week. Also, this may have influenced stair climbing behaviour, as stressful periods can cause people to be less concerned with health or sustainability (Lutz, Stults-Kolehmainen, & Bartholomew, 2010; Ng & Jeffery, 2003). Future studies could consider a design including a control building to limit these seasonal effects.

Fifth, the current study did not separately study the effect of the motivational posters (i.e., point-of-choice prompts and deterring posters) and the footsteps. Hence, no insight can be given on the individual contribution of each method and whether they enforce one another when combined. Whereas a large section of research has illustrated that motivational messages alone solely elicit small effects on stair climbing in several-story buildings (Eves et al., 2006, 2012; Eves & Webb, 2006; Webb & Eves, 2007), the sole use of footsteps to promote stair ascent has not yet been studied. Future research could examine if this even simpler version of the intervention would generate comparable effects on stair climbing as found thus far.

Notwithstanding these limitations, this study also knows several strengths. It is one of the first studies on this easy implementable intervention that is applied to increase stair climbing in several-story buildings. The stair climbing percentages found are in line with those of comparable studies (e.g., Åvitsland et al., 2017; Marshall et al., 2002; Van Nieuw-Amerongen et al., 2011; Weghorst, 2016), and point in a positive direction. Above all, it is the first study on this specific nudge that examined stair climbing behaviour *after* removal of the intervention. The two follow-up measures, covering a total period of 4 weeks post intervention, provide useful information on the long-term effectiveness of the intervention and scaffold the assumption that the intervention facilitates the formation of new, optimal habits.

Conclusion

Current findings on increased stair climbing over elevator use are promising for public health and possibly even sustainability. Nudging is a libertarian method that can effectively be applied to change habitual behaviour as it appeals to human's automatic, peripheral routes of decision making. The studied nudge is cheap and simple to implement, and therefore within each organisation's reach. Especially within offices – where people spend large portions of their time and subsequently often fail to gain sufficient physical activity – increased stair climbing can contribute to an active lifestyle that produces health benefits. Energy consumption in a building will reduce only when large amounts of people exchange the elevator for stairs, so that less elevators move up and down between floors. Thus, the intervention might only have an impact on sustainability when the ascending traffic exposed to and influenced by the intervention is substantially high, whereas from a health perspective each individual taking the stairs can be considered a gain. The residual effect found after removal of the intervention suggests that the intervention helps to form stair climbing habits, creating sustained behaviour change that could extend to other settings. Future research should help to confirm whether indeed new habits form during the intervention phase. The current study already made a first step in illustrating the promising potential of a simple and cheap nudge in actualizing not only temporary, but sustained behaviour change.

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Appendix A - Privacy protocol for camera use.

Privacy gerelateerd protocol voor cameragebruik in thesisonderzoek naar nudging in het Willem C. van Unnikgebouw op de Uithof in Utrecht.

Korte omschrijving van het onderzoek

In het kader van mijn masterthesis voor de opleiding Toegepaste Cognitieve Psychologie zal ik van 30-11-2015 t/m 15-01-2016 (exclusief kerstvakantie) in het van Unnikgebouw onderzoeken of het mogelijk is door het plaatsen van een aantal zogenoemde 'nudges' meer mensen de trap te laten nemen en zo energie te besparen. De nudges bestaan uit (1) groene stickers in de vorm van voetstappen die van de ingang van het van Unnikgebouw naar de trap leiden, (2) een poster met positieve feedback bij de trap, en (3) bordjes met negatieve feedback en informatie over energiegebruik van de lift bij de liften. Om te kijken of het plaatsen van deze nudges werkt, ga ik op verschillende momenten (2 dagen per week) gedurende 5 weken tellen hoeveel mensen de trap nemen en hoeveel de lift. De eerste week geldt hierbij als ‘benchmark meting’, er worden dan nog geen nudges geplaatst. Ook zal ik kijken naar het verschil in effect van de nudges op mensen die in een groep lopen en mensen die alleen lopen. Verder onderzoek ik met korte vragenlijsten of mensen de nudges bewust gezien hebben en daardoor over hun keuze zijn gaan nadenken e.d. Bij de dataverzameling van dit onderzoek wordt sterk rekening gehouden met de privacy wetgeving. Onderstaande geeft uitleg over de precieze procedure omtrent de dataverzameling.

Reden voor het gebruik van camerabeelden

De camera wordt binnen de bovengenoemde periode op dinsdagen en donderdagen ingezet om de volgende aspecten te kunnen meten:

1. Het aantal personen dat de trap neemt vs. het aantal personen dat de lift neemt.

2. Het aantal personen dat na het zien van de bordjes die zich bij de lift bevinden de trap neemt.

3. Het verschil in percentage personen dat de trap neemt tussen personen die in een groep lopen en personen die alleen lopen.

4. Het aantal liften dat per persoon wordt gebruikt.

Deze vier aspecten zijn de enige aspecten waarvoor de camerabeelden gebruikt worden. De reden dat er een camera gebruikt wordt is dat eventuele andere meetmethoden niet voldoen om een betrouwbaar resultaat te behalen. Bewegings- en druksensoren zijn niet voldoende in staat onderscheidt tussen personen te maken, laat staan onderscheidt in de looprichting van deze personen. In dit onderzoek moet alleen het aantal personen dat naar boven gaat geteld worden, daarom voldoen deze sensoren niet. Het inzetten van menselijke observatoren voldoet niet vanwege twee redenen. Ten eerste moet er teveel informatie tegelijk worden geobserveerd, een observator kan dit niet 25 nauwkeurig genoeg doen. Bij het gebruik van camerabeelden is dit geen probleem, omdat deze kunnen worden gepauzeerd. Ten tweede kan een observator in de setting van dit onderzoek niet onopvallend genoeg blijven, waardoor hij mogelijk het gedrag van mensen beïnvloedt.

Onherkenbaarheid van personen

De personen zullen zo onherkenbaar als mogelijk op de camera worden vastgelegd. Uiteraard moeten personen nog wel te onderscheiden zijn voor de genoemde onderzoeksdoeleinden. De gebruikte camera heeft niet de optie het beeld vager in te stellen, daarom zal het vervagen van het beeld zo veel als mogelijk gedaan worden door doorzichtige/matte folie voor de lens te plaatsen.

Bescherming gegevens

De camerabeelden worden in eerste instantie opgenomen op een sd-kaart. Aangezien deze niet versleuteld kan worden zal er altijd iemand in de centrale hal van het van Unnikgebouw aanwezig zijn om ervoor te zorgen dat de camera en de sd-kaart niet kunnen worden gestolen. Tevens wordt de camera op een hoogte opgehangen waar mensen alleen bij kunnen met een trappetje of een andere vergelijkbare verhoging. Eenmaal opgenomen zullen de beelden gelijk, versleuteld met het programma 'Truecrypt', worden opgeslagen op mijn computer. De beelden op de sd-kaart worden dan gelijk gewist. De versleutelde beelden worden vervolgens zo snel mogelijk omgezet in ruwe onderzoeksdata. Zo gauw dit gedaan is worden de beelden ook van de computer gewist en bestaan ze niet meer.

Mededeling aanwezigheid camera

Op de deuren bij de ingang van het gebouw zullen bordjes komen te hangen waarop staat aangegeven dat er in de centrale hal van het van Unnikgebouw gefilmd wordt i.v.m. onderzoek. De tekst van dit bordje zal er ongeveer als volgt uitzien: 'In de centrale hal van het van Unnikgebouw worden i.v.m. een onderzoek i.h.k.v. een masterthesis van 30-11-2015 t/m 15-01-2016 camerabeelden gemaakt. Bij de dataverzameling wordt sterk rekening gehouden met de privacy wetgeving. Meer info: Max Weghorst, e-mailadres'.