

Fall 2013

## Use of Stair Prompts to Encourage Physical Activity

Nima Chhay  
*San Jose State University*

Follow this and additional works at: [https://scholarworks.sjsu.edu/etd\\_theses](https://scholarworks.sjsu.edu/etd_theses)

---

### Recommended Citation

Chhay, Nima, "Use of Stair Prompts to Encourage Physical Activity" (2013). *Master's Theses*. 4380.  
DOI: <https://doi.org/10.31979/etd.d6sd-jkh5>  
[https://scholarworks.sjsu.edu/etd\\_theses/4380](https://scholarworks.sjsu.edu/etd_theses/4380)

This Thesis is brought to you for free and open access by the Master's Theses and Graduate Research at SJSU ScholarWorks. It has been accepted for inclusion in Master's Theses by an authorized administrator of SJSU ScholarWorks. For more information, please contact [scholarworks@sjsu.edu](mailto:scholarworks@sjsu.edu).

USE OF STAIR PROMPTS TO ENCOURAGE PHYSICAL ACTIVITY

A Thesis

Presented to

The Faculty of the Department of Psychology

San José State University

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

by

Nima Chhay

December 2013

© 2013

Nima Chhay

ALL RIGHTS RESERVED

The Designated Thesis Committee Approves the Thesis Titled

USE OF STAIR PROMPTS TO ENCOURAGE PHYSICAL ACTIVITY

by

Nima Chhay

APPROVED FOR THE DEPARTMENT OF PSYCHOLOGY

SAN JOSÉ STATE UNIVERSITY

December 2013

Dr. Sean Laraway

Department of Psychology

Dr. Susan Snycerski

Department of Psychology

Dr. Marjorie Freedman

Department of Nutrition,  
Food Science, and Packaging

## ABSTRACT

### USE OF STAIR PROMPTS TO ENCOURAGE PHYSICAL ACTIVITY

by Nima Chhay

Stair prompts can encourage stair use in both public and private settings and thereby increase overall physical activity. Stair visibility in multi-level buildings increases stair use. For this study, an intervention using a modified New York City Department of Health and Mental Hygiene stair prompt was implemented to encourage stair use in an academic setting. The modification included a time management theme, chosen because individuals in this setting may find taking the stairs to be faster than taking the elevator. To evaluate the effectiveness of the modified stair prompt, two buildings—one with hidden stairs and one with visible stairs—were selected for observing subjects' responses to the modified prompt. This 13-week observational study used a multiple-baseline design that included a baseline phase (no exposure to the stair prompt) followed by an intervention phase (exposure to the stair prompt).

Overall, the stair prompts had no measurable effect on ascending stair use. Men, as compared to women, were more likely to walk up hidden stairs; however, men and women were equally likely to walk up visible stairs. Thus, having visible stairs in multilevel buildings, rather than the presence of stair prompts, may be an alternative and perhaps more effective approach toward promoting stair use for physical activity.

## ACKNOWLEDGMENTS

I would like to recognize several key individuals whose contributions made this thesis research project possible. I begin by thanking Dr. Sean Laraway for serving as my mentor and thesis adviser in graduate school. I first came to know Dr. Laraway when I was an undergraduate in his research methods class at SJSU. Since that time, he has nurtured my interest in research methodology and statistics. The truth is that, without his tremendous support and extraordinary guidance, I would probably not have done as well in graduate school or even applied to graduate school in the first place. In addition, I am privileged to have had Dr. Susan Snycerski and Dr. Marjorie Freedman as thesis committee members, from beginning to end with this research project. Throughout this entire process, their input, insightful comments, and editing were invaluable.

To encourage stair use for physical activity at San José State University, I chose the prompt developed by the New York City Department of Health and Mental Hygiene. I thank Johnny Adamic, the enthusiastic middleman, for communication and assistance, and Dr. Karen Lee for granting permission to modify the original stair prompt for research use. I am also grateful for Dr. Emily Allen, from the College of Engineering, and Denny Yau, from Parking Services, for allowing research activities at their buildings. Additionally, I am grateful to Samuel Haas, Sarah Garcia, and Aron Martinez for their work as research assistants. Lastly, I express gratitude to the Clarence F. and Lyle V. Burmahln scholarship committee for the award that funded the research supplies.

## TABLE OF CONTENTS

LIST OF TABLES .....	viii
LIST OF FIGURES .....	ix
INTRODUCTION .....	1
The Promotion of Stair Use .....	3
Health Benefits of Stair Use .....	4
Studies on Stair Use .....	5
The Present Study .....	10
METHOD .....	14
Participants and Settings .....	14
Materials .....	15
Research Design.....	15
Procedures.....	16
Statistical Analyses .....	18
RESULTS .....	22
Descriptive Statistics.....	22
Inferential Statistics .....	23
Post-Hoc Analyses .....	32
DISCUSSION.....	35
Implications.....	40
Limitations .....	44
Future Research .....	47

Conclusion .....	48
REFERENCES .....	50
APPENDICES .....	56
Appendix A: Modified NYC DHMH Stair Prompt.....	56
Appendix B: IRB Form.....	57
Appendix C: Demographics for Students and Faculty .....	58
Appendix D: Interobserver Agreement Graphs .....	59
Appendix E: Time-series Regression Procedures.....	60



## LIST OF TABLES

Table 1 Descriptive Statistics for Interobserver Percent Agreement.....	18
Table 2 Descriptive Statistics of Daily Stair Ascend Averages.....	23
Table 3 Statistics of Stair Ascend Percentages at the Engineering Building.....	24
Table 4 Statistics of Stair Ascend Percentages at the Garage.....	24
Table 5 Time-Series Regression Predicting Total Stair Ascend Percentages.....	26
Table 6 Time-Series Regression Predicting Men Stair Ascend Percentages.....	28
Table 7 Time-Series Regression Predicting Women Stair Ascend Percentages ...	30
Table 8 Between Observational Settings Comparison on Stair Ascend.....	33
Table 9 Between Gender Comparison on Stair Ascend.....	34

## LIST OF FIGURES

Figure 1. Graph for Overall Stair Ascend Percentages.....	22
Figure 2. Time-series Graph for Total Stair Ascend Percentages .....	27
Figure 3. Time-series Graph for Men Stair Ascend Percentages.....	29
Figure 4. Time-series Graph for Women Stair Ascend Percentages .....	31

## **Introduction**

In 2010, approximately 36% of adult Americans were categorized as obese. Obesity is caused by an energy imbalance, specifically, the intake of excess calories relative to energy expenditure. Obesity prevention is important because this disease increases the risk of other chronic diseases (e.g., coronary heart disease, hypertension, and type 2 diabetes). In addition, the health cost of obesity and the subsequent treatment are expensive; current estimates put the cost of annual medical care in the US at \$147 billion (Centers for Disease Control and Prevention [CDC], 2012a,b; National Institutes of Health [NIH], 2012).

The CDC recommends that healthy adults participate in 150 minutes each week of moderate intensity physical activity (e.g., 30 minutes for five days weekly). Moderate intensity physical activities include climbing stairs, walking briskly (3-4 mph), cycling, and dancing. Short bouts (e.g., 8-10 minutes each) of various intensity physical activities throughout the day are sufficient to help prevent chronic diseases and improve the quality of life for most adults (CDC, 2011a,b; Pate et al., 1995). In an effort to help prevent progressive weight gain which might lead to obesity, the present study focused on changing one behavior—using the stairs instead of the elevator—to increase overall energy expenditure. This change, in combination with other lifestyle and dietary changes, may be effective in preventing weight gain and subsequent negative effects.

About 22% of adult Americans comply with physical activity recommendations, and about half (54%) participate in physical activity but do not meet the recommended guidelines; 24% of adults are considered physically inactive (Pate, et al., 1995).

Similarly, in a recent national health survey, only about 20% of college students reported participation in at least 30 minutes of moderate intensity physical activity five or more days weekly, 55% reported participating up to four days weekly, and 25% reported being sedentary (American College Health Association [ACHA], 2012). At San José State University (SJSU), 13% of students reported participating in at least 30 minutes of moderate intensity physical activity five or more days weekly, 62% reported participating up to four days weekly, and 25% reported no physical activity at all (ACHA, 2009).

Physical activity may include participation in exercise and sports. Lacaille, Dauner, Krambeer, and Pedersen (2011) reported that college students were motivated to participate in physical activity to stay in shape, improve mood, increase energy, and boost self-esteem. Kilpatrick, Hebert, and Bartholomew (2005) examined gender differences for motivation to participate in exercise and sports. In general, students were motivated to exercise to improve appearance, strength and endurance, decrease stress, manage weight, and improve overall health. In contrast, they were motivated to participate in sports to develop affiliations, to partake in challenges and competitions, and to increase enjoyment and social recognition. Men, but not women, were more likely to associate sports participation, as compared with exercise, with enjoyment. Women were more likely to identify exercise, as compared with sports participation, with stress and weight management, and positive health outcomes. Men felt that exercise and sports participation was equally effective for stress management and positive health outcomes. Thus, motivation for engaging in certain types of physical activity may be gender specific.

Among adults and college students, the most frequently reported barrier to physical activity was lack of time (Lacaille et al., 2011; Pate, et al., 1995). College students noted little time for physical activity after accounting for time devoted to school and to forming and maintaining friendships. Besides lack of time, female students reported feeling crowded, uncomfortable, and unwanted by men in exercise facilities. Females also reported that they did not want to pay additional fees for fitness classes and that they lacked knowledge of how to use fitness equipment. To address these barriers, the present study aimed to encourage physical activity among males and females on a college campus through a no-cost, barrier-free approach that required little change to daily routines, and little investment of additional time.

### **The Promotion of Stair Use**

The desire for convenience has perpetuated a lifestyle that favors physical inactivity over activity—driving over walking, using elevators and escalators over taking stairs, and using dishwashers and washing machines over hand washing of kitchen items and clothing. These changes mean fewer calories expended in day-to-day activities, potentially leading to weight gain (Lanningham-Foster, Lana, & Levine, 2003). Recent public health campaigns have focused on finding ways to encourage individuals to expend more energy throughout the day without significant time investments. Taking stairs has been targeted as one approach toward encouraging more physical activity, as it requires minimal disruption to daily routines and little additional time investment.

Many federal, state, and local governmental organizations promote stair use for increasing daily physical activity. The CDC promotes the “StairWELL to Better Health”

program, and the Public Health Agency of Canada (PHAC) promotes the “Stairway to Health” program (CDC StairWell, 2010; PHAC, 2007). The California Department of Public Health (CDPH) adopted the “California 5 a Day-Be active! worksite program” (CDPH, 2006). The New York City Department of Health and Mental Hygiene (NYC DHMH) created the “Burn Calories, Not Electricity—Take the Stairs!” campaign (NYC DHMH, 2008). To make stair use more appealing, organizations have suggested placing motivational signs, as well as enhancing stairwell appearance and atmosphere. Collectively, these governmental organizations suggest that stair use for accumulating physical activity can occur in any setting that has stairs.

### **Health Benefits of Stair Use**

Stair use, rated as a moderate-to-vigorous intensity type of physical activity, has the potential to decrease low-density lipoprotein cholesterol (a cardiovascular risk factor when elevated) and increase VO<sub>2</sub> max (a marker for cardiorespiratory fitness) (Boreham et al., 2005; Pate, et al., 1995; Teh & Aziz, 2002). Stair-climbing regimens offer viable alternative to working out at gyms and fitness facilities, which pose the disadvantages of potential crowdedness, extra fees, and unfamiliar equipment. However, adults and college students need not be on a strict stair-climbing regimen to obtain health benefits, as short bouts of walking up stairs at school, work, and elsewhere in combination with other physical activities daily are sufficient for a healthy lifestyle (CDC, 2011a).

Brownell, Stunkard, and Albaum (1980) used an antecedent control procedure (e.g., a stair prompt) to encourage individuals to walk up stairs to increase levels of physical activity. Antecedent control procedures present cues, such as visual prompts, to

make a desired behavior more likely (Miltenberger, 2012). The research procedure involved placing a sign (91.4 cm × 106.7 cm [36 in × 42 in]) which suggested the heart needs exercise (*Your heart needs exercise ... Here's your chance.*) at the point-of-decision between entering the stairs and escalators in a train station. This stair prompt led to a marked increase in stair use across different racial, age, and gender groups, with no difference in stair use based on body weight. In general, 11.6% of individuals were stair users at baseline, and 18.3% of individuals were stair users during the 2-week intervention period. However, only 11.9% of individuals used the stairs 3-months later. These results suggested an inexpensive stair prompt could sway behavioral choices toward stair use in the short-term, but removal of the stair prompt would result in reversal of behavior over time.

Following Brownell et al. (1980), other studies have examined the use of stair prompts (e.g., signs, posters, and banners) that act as visual prompts or cues for stair use. These stair prompts have contained different images and messages that act to motivate behavioral change. Images have ranged from cartoon caricatures to stick figures, while messages have suggested various benefits of using stairs (e.g., maintaining good health, maintaining healthy body weight, saving time, and saving energy).

### **Studies on Stair Use**

Research to encourage stair use over elevator use has been conducted in various settings. Selected studies follow, starting with more complex types of intervention (e.g., treatment package approach) that involve a combination of intervention components that require more effort to implement, and ending with simple interventions (e.g., stair prompt

alone) that require less effort. Howie and Young (2011) used various campaigns, such as rotating stair prompts sized 21.6 cm × 27.9 cm to 61.0 cm × 91.4 cm (8.5 in × 11 in to 24 in × 36 in) in dormitories, competition for prizes through stair climbing, and a scavenger hunt in the stairwell. The stair prompts had various message themes (e.g., *Got legs? Use Em. Take the Stairs and Save the Environment, Use Leg Power*). Stair use increased from 24.9% at baseline to 33.2% during the campaign, but stair use returned to baseline levels of 25.4% after the campaign. This study revealed the weakness of using incentives as behavioral reinforcement along with other components. The incentive rewarded the desired behavior, but unsurprisingly, the desired behavior lessened when the opportunities for reinforcement ceased.

Van Nieuw-Amerongen, Kremers, de Vries, and Kok (2011) made environmental changes (e.g., green paint in stairwell, speckled carpeting, and glass doors) to university buildings' stairs to heighten visibility and attractiveness along with stair prompts and footprints leading to the stairs. The stair prompts had several message themes (e.g., *exercise prevents diseases, saves you time, and such exercise is free*). These modifications increased stair use from 51.8% at baseline to 60.0% after a 4-week intervention. In contrast, Lewis and Eves (2012) reported that a stair prompt placed in the elevator did not increase stair use (i.e., 59.4% at baseline compared to 55.1% during the intervention). It was only when multiple stair prompts were added to the point-of-decision area in the building and placed outside the elevator with arrows pointing to stairs near the elevator call button that stair use increased to 60.1%. Boutelle, Jeffery, Murray, and Schmitz (2001) reported that at a school of public health building, using just a stair



prompt that read “Take the stairs for your health” increased stair use from 11.1% to 12.7%, but when the prompt was accompanied by stairwell music and artwork, stair use increased to 15.5%.

Although treatment packages using a single stair prompt (or multiple replicas) along with other components have been shown to be effective, studies that focused on generating multiple stair prompts with variable message themes have shown mixed results. After conducting interviews with stairs and elevator users, Adams and White (2002) found that themes relating to healthfulness, burning calories for weight control, speed for saving time, and healthful lifestyles were factors likely to encourage stair use at a medical school building. Thirty-nine stair prompts (41.9 cm × 29.7 cm [16.5 in × 11.7 in]) with various message themes were developed and placed at the ground-floor directory of an academic building, on different building levels, and in elevators. Researchers concluded that the stair prompts were ineffective with regard to increasing stair use because stair use declined from 20.1% at baseline to 19.5% after the 4-week intervention. Blake, Lee, Stanton, and Gorely (2008) found that rotating five different stair prompts (84.1 cm × 59.4 cm [33.1 in × 23.4 in]) with similar prompt themes (e.g., *stay fit, stay healthy, save time*) did not increase stair use in a hospital. Ford and Torok (2008) used multiple stair prompts (21.6 cm × 27.9 cm [8.5 in × 11 in]) that were rotated daily at an academic building. The various messages on the stair prompts included *Step up to a healthier lifestyle, When you go up, your blood pressure goes down, and Small steps make a big difference*. Results indicated that stair prompts placed inside a stairwell,

as well as inside and outside elevators, were adequate for increasing stair use from 23.6% at baseline to 28.0% with the intervention.

Two of these studies conducted follow-up surveys in which most people reported being regular stair users. Adams and White (2002) reported that respondents thought the intervention was informative but guilt-inducing and less likely to work if overtly trying to change behavior. Blake et al. (2008) reported that most respondents did not notice the stair prompts. Among respondents who did notice the stair prompts, however, the one relating to time-saving was the most noticed.

Apart from treatment packages and multiple stair prompt interventions, the effect of stair visibility (e.g., the ability to see stairs from the elevator area) on stair usage has been examined. Grimstvedt et al. (2010) examined stair visibility as a variable apart from a stair prompt in academic buildings. Researchers placed 61.0 cm × 40.6 cm (24 in × 16 in) stair prompts on the first three floors and 20.3 cm × 15.2 cm (8 in × 6 in) stair prompts in stairwells that contained the school mascot and a message saying, *Walking up stairs burns almost 5 times as many calories as riding an elevator*. Stair use increased from 35.5% at baseline to 47.5% following a 3-week stair prompt intervention and remained at 48.9% four weeks after the prompt was removed. Stair visibility was an important factor for stair use as individuals were more likely to use visible stairs as opposed to hidden stairs. Bungum, Meacham, and Truax (2007) used various sizes of stair prompts (e.g., 21.6 cm × 27.9 cm or 21.6 cm × 43.2 cm [8.5 in × 11 in or 8.5 in × 17 in]) at two academic buildings, five banks, and one garage. Stair prompts had various messages (e.g., *Increase your fitness level one step at a time ... Take the stairs!, Raise your fitness level one step*

*at a time*, and *Step up to a healthier lifestyle*). Results indicated that besides the presence of stair prompts, being able to see the stairs from the elevator waiting area was an important factor for stair use. At baseline, stair use was 22.8% (16.5% for ascending stairs and 28.8% for descending stairs). After the intervention, stair use increased to 30.8% (25.7% for ascending stairs and 35.1% for descending stairs). These studies thus suggest that stair visibility may contribute significantly to stair use.

Lee et al. (2012) implemented a stair prompt intervention alone, without emphasis on treatment packages, multiple stair prompts, or stair visibility. Using the NYC DHMH stair prompt, Lee et al. reported that one stair prompt was adequate for increasing stair use. They reported that a 1-week stair prompt intervention increased stair use from 70.1% to 76.5% at a health clinic, from 25.1% to 33.8% at an academic building, and from 13.0% to 17.4% at an affordable housing site. Follow-up assessments for the health clinic and the affordable housing sites showed the increase in stair use was sustained above baseline levels nine months later, with stair use remaining at 72.1% for the health clinic and at 18.6% for the affordable housing site. This study demonstrated that the NYC DHMH stair prompt has the potential to increase and maintain stair use.

Besides showing that a stair prompt alone can be effective for increasing stair use, Lee et al. (2012) also showed that the NYC DHMH stair prompt placed at the health clinic was effective for increasing both upward and downward stair use. The NYC DHMH stair prompt has a stick figure walking up the stairs with a message reading, *Burn calories, Not Electricity, Take the stairs* in large print, and *Walking up the stairs just 2 minutes a day helps prevent weight gain. It also helps the environment* in small print.

Lee et al. reported that change in upward stair use had higher effect size (20.2 relative percentage change) than change in downward stair use effect size (4.4 relative percentage change). Upward stair use is relevant with regard to preventing weight gain because upward as opposed to downward stair use expends more energy and produces a higher metabolic rate (Eves & Webb, 2006; Nocon, Müller-Riemenschneider, Nitzschke, & Willich, 2010).

The Lee et al. (2012) study used one effective stair prompt by following the antecedent control procedure of one cue for one behavior. Relevant message themes were contained within one NYC DHMH stair prompt, rather than multiple message themes scattered across various prompts: *Burn Calories, Not Electricity—Take the Stairs!* The weight management and the sustainability themes increased stair use across multiple settings. Hence, multiple themes on one stair prompt might be better than individual theme placed on different stair prompts.

### **The Present Study**

Stair use can be a simple way to accumulate physical activity for college students and other individuals on campus, so a pilot study observed upward stair use at SJSU in spring of 2010. Observations revealed about half of college students and other individuals were stair users (i.e., 51% stair users and 49% elevator users), suggesting a stair-prompt intervention to encourage physical activity may be useful (Barga, Chhay, Snyckerski, & Laraway, 2010). Therefore, the present study aimed to use these preliminary findings as a springboard for creating a stair-prompt intervention at the college campus and for continuing research on stair-prompt message themes.

With this framework, instead of creating another stair prompt, permission was obtained to modify the NYC DHMH stair prompt for research purposes at SJSU, with the idea of including a time management theme, to enhance effectiveness. The NYC DHMH stair prompt was chosen because it was shown to be effective in different settings (Lee et al., 2012). The slogan, *Burn Calories, Not Electricity—Take the Stairs!*, has themes likely to appeal to individuals concerned with potential weight gain, a more sustainable environment, or both.

Recent studies of students, faculty, and staff at SJSU indicate that an intervention to prevent weight gain through physical activity would be relevant. A 2009 health survey conducted among SJSU students revealed about 40% describe themselves as slightly overweight or very overweight; a quarter of both genders desired to maintain their current body weight, and about 55% of all the students surveyed were interested in obtaining information related to physical activity (ACHA, 2009). A 2010 survey among SJSU faculty and staff reported 48% could be classified as either overweight or obese based on self-reported weight and height used to calculate body mass index (Freedman & Rubinstein, 2010).

Stair use is not only a simple form of physical activity that increases caloric expenditure to help prevent weight gain, but also it is a more sustainable behavior for traveling within multilevel buildings. For able-bodied individuals, using the stairs helps conserve electricity and the environmental cost of producing energy. Sustainable ideas align with the California State University system and SJSU because the current aim of the educational system is to become more sustainable via energy and water conservation

projects (Reed, 2006; SJSU Facilities Development & Operations, 2011; SJSU Sustainability, 2011). Although a majority of energy consumption comes from building heating and cooling systems, various electrical equipment, and lights, elevators account for about 1% to 7% percent of total energy usage, with higher rise buildings accommodating more occupancies and more energy consumption (Hakala, Siikonen, Tyni, & Ylinen, 2001). One to 7% can be costly when considering the hundreds of thousands of dollars needed to power high-traffic buildings. Thus, one of these energy conservation projects could include lower elevator use.

Walking up stairs use may also be faster than using an elevator. On average, it takes about 13 seconds to ascend one building level by stairs, compared to about 36 seconds to ascend by elevator (Shah, O'Byrne, Wilson, M. & Wilson, T., 2011). Therefore, using the stairs rather than the elevator can be much quicker when taking into consideration the variables that can influence average elevator wait and travel time (e.g., the number of individuals using elevator(s), the elevator capacity, and the speed of the moving elevator) (Luh et al., 2005). Kerr, Eves, & Carroll (2001a) reported that commuters were motivated to increase stair use with the inclusion of a save time message beside the conventional stair prompt suggesting health benefits. At SJSU, it is possible that some individuals may want to save time when going from one building level to another in between classes, especially if they have a short window of time to get from one class to another. A stair prompt tailored to time management could be a simple theme to bolster the appeal of taking the stairs instead of the elevator.

The original NYC DHMH stair prompt only incorporated weight management and sustainability themes. For a setting such as SJSU that has a higher baseline level for individuals walking up the stairs than those reported in previous studies, it was important to maximize the likelihood of stair prompt effectiveness as much as possible (Foster & Hillsdon, 2004). Therefore, the present study modified the original NYC DHMH stair prompt to include a time management theme in addition to the existing two themes. The stair prompt used in this study had the primary slogan, *Burn Calories, Not Electricity. Save Time!—Take the Stairs!* With three message themes, it was believed that at least one of the themes could be an effective motivational factor for stair use regardless of whether individuals are in a hurry or not, but it was also conceivable that all three themes could work synergistically as one cue to increase the likelihood of stair use. Furthermore, a caption in smaller print reads: *Walking up the stairs helps prevent weight gain and helps the environment. It can also be quicker than the elevator* (see Appendix A).

The primary goal of the present study was to create a stair-prompt intervention for increasing short bouts of physical activity as one approach to prevent weight gain among individuals at SJSU. A secondary goal of the study was to examine whether the response to the stair prompt varied based on gender. The present study thus aimed to answer two research questions. First, will the stair-prompt intervention increase overall stair use? Second, will the stair-prompt intervention differentially affect men and women in their stair use?

## **Method**

### **Participants and Settings**

Upon approval from the San José State University Human Subjects Institutional Review Board (see Appendix B), behavioral observations were performed on individuals using the stairs and elevators at two multi-level buildings at SJSU. The majority of individuals who visit these buildings are students and faculty; others include staff and visitors. The demographic characteristics of the student body and faculty are included in Appendix C (SJSU Office of Institutional Effectiveness and Analytics, 2012a,b). Exclusion criteria were individuals who appeared unable to use stairs (e.g., those wearing a leg brace, using a wheelchair, moving cargo, or carrying large objects). Building staff members who were informed of the study were also excluded.

One of the buildings was the four-level engineering building containing classrooms, offices, and laboratories. This building was chosen because the stairs and elevators are not adjacent. Upon entry into the main building entrance, the stairs are hidden, whereas the two elevators are immediately visible about 12 m (40 ft) straight ahead. To reach the stairs, individuals must walk straight ahead for 4.5 m (15 ft) before turning right for a corridor leading to the stairs or use a side entrance to the building to reach this corridor and stairs. That is, once at the elevator waiting area, individuals have walked past the corridor leading to the stairs; thus, the stairs are hidden.

A six-level garage was chosen as the second site because the stairs and elevator are adjacent. Although there are two stair entryways in this building, the south stairs and elevator entrance closer to instructional buildings were observed. Here, upon entry into



the stairs and elevator entrance, individuals are immediately confronted with a point-of-decision: walk forward a few feet and turn left to reach an elevator or simply turn right to take stairs. Once at the elevator waiting area, individuals can turn around and opt for stairs instead if the motivation for the elevator ceases.

## **Materials**

The NYC DHMH granted permission to modify its stair prompt for our research use (see Appendix A). According to Kerr, Eves, and Carroll (2001a), a stair prompt should be at least 60.0 cm × 42.0 cm (24 in × 17 in) or larger to maximize visibility and effectiveness, especially when other signs are competing for attention. Thus, modified stair prompts were printed on laminated foam boards measuring 55.8 cm × 71.1 cm (22 in × 28 in) and stood 152.4 cm (60 in) tall when seated in metallic chrome sign stands (ExecuSystems Direct via Amazon.com).

During the intervention phase at the engineering building, the modified NYC DHMH stair prompt was locked to a building column about 3 m (10 ft) from the two elevator entrances. For the intervention phase at the garage, the modified NYC DHMH stair prompt was locked to fencing adjacent to the elevator entrance. At both settings, the stair prompts and sign stands did not obstruct elevator entrances.

## **Research Design**

A naturalistic observation approach with a multiple-baseline research design across two settings was used in this study. During the baseline phase for each setting, no stair prompt was present. The stair prompts were introduced in the intervention phase for both settings. However, the baseline and intervention phases were staggered, so that the

engineering building received the intervention first, and the garage remained in the extended-baseline phase for three weeks longer before the intervention phase started. The observational variables (i.e., total stair ascend, men stair ascend, and women stair ascend) were the percentage of individuals walking up the stairs relative to both individuals walking up the stairs and individuals ascending by elevator.

### **Procedures**

Three research assistants were trained by the graduate student researcher for two hours, yielding 90% agreements or higher on interobserver agreement before data collection. Afterwards, occasional interobserver agreement days were scheduled for about a third of the total observations at each setting.

For interobserver agreement, two methods were used due to constraint of research assistants' availability: the two observer method and three observer method. For the two-observer method, the graduate student researcher observed both individuals walking up the stairs and individuals ascending by elevator, while the second observer observed only individuals ascending by elevator. For the three-observer method, the graduate student researcher observed both individuals walking up the stairs and individuals ascending by elevator, while the second observer observed only individuals walking up the stairs, and the third observer observed only individuals ascending by elevator. The three-observer method allowed for checking observation accuracy for individuals walking up the stairs and individuals ascending by elevator at the same time. In some cases, the graduate student researcher switched to observe individuals ascending by elevator to provide some balance.

On regular days of observation, the graduate student researcher and one research assistant observed one of the buildings from 12:15 p.m. to 1:00 p.m., Monday through Thursday. The 45 minute observations occurred 15 minutes after course instruction started and ended 15 minutes before course instruction ended. Observations during slower times were conducted to ensure that individuals walking up the stairs were likely a behavioral choice rather than a result of overcrowding in elevators. Observations at each building were conducted on alternating week days. For example, observations at the engineering building might occur on Monday and Wednesday, and observations at the garage might occur on Tuesday and Thursday of the same week, with observations the following week starting at the garage, using the same alternating sequence. In this manner, over the course of the 13-week study, each Monday, the observational setting was switched back and forth, also to provide balance.

When collecting data, observers were in the area near both the stairs and the elevators. Observers sat on chairs in the engineering building lobby within 4.5 m to 9 m (15 ft to 30 ft) from stairs and elevators. At the garage, they sat on a bench within 6 m (20 ft) in front of the stairs and elevator entrance. At both buildings, observers collected data with laptops. One observer made an observational count of individuals walking up the stairs, while the other observer made an observational count of individual ascending by elevator. The procedures allowed each observer to focus on one mode of ascending from the ground level of each building. Observers recorded into spreadsheets each occurrence of an individual walking up the stairs or an individual ascending by elevator

as dummy code value (e.g., 1 for a man, 2 for a woman, and 3 for an undetermined gender).

### Statistical Analyses

Interobserver agreement (IOA) was calculated as simple percent (smaller number observed/larger number observed × 100), by creating a percent agreement ratio. For example, if one observer recorded 18 men and 20 women, and the second observer recorded 20 men and 17 women, the calculations would be as follows: first observer (18 men + 20 women = 38) and second observer (20 men + 17 women = 37). The lower count was divided by the higher count to produce the percent agreement (i.e., 37/38 = .97 or 97%). In addition to total numbers, percent agreement was also calculated for men and women observations separately.

Table 1 provides the descriptive statistics for interobserver percent agreement. Calculations for average percent agreement were done for each setting. This combined both agreements for stairs and elevator observations. Appendix D provides a graph of interobserver agreement and the corresponding days the procedure was done.

Table 1

#### *Descriptive Statistics for Interobserver Percent Agreement*

Observational setting	Days	Total	Men	Women
Engineering building	10	95.2 (4.2)	94.4 (3.9)	92.3 (6.1)
Garage	13	96.3 (3.7)	94.9 (5.1)	94.4 (4.0)

*Note: Days = the number of days for the interobserver agreement procedure. Percent values represent averages and standard deviations in parentheses across the number of interobserver days.*

To evaluate the effectiveness of the modified NYC DHMH stair prompt for increasing stair use across settings, two statistical procedures were employed to compare

the percentage of individuals walking up the stairs between the two observational phases. First, the chi-square statistic was used to determine whether the overall percentage of individuals walking up the stairs differed across the two phases in each building (Levine, Krehbiel, Berenson, Ng, & Stephan, 2007). Second, time-series regression procedures were used to evaluate the change in stair behavior over time across the two phases. For analyzing data from multiple-baseline designs, Huitema (2011) recommended time-series regression models that compare behaviors during baseline and intervention phases. The main parameters of interest are Time ( $T$ ), Level Change ( $LC$ ) from baseline to intervention, and the Slope Change ( $SC$ ) from baseline to intervention. The  $T$  parameter evaluated whether observed behavior changed across time, independent of an intervention effect. The  $LC$  parameter evaluated whether an intervention changed the level of the observed behavior in the intervention phase by comparing the data for before and after the intervention. The  $SC$  parameter evaluated whether there is a gradual change in observed behavior following the intervention. Therefore, a conclusion in favor of a stair prompt intervention must have a statistically significant parameter corresponding to the  $LC$  coefficient, the  $SC$  coefficient, or coefficients for both parameters. That is, the presence of a statistically significant  $LC$  coefficient and/or the  $SC$  coefficient suggests a change in observed behavior at the time point of transition between the baseline phase and the intervention phase.

Accordingly, the OLS regression procedure, common in most statistical packages, was used to run the time-series regression. The time-series regression summary tables, the unstandardized beta coefficients, the test statistics, and the probability values

provided evidence of intervention effectiveness. In this case, a positive unstandardized beta coefficient suggested an upward behavioral trend, whereas a negative unstandardized beta coefficient suggested a downward behavioral trend. Appendix E provides examples of dummy codes for the model parameters when running the time-series regression procedure (see also Huitema, 2011, for more information about statistics).

Similar to the OLS regression model, the assumptions of the time-series regression models used in this study expected that the residuals of the models are normally distributed, homoscedastic, linear, and independent (i.e., no significant autocorrelation is present). Autocorrelation can produce an inadequate model fit. The presence of lag-1 autocorrelation in the errors was tested using the H-M test for autocorrelation (Huitema, 2011). Following Huitema's recommendation for small samples, the alpha level was set at .20. When significant autocorrelation was detected, the Time Series Double Bootstrap procedure was used to correct for the presence of autocorrelation (Huitema & McKean, 2000; McKean, 2010; McKnight, McKean, & Huitema, 2000).

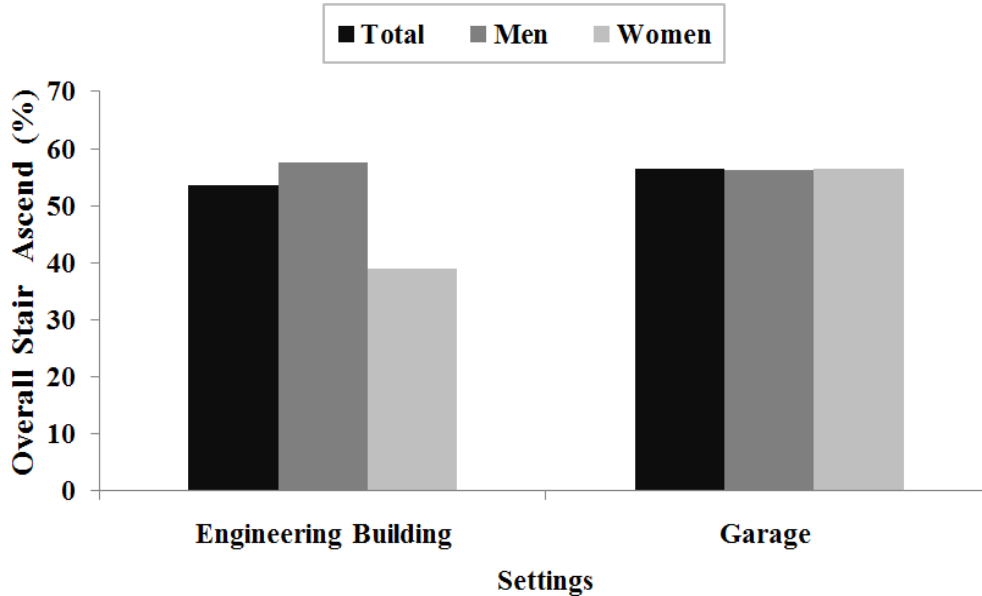
For the three observational variables, data for each day of observation were converted to percentages, using a proportion formula, as an example (the frequency or number of individuals walking up the stairs/[the number of individuals walking up the stairs + the number of individuals ascending by elevator]) at each building, and the percent of men and women walking up the stairs using the same proportion formula. Thus, the three observational variables in percentages were total stair ascend percent,

men stair ascend percent, and women stair ascend percent. In total, the chi-square and the time-series regression procedures were performed for each of these observational variables and for each setting using the  $\alpha = .05$  level of significance.

## Results

### Descriptive Statistics

At the engineering building, 2,210 men, 652 women, and 19 individuals of undetermined gender were observed as both stairs and elevator users. At the garage, 1,289 men, 1,183 women, and 14 individuals of undetermined gender were observed as stairs and elevator users. Figure 1 displays the overall percentages of individuals walking up the stairs (i.e., overall stair ascend percentages) for the three observational variables according to building. For all observations at the engineering building and the garage, a total of 68 individuals met the exclusion criteria and were not included in any of the calculations. Overall stair ascend percentages are summary statistics combining values for both baseline phase and intervention phase.



*Figure 1.* Graph for Overall Stair Ascend Percentages  
Overall stair ascend percentages show the percentages of individuals walking up the stairs across observational phases.



Table 2 provides detailed descriptive statistics on the average number of individuals walking up the stairs per observational day, reported as stair ascend percentages and frequencies. This table also gives the breakdown of daily averages for each of the observational variables (i.e., total stair ascend, men stair ascend, and women stair ascend) across each of the observational settings (i.e., engineering building and garage) as well as for each observational phase.

Table 2

*Descriptive Statistics of Daily Stair Ascend Averages*

Observational variable	Engineering building		Garage	
	Baseline	Intervention	Baseline	Intervention
Total stair ascend %	52.4 (6.3)	53.8 (6.2)	56.7 (6.8)	56.7 (6.1)
Frequency	66.0 (15.8)	63.0 (15.4)	52.0 (9.0)	57.0 (9.7)
Men stair ascend %	55.9 (7.9)	57.8 (6.8)	55.3 (8.3)	57.9 (6.4)
Frequency	54.0 (15.4)	52.0 (12.3)	26.0 (4.0)	30.0 (6.0)
Women stair ascend %	39.7 (7.7)	39.4 (8.3)	57.6 (9.3)	54.8 (8.7)
Frequency	11.0 (2.3)	10.0 (3.6)	25.0 (7.3)	27.0 (6.9)

*Note.* Percentages and frequencies are means (standard deviations in parentheses) of daily stair use. At the engineering building, there were 9 baseline and 15 intervention observational days; at the garage, there were 14 baseline and 12 intervention observation days.

**Inferential Statistics**

To answer the first research question as to whether the modified NYC DHMH stair prompt increased stair use, the chi-square statistic revealed no differences in the total stair ascend percentages following a stair-prompt intervention across both observational phases and observational settings. Examinations of men stair ascend and women stair ascend percentages for each gender also revealed no increase for men and women walking up the stairs. Thus, the findings suggested that the modified NYC DHMH stair prompt did not motivate individuals to walk up the stairs at all. Details on the stair

ascend percentages for the observational variables at each observational setting and under each observational phase are shown in Table 3 and Table 4. In these tables, effect size measures are reported as absolute percentage change and relative percentage change according to formulae provided by Soler et al. (2010).

Table 3

*Statistics of Stair Ascend Percentages at the Engineering Building*

Observational variable	Baseline	Intervention	Effect Size		Test of Proportion	
	% ( <i>n</i> )	% ( <i>n</i> )	<i>APC</i>	<i>RPC</i>	$\chi^2$	<i>p</i>
Total stair ascend	52.8 (592)	54.0 (951)	1.2	2.3	.64	.52
<i>N</i> total	1121	1760				
Men stair ascend	56.7 (486)	58.1 (786)	1.4	2.4	.64	.52
<i>N</i> men total	857	1353				
Women stair ascend	38.9 (100)	39.0 (154)	.07	.20	<.001	.98
<i>N</i> women total	257	395				

*Note.* Rows are stair ascend percentages based on *n* = the number of individuals walking up the stairs divided by *N* = the number of individuals walking up the stairs and the number of individuals ascending by elevator per observational phase. *APC* = absolute percentage change and *RPC* = relative percentage change based on formulae as described by Soler et al. (2010). There were 9 baseline and 15 intervention observational days.

Table 4

*Statistics of Stair Ascend Percentages at the Garage*

Observational variable	Baseline	Intervention	Effect Size		Test of Proportion	
	% ( <i>n</i> )	% ( <i>n</i> )	<i>APC</i>	<i>RPC</i>	$\chi^2$	<i>p</i>
Total stair ascend	56.3 (724)	56.7 (681)	0.36	.64	.03	.86
<i>N</i> total	1285	1201				
Men stair ascend	54.5 (363)	58.0 (361)	3.40	6.3	1.55	.21
<i>N</i> men total	666	623				
Women stair ascend	57.7 (350)	55.2 (318)	-2.50	-4.3	.72	.40
<i>N</i> women total	607	576				

*Note.* Rows are stair ascend percentages based on *n* = the number of individuals walking up the stairs divided by *N* = the number of individuals walking up the stairs and the number of individuals ascending by elevator per observational phase. *APC* = absolute percentage change and *RPC* = relative percentage change based on formulae as described by Soler et al. (2010). There were 14 baseline and 12 intervention observational days.

The time-series regression procedure provides information on upward, downward, or constant behavioral trend over time across observational phases. Summaries of time-series regression procedures are presented in tables. Each table shows two time-series regression summaries for each setting on one observational variable. That is, summaries of time-series regression and of TSDB procedures are shown in Table 5 for total stair ascend, while men stair ascend percentages and women stair ascend percentages are shown in Tables 6 and 7, respectively.

None of the time, level change, and slope change parameters were statistically significant (See Table 5-7). The overall level change coefficient was computed as a weighted average for level change parameters across settings, and the standardized effect size for the level change parameter was reported. Corresponding figures show the stair ascend percentages for the three observational variables below each of the time-series regression summary table. Figure 2 shows a graph of the total stair ascend percentages staggered across observational days for both the engineering building and the garage; Figures 3 and 4 show men and women stair ascend percentages, respectively.

Table 5

*Time-Series Regression Predicting Total Stair Ascend Percentages*

Observational setting and parameter	<i>Coefficient</i>	<i>p</i>	<i>Effect Size</i>
Engineering building			
Time	-.010	.21	
Level change	.073	.20	1.15
Slope change	.009	.31	
Garage			
Time	-.008	.44	
Level change	.008	.90	0.80
Slope change	.013	.36	
Overall level change	.055	.54	0.90

*Note.* The effect size column represents standardized level change effect size for each setting. The overall level change effect size represents a standardized level change effect size across settings. These effect size formulae are from Huitema (2011). There were 24 observational days at the engineering building and 26 observational days at the garage.

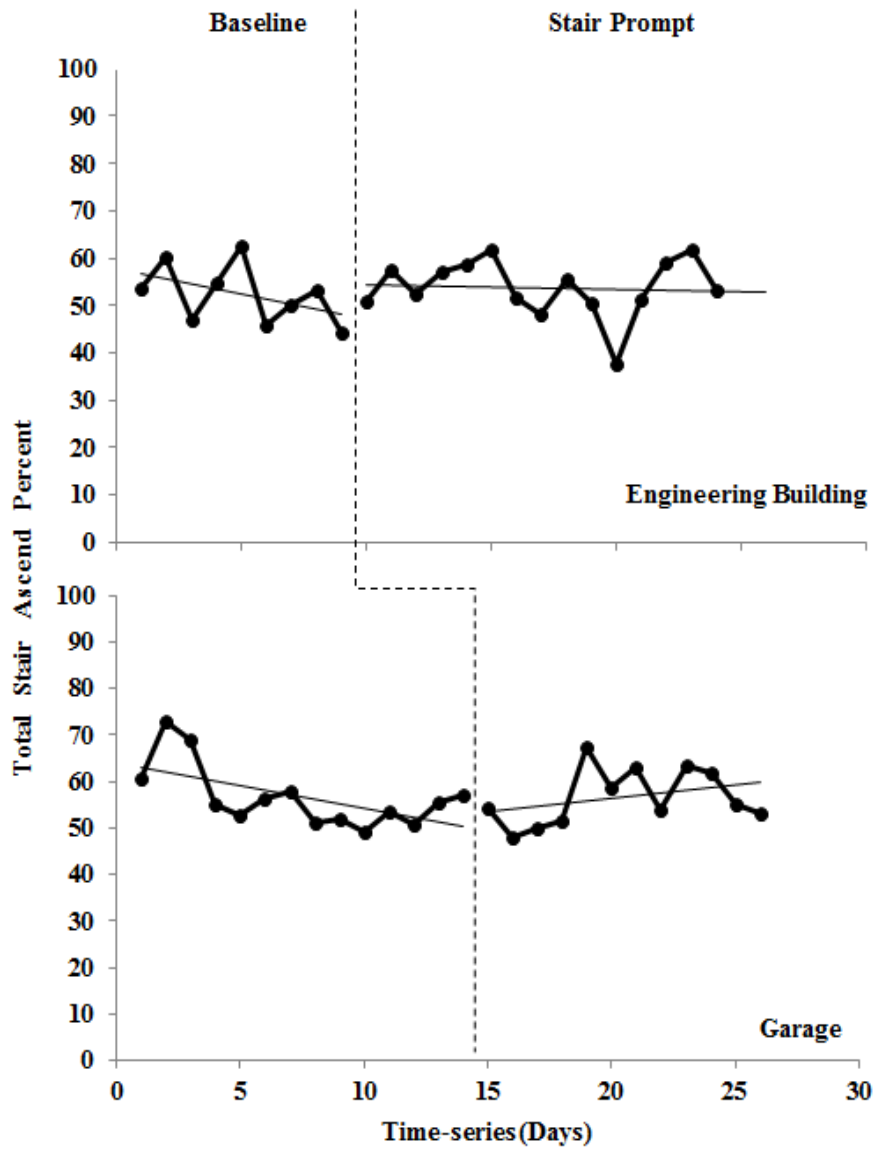


Figure 2. Time-series Graph for Total Stair Ascend Percentages  
 Time-series graph for total stair ascend percent has trend lines to represent total stair ascend for each phase. These lines help display an increase, decrease, or no change in stair ascend trend across phases.

Table 6

*Time-Series Regression Predicting Men Stair Ascend Percentages*

Observational setting and parameter	<i>Coefficient</i>	<i>p</i>	<i>Effect Size</i>
Engineering building			
Time	-.014	.15	
Level change	.105	.11	1.48
Slope change	.011	.27	
Garage			
Time	-.014	.08	
Level change	.095	.18	0.90
Slope change	.019	.12	
Overall level change	.083	.17	1.20

*Note.* The effect size column represents standardized level change effect size for each setting. The overall level change effect size represents a standardized level change effect size across settings. These effect size formulae are from Huitema (2011). There were 24 observational days at the engineering building and 26 observational days at the garage.

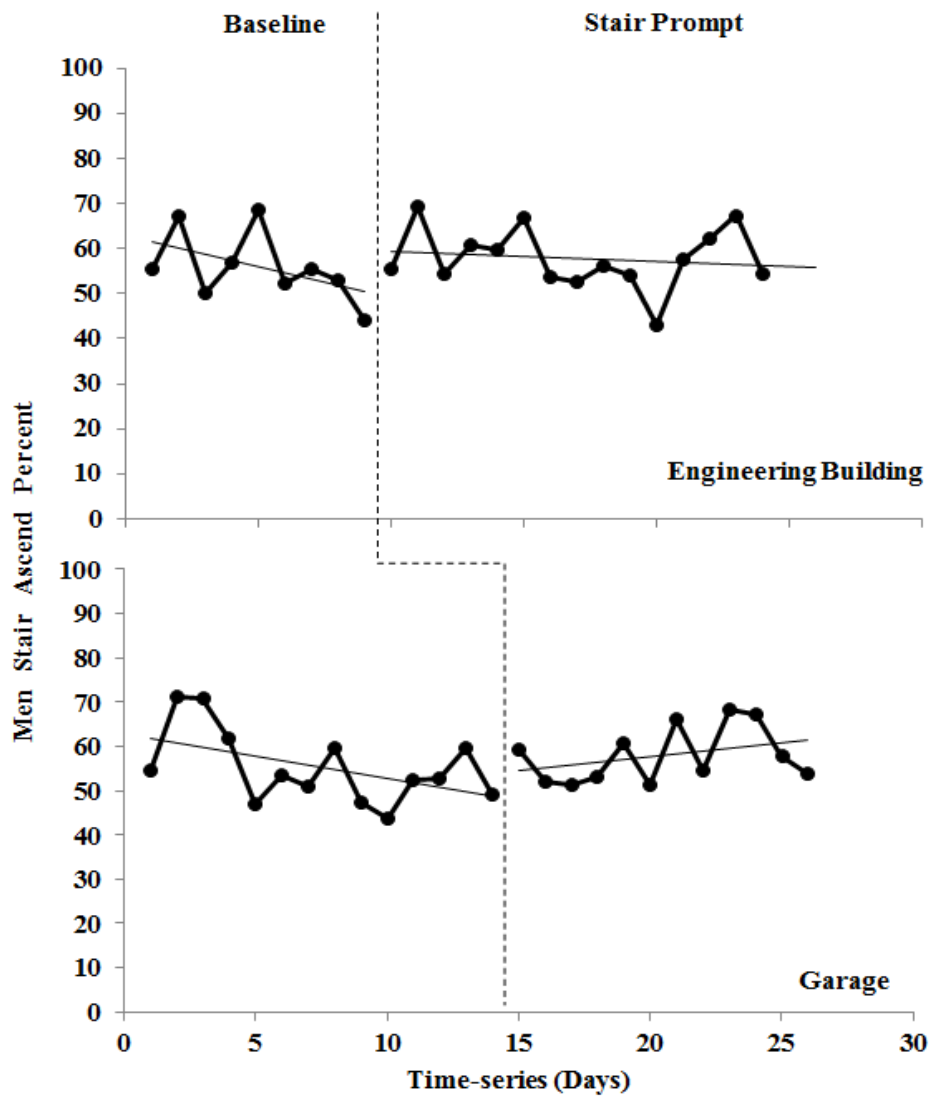


Figure 3. Time-series Graph for Men Stair Ascend Percentages  
 Time-series graph for men stair ascend percent has trend lines to represent men stair ascend for each phase. These lines help display an increase, decrease, or no change in stair ascend trend across phases.

Table 7

*Time-Series Regression Predicting Women Stair Ascend Percentages*

Observational setting and parameter	<i>Coefficient</i>	<i>p</i>	<i>Effect Size</i>
Engineering building			
Time	.003	.77	
Level change	-.030	.70	0.36
Slope change	-.002	.88	
Garage			
Time	-.003	.84	
Level change	-.059	.60	
Slope change	.009	.66	
Overall level change	.033	.59	0.39

*Note.* The effect size column represents standardized level change effect size for each setting. The overall level change effect size represents a standardized level change effect size across settings. These effect size formulae are from Huitema (2011). There were 24 observational days at the engineering building and 26 observational days at the garage.



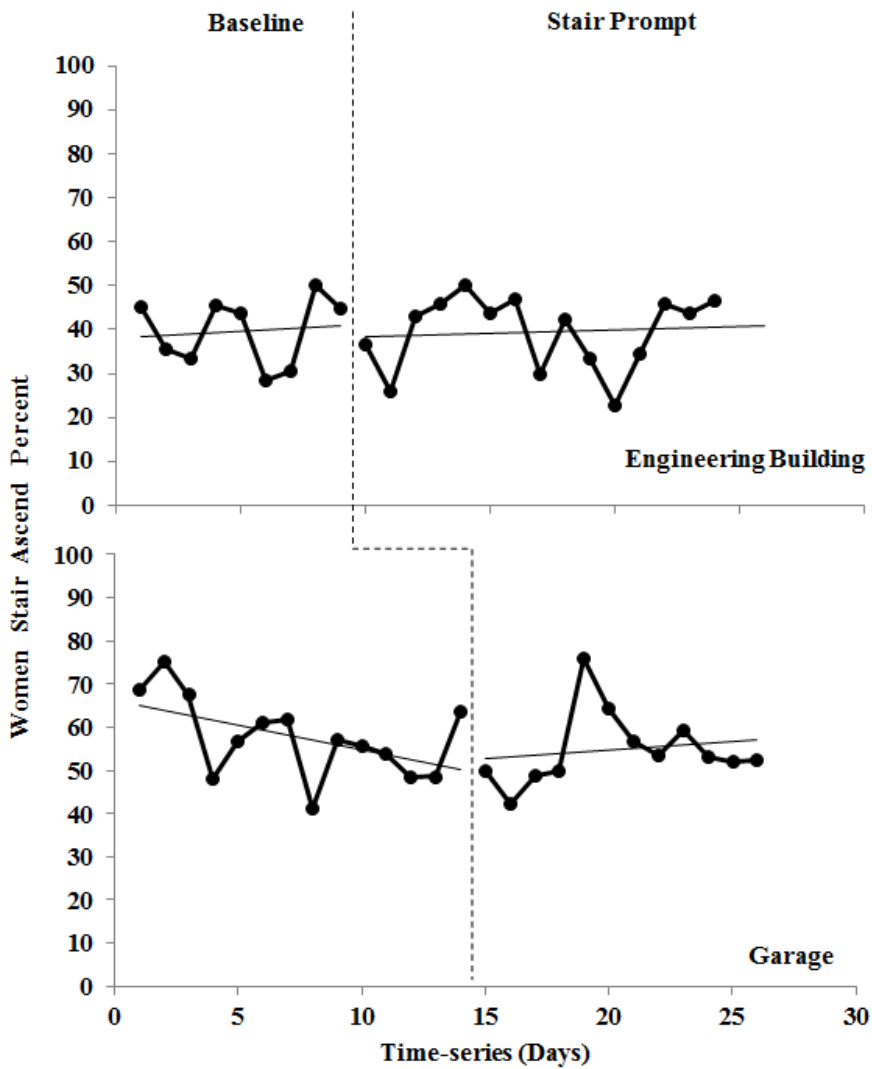


Figure 4. Time-series Graph for Women Stair Ascend Percentages  
 Time-series graph for women stair ascend percent has trend lines to represent women stair ascend for each phase. These lines help display an increase, decrease, or no change in stair ascend trend across phases.

This research aimed to answer whether the stair-prompt intervention differentially affected the stair use of men and women. Results revealed that there was no gender differences in stair use following the stair-prompt intervention, as there were no reported changes for all three observational variables in either the engineering or garage building.

### **Post-Hoc Analyses**

Results indicated that the modified NYC DHMH stair prompt was ineffective for motivating individuals to walk up the stairs beyond baseline levels. Visible stairs may be important for individuals when choosing options between taking stairs or the elevator, the stair visibility aspect of the building layout was next considered. At the engineering building, the stairs are not immediately visible upon entry in the lobby, reside farther from the two main elevators, and are hidden from view once individuals reach the elevator waiting area. At the garage, however, the stairs are easily visible and are directly opposite the elevator.

For comparing the percentages of individuals walking up the stairs between the two building layouts (i.e., hidden stairs versus visible stairs), the chi-square statistic was employed for each of the three observational variables because the goal was to compare two percentages rather than to evaluate behavioral trends over time. Table 8 provides details on the comparison of percentages for the observational variables. Results indicated differences on the percentage of individuals walking up the stairs for the two building layouts and the two genders. There were significantly greater percentages of total stair ascend and of women stair ascend at the garage where stairs are visible when compared to the percentages of total stair ascend and women stair ascend at the

engineering building where stairs are hidden upon entry and once at the elevator waiting area. The percentages for men stair ascend, however, did not differ across building layouts.

Closer examination between the percentages of men and women walking up the stairs at each setting yielded equally interesting findings. Men and women walked up the stairs at similar percentages at the garage, where stairs are visible upon entry and from the elevator waiting area. However, a greater percentage of men walked up the stairs than did women at the engineering building, where stairs are hidden from view upon entry and when at the elevator waiting area (Table 9).

Table 8

*Between Observational Settings Comparison on Stair Ascend*

Observational variable	Observational setting		Test of Proportion	
	Engineering building % ( <i>n</i> )	Garage % ( <i>n</i> )	$\chi^2$	<i>p</i>
Total stair ascend	53.6 (1543)	56.5 (1405)	4.72	.03
<i>N</i> total	2881	2486		
Men stair ascend	57.6 (1272)	56.2 (724)	0.64	.42
<i>N</i> men total	2210	1289		
Women stair ascend	39.0 (254)	56.5 (668)	51.55	<.001
<i>N</i> women total	652	1183		

*Note.* Rows are stair ascend percentages based on *n* = the number of individuals walking up the stairs in parentheses divided by *N* = the number of individuals walking up the stairs and the number of individuals ascending by elevator. At the engineering building, the stairs were hidden from the elevator waiting area, and at the garage, the stairs were visible from the elevator waiting area.

Table 9

*Between Gender Comparison on Stair Ascend*

Observational setting	Observational variable		Test of Proportion	
	Men stair ascend % ( <i>n</i> )	Women stair ascend % ( <i>n</i> )	$\chi^2$	<i>p</i>
Engineering building				
Stair ascend	57.6 (1272)	39.0 (254)	69.98	<.001
<i>N</i> total	2210	652		
Garage				
Stair ascend	56.2 (724)	56.5 (668)	0.02	.88
<i>N</i> total	1289	1183		

*Note.* Rows are stair ascend percentages based on  $n$  = the number of individuals walking up the stairs in parentheses divided by  $N$  = the number of individuals walking up the stairs and the number of individuals ascending by elevator. At the engineering building, the stairs were hidden from the elevator waiting area, and at the garage, the stairs were visible from the elevator waiting area.

## **Discussion**

The goal of the present study was to find a simple approach for accumulating short bouts of physical activity throughout the day for college students, faculty, and staff on a college campus. It was believed that walking up stairs at SJSU would be one way for individuals to increase physical activity. The original NYC DHMH stair prompt, known to be effective for encouraging stair use, was adapted for research in this setting. Themes deemed relevant to college students, faculty, and staff, such as burning calories for preventing progressive weight gain, reducing energy consumption for sustainability, and saving time while travelling, were expected to bolster motivation towards stair use. Another goal of the present study was to examine the stair use response for each gender corresponding to the stair-prompt intervention, as men and women engage in physical activity for different reasons (Kilpatrick et al., 2005).

None of the three observational variables observed in this study (i.e., total stair ascend, men stair ascend, and women stair ascend) showed an increase following the stair prompt intervention. This pattern was seen in two settings where stairs were hidden in one building and where stairs were visible in another building. Thus, the finding from the present study, that the stair prompt intervention alone did not increase stair use, was different from that previously reported (Lee et al., 2012).

There are a number of possible reasons for this unexpected response to the modified NYC DHMH stair prompt. In stairs and elevator choice scenario, the percentage of stair use can be high at baseline; elevators are not always available for use and require waiting time (Eves & Webb, 2006; Nocon et al., 2010). Thus, individuals

who are in a hurry and willing to take the stairs could already be among the stair users and help contribute to the high baseline stair use. In the present study, there was already high baseline stair use. High stair use percentages at baseline could reduce stair prompt effectiveness and produce smaller effect size, as evidenced by Lee et al. (2012). The original NYC DHMH stair prompt was effective, but the shorter, three-level health clinic building with higher stair use percent at baseline had smaller effect size (a 9% in relative percentage change) in response to the stair prompt, while the two taller buildings (i.e., 8-level academic and 10-level housing buildings) with lower stair use percent at baseline had the larger effect size (around 34% for both) in response to the stair prompt. The unexpected consequence is that high baseline stair use percentages in the present study reduced the stair prompt effectiveness and produced smaller effect size. This means that a response to a stair prompt may be dependent upon baseline stair-use levels.

Based on previous pilot study results, it was speculated that a stair-prompt intervention could be less effective in buildings with high stair use percent at baseline (Barga et al., 2010). Because the original stair prompt could increase the percentage of individuals walking up the stairs from 56% to about 67% (at a health clinic, Lee et al., 2012), it was believed that including a save-time message could bolster the stair prompt effectiveness beyond 67% by attracting more individuals unaware of the benefits of walking up the stairs. Although the percentages of individuals walking up the stairs at baseline were also in the mid-fifties in the present study, a modified stair prompt did not increase the percentage of individuals walking up the stairs to a level reported by Lee et al., indicating that addition of a time management theme provided no benefit. It remains

uncertain as to whether modification to the original NYC DHMH stair prompt reduced its effectiveness, or whether 67% of individuals walking up the stairs was a rare occurrence. To date, only one other study at an office building reported an increase in individuals walking up the stairs from 69% at baseline to 77% following a stair-prompt intervention alone, and an additional increase to 85% after an email reminded employees about the health benefits of stair use. However, removal of the stair prompt resulted in the percentage of individuals walking up the stairs returning to baseline level (Auweele, Boen, Schapendonk, & Dornez, 2005).

It is infrequent for a stair-prompt intervention alone to increase the percentage of individuals walking up the stairs above the mid-fifties. In the other two buildings in the Lee et al. (2012) study, the percentage of individuals walking up the stairs after the stair-prompt intervention was lower than 35%. Some studies reported higher percentages of individuals walking up the stairs (e.g., from 50% to 60%), while other studies reported lower percentages (Blake et al., 2008; Eckhardt, 2013; Kerr, Eves, & Carroll, 2001b; Kwak, Kremers, van Baak, & Brug, 2007; Lewis & Eves, 2012; Olander & Eves, 2011a; van Nieuw-Amerongen, et al., 2011). Because two buildings in the present study had baseline stair use percentages at 52.8% and at 56.3%, it is now apparent that significant increases in the percentage of individuals walking up the stairs above baseline levels would have been difficult to achieve.

In studies that were able to increase the percentage of individuals walking up the stairs towards 60% after an intervention, aggressive treatment packages were implemented (Lewis & Eves, 2012; van Nieuw-Amerongen, et al., 2011). For the present

study, a treatment package of those magnitudes (e.g., multiple components and expensive) would not have been feasible. It is also likely that future studies aiming to encourage stair use for physical activity would find treatment packages of those magnitudes unfeasible.

Nothing regarding gender and stair use in response to the modified NYC DHMH stair prompt could be concluded because there were no significant gender responses to the stair prompts intervention. In previous studies, men and women often responded to stair prompt interventions with increases in stair use, but stair use percentages between men and women were rarely similar (Eves, Webb, & Mutrie, 2006; Grimstvedt et al., 2010; Kerr, et al., 2001b; Kwak et al., 2007; Boutelle et al., 2001; Howie & Young, 2011; Olander & Eves, 2011a). In some studies, men used the stairs more than women, while in other studies, the opposite was true. The reasons for these differences are unknown.

The effect of stair visibility on stair use is also inconsistent. An individual standing in front of an elevator who sees the stairs may not necessarily take the stairs over the elevator. However, placing a stair prompt at the point-of-decision in a building has been shown to predict stair use. Distance from the elevator to the stairs, however, has not been shown to predict stair use (Bungum, Meacham, & Truax, 2007). The visible quantity of a building layout (i.e., the isovist) to incorporate an architectural perspective may be related to stair use. Eves, Olander, Nicoll, Puig-Ribera, and Griffin (2009) confirmed that a larger isovist contributed to stair prompt effectiveness since a larger isovist also increases the chance of seeing stairs. Olander and Eves (2011a) examined stairs and elevator distance upon entry into a building and reported that individuals were



more likely to walk up the stairs if upon entering a building, the distance to stairs was shorter than the distance to the elevator. Thus, these findings suggest that seeing stairs, particularly when entering a building, may help to promote stair use if walking up stairs is considered to be convenient.

Since some studies have cited that visibility of stairs contributed to stair use, two building layouts with one hidden stairs and the other visible stairs were part of the research design of the present study because it was believed that the modified stair prompt would be robust in both building layouts. Results from this study, however, were contrary to expectations. The modified NYC DHMH stair prompt, in fact, had no effect on individuals walking up the stairs in either building.

In the present study, there was a difference in the percentages of individuals walking up the stairs with regard to stair visibility. The building layout with the visible stairs upon entry and at the elevator waiting area had a greater percentage of individuals taking stairs. Closer inspection on the percentages of individuals taking stairs for each building layout suggested that when stairs were hidden, the percentage of men walking up the stairs were higher than those for women. However, when stairs were visible, the percentages of individuals taking stairs were similar for men and women. Therefore, results from the present study suggested that women's choice for stairs may be sensitive to stair visibility in multilevel buildings.

In studies where buildings had stairs and elevators adjacent—thus making stairs visible—Eves, Webb, and Mutrie (2006) and Grimstvedt et al. (2010) reported men took the stairs more often than women. However, Kerr, et al. (2001b) and Kwak et al. (2007)

reported women took the stairs more than men; van Nieuw-Amerongen et al. (2011) reported no difference between genders. In other studies that did not report building layouts for stairs and elevators, it is difficult to determine whether stair visibility effected men and women differently. Boutelle et al. (2001), Howie and Young (2011), and Olander and Eves (2011a) reported gender differences in stair use, while Bungum et al. (2007) and Lewis and Eves (2012) reported no gender differences.

### **Implications**

Findings from the present study add to the body of knowledge on stair prompt research used to encourage stair use for physical activity. Lack of effectiveness of the modified NYC DHMH stair prompt revealed a likely weakness among most stair-prompt intervention. Specifically, it is difficult to increase the percentage of individuals walking up stairs beyond the mid-fifties, even in buildings with visible stairs. Studies using stair-prompt interventions that have shown stair use percentages reaching up to and exceeding 60% are rare. The majority of studies reported stair use percentages well below the mid-fifties.

Prior to uncovering this possible ceiling regarding stair prompt effectiveness, it was unknown whether there was a limit in terms of the percentage of individuals who would respond to a stair-prompt intervention. The reason for this may stem from the fact that most stair prompt studies focused mainly on determining whether stair-prompt interventions were effective for encouraging stair use for accumulative physical activity and its potential health benefits across various settings rather than focusing on

determining the percentage of the population who would respond to a stair-prompt intervention.

To date, various studies have reported gender differences on stair use percentages without providing much explanation. It has remained unclear which factors may motivate one gender to preferentially use stairs. The limited description of the stairs (e.g., visible or hidden) has also made it difficult to conclude whether stair visibility is a determining factor in stair use. Based on Kwak et al. (2007) and van Nieuw-Amerongen et al. (2011) and the present study, it can be tentatively concluded that when a building has visible stairs, women, as compared to men, use stairs at equivalent or at higher percentages. Specifically, in the present study, when a building has hidden stairs, women used these stairs at much lower percentage than men.

In general, how likely are individuals to seek out hidden stairs when entering a strange building? Stair use research focusing on the explorative nature of individuals in building environments is lacking. Besides personal attitudes about physical limitations or beliefs about meeting the physical activity recommendations which could inhibit willingness to use stairs, there are other cognitive factors, such as anxiety about getting lost might hinder exploration to seek out stairs, when considering costs and benefits.

When pressed for time, how likely is anyone to consider exploring a building for stairs when the potential cost is wasting more time as a result of getting lost? Ehlers, Hofmann, Herda, and Roth (1994) compared feelings of driving-phobic and control individuals. Among reasons that might contribute to driving phobia, concern about getting lost scored higher than dangerous road conditions among driving-phobic

individuals and higher than losing control of the vehicle among control individuals. Thus, it can be inferred that concern about getting lost in general may, for some, deter motivation to search for hidden stairs in buildings. Concern about getting lost when navigate an unfamiliar building can affect anxiety levels differently in males and females. The evidence to lend some support for this idea stemmed from self-reported research in which more women compared to men reported feelings of spatial anxiety (anxiety about navigating) (Lawton, 1994).

Women's anxiety about getting lost could come from their preferred navigational strategy and from personal experience. Studies have shown that women tend to favor a route strategy of using landmarks (e.g., houses, shops, and ponds), while men tend to favor a survey strategy using Euclidean-orientation and cardinal directions to aid navigation towards a destination. Studies have also alluded to the notation that the strategies used by men could be more efficient than the strategies used by women in learning a novel route (Choi, McKillop, Ward, & L'Hirondelle, 2006; Galea & Kimura, 1992; Lawton, 1994; Moffat, Hampson, & Hatzipantelis, 1998; Tlauka, Brolese, Pomeroy, & Hobbs, 2005). For example, the route strategy involves sequential noting of steps for turn-by-turn directions such as turn right at the first landmark, then turn left at the second landmark, to reach a particular destination. Accordingly, this strategy is more susceptible to route disruption such as a missed turn due to the sequential nature. If an individual misses a turn at the first landmark, the individual is not likely to encounter the second landmark and thus is more likely to experience the anxiety of being lost. The survey strategy, however, uses a mental map of the environment, allowing the individual

to reference the self in relation to the route and the destination as residing on a geometric configuration. Therefore, individuals using the survey strategy can adapt alternative routes for route detour, shortcuts, and deviations from a missed turn, once the individual can reference the self towards the destination direction. Hence, the results of these navigational studies collectively help shed light as to why there were some gender differences regarding stair use in the present study, given the two different building layouts.

It should also be noted that women may have anxiety about getting lost in a new environment and thus hindering their stair use, and that men may have a navigational advantage over women in the environment, but these cognitive factors may only explain part of stair-use discrepancy, as convenient elevator use could be another factor deterring stair use. Even in buildings with stairs next to escalators, and anxiety about getting lost and navigational advantages are eliminated, more men than women have been observed using stairs (Blamey, Mutrie, & Aitchison, 1995; Brownell et al., 1980; Kerr, Eves, & Carroll, 2001a,c,d; Nomura, Yoshimoto, Akezaki, & Sato, 2009).

Inconvenience may be a better deterrent of elevator use than the desire to conserve energy. Van Houten, Nau, and Merrigan (1981) demonstrated that using posted feedback to state elevators' cost energy was not effective for deterring elevator use. It was only until elevators' doors were slowed to induce inconvenience, in addition to the posted energy cost, that individuals responded with reduced elevator usage. Likewise, traffic patterns in buildings can also induce inconvenience of slower elevator use. Researchers have found a negative relationship between the number of elevators

available and the number of individuals using stairs. A reduction from four to three elevators increased stair use (Olander & Eves, 2011b). It can be difficult for individuals to break past habits because there is a tendency to favor convenient behaviors that demand less effort such as using elevators. It takes slower elevator doors or less elevator availability to weaken the convenience of elevator use, so that more effort, such as increased wait time and patience, are required to decrease the use of elevators (Friman & Poling, 1995; Miltenberger, 2012).

Finally, the present study is the first to use both the chi-square statistic and the time-series regression procedures to evaluate stair prompt intervention effectiveness. In particular, the time-series regression procedure is more ideal for research when the goal is to track changes in behavior over time because the unstandardized beta coefficient signs (i.e., slopes of trend lines) help to describe the direction and the rate of behavioral change. As evidenced in the present study, when summaries of time-series regression procedures are reported together with graphical displays of behavior trending, these visual aids help conceptualize the effectiveness of the stair prompt intervention.

### **Limitations**

In the present study, limited observations on stair and elevator use in buildings were constrained by the 16-week fall 2012 semester session and by the limited number of personnel involved with research observations at each building. For these reasons, four observations a week (e.g., two observations at each building) were the norm, and these limited observations may have contributed to more variation in the stair use data.

In addition, observation times when courses were in session at the two academic buildings showed two separate stair use patterns. It is uncertain whether these two patterns relate strongly to building layouts (e.g., stair visibility) or to time of day. As seen in Figure 1-3, percentages of individuals walking up the stairs did not show any obvious change in trend at the engineering building. However, these figures with trend lines show expected changes at the garage during the intervention phase where stair ascend percentages reverse course from downward trend at baseline to upward trend with the intervention. This conclusion for each of the observational variables is also marked with the negative unstandardized beta coefficients for the time parameter and with the positive unstandardized beta coefficients for the slope change parameter. This may have indicated small effects of the stair prompt on commuters motivated to save time at the garage when leaving campus, compared to non-commuters taking the stairs in the engineering building. It remains uncertain as to whether a longer intervention phase would have produced a stronger upward pattern of stair ascend percentages at the garage. Nonetheless, even if stair ascend percentages were to increase substantially at the garage, the effectiveness of the modified NYC DHMH stair prompt would still be in question because the multiple-baseline design of the present study required stair ascend percentages to increase at both buildings in order for a strong conclusion in favor of the stair-prompt intervention.

Another limitation of this study is that the statistical models used assumed independent behaviors, in that each individual is assumed to use stairs or elevators independent of other individuals' influence. This could be far from true. In some

instances, individuals in a group might follow the leader of the group or a majority of the group if the leader or the group heads in the direction of the stairs or elevators. In the present study, as well as in other studies, these types of group stair and elevator use were not excluded from observation. Currently, it is unclear whether groups of individuals tend to favor stairs or elevator use more. If individuals tend to favor one mode of ascending multilevel building more when in a group as opposed to when alone, the extent of the bias results is unknown. It might be best to treat individuals and groups of individuals as separate grouping variables for statistical procedure in order to account for this potential bias.

Lastly, it is common for the percentage of individuals walking down the stairs to be higher than the percentage of individuals walking up the stairs, with or without any intervention (for examples, Boutelle et al., 2001; Bungum et al., 2007; Eves et al., 2006; Kerr et al., 2001b; Lee et al., 2012; Olander & Eves, 2011b). Unfortunately, studies to evaluate to what extent the population is willing to use stairs for descending multilevel buildings are also lacking. Because walking up stairs, as contrasted to walking down stairs, is believed to be more beneficial for health, the present study followed methods described in previous studies and only observed upward stair use. Although walking up stairs burns more calories than walking down the stairs and therefore aligns well with the weight management theme of burning calories, walking down the stairs aligns with the sustainability theme of saving electricity and the time management theme of saving time. Individuals could have walked down the stairs in accordance with themes of the modified



NYC DHMH stair prompt (i.e., *Burn calories, Save electricity, and Save time*) without our knowing because observations did not capture individuals walking down the stairs.

### **Future Research**

In the present study, only the number of individuals walking up the stairs (i.e., total stair ascend, men stair ascend, and women stair ascend) were observed for evaluating the effectiveness of the modified NYC DHMH stair prompt for physical activity. Unlike other studies, demographic variables such as race, body types, and age were not observed because it would have been difficult in this setting. The SJSU community is extremely diverse, and it would be impossible to distinguish between non-Hispanic and Hispanic whites, Asians and Pacific Islanders, and multiracial individuals purely from visual observation. Asking individuals sensitive information about their racial background, body weight, and age was not an option without full disclosure of the purpose of this study. Therefore, a future survey study could randomly select individuals to attain sensitive information once they are observed as stair or elevator users.

A study that involves interviewing individuals could be of great importance for health researchers, health organizations, and governmental health agencies that promote stair use for physical activity and could be used to further evaluate the effectiveness of a stair-prompt promotion program. Additionally, it would be important to determine whether stair users comprise the 50% of adults that participate in physical activity but do not meet the recommended guidelines or are part of the group that already engages in the recommended levels of physical activity. Further research is needed to examine

characteristics of individuals who use stairs and characteristics of those who could benefit from more physical activity through stair use.

Future research using a stair-prompt intervention should examine gender and stair visibility with building layouts more closely. It remains unclear whether women are indeed more sensitive to stair visibility in multilevel buildings, as the results of the present study speculate. Since the original stair-prompt research in the 1980s, gender differences have been consistently noted yet explanations for these differences is still lacking. Research on stair use for physical activity should not fixate only on the stair-prompt intervention following the antecedent-control procedures of behavioral psychology. Rather, more research should also incorporate ideas of environmental psychology on the interplay between environment and behaviors. Finally, future research on stair use may be useful in building layouts where individuals encounter stairs upon entry into a building, and elevators are farther and more effortful to search and use.

## **Conclusion**

Within the last three decades, there has been great interest in using stair prompts to promote stair use for physical activity in various settings. Accordingly, an overwhelming majority of research findings have corroborated the idea that stair-prompt interventions are effective for promoting stair use, thus suggesting stair use whenever possible could be a useful tool for combating the effects of a sedentary lifestyle—a lifestyle that puts individuals at risk of progressive weight gain and later obesity, as well as the increased risk of poor health and increased financial costs associated with weight-related illnesses. Therefore, the present study modified an effective NYC DHMH stair

prompt with the aim of bolstering its efficacy as one approach for encouraging stair use for physical activity.

Through the use of a multiple-baseline design, display of the modified stair prompts in two buildings on a college campus did not produce the expected increase in individuals walking up the stairs, as evidenced from statistical procedures used herein. The explanation for this inconsistency between the literature and current findings could be attributed to higher baseline stair use percentages. In the case of the present study, high stair use percentages at baseline may have made it less likely that any intervention approach would increase more stair use. Apart from this unexpected finding, it also appears that women might be less likely than men to use stairs if the stairs are hidden. Thus, the findings from the present study suggested that visibility of stairs from the elevator waiting areas, and potentially visibility of stairs upon building entry, may play an important role in the motivational process for individuals to walk up the stairs over taking the elevator.

## References

- Adams, J., & White, M. (2002). A systematic approach to the development and evaluation of an intervention promoting stair use. *Health Education Journal*, 61(3), 272-286.
- American College Health Association. (Spring 2009). *National College Health Assessment (ACHA-NCHA-II)*. Baltimore, MD.
- American College Health Association. (Fall 2012). *National College Health Assessment: Reference group data report undergraduate students fall 2012 (ACHA-NCHA-II)*. Hanover, MD.
- Auweele, Y. V., Boen, F., Schapendonk, W., & Dornez, K. (2005). Promoting stair use among female employees: The effects of a health sign followed by an E-mail. *Journal of Sport & Exercise Psychology*, 27(2), 188-196.
- Barga, G., Chhay, N., Snyckerski, S., & Laraway, S. (2010). *Elevator versus stair traffic: A forced decision*. Unpublished manuscript, Department of Psychology, San Jose State University, CA.
- Blake, H., Lee, S., Stanton, T., & Gorely, T. (2008). Workplace intervention to promote stair-use in an NHS setting. *International Journal of Workplace Health Management*, 1(3), 162-175.
- Blamey, A., Mutrie, N., & Aitchison, T. (1995). Health promotion by encouraged use of stairs. *British Medical Journal*, 311(7000), 289-290.
- Boreham, C. A. G., Kennedy, R. A., Murphy, M. H., Tully, M., Wallace, W. F. M., & Young, L. (2005). Training effects of short bouts of stair climbing on cardiorespiratory fitness, blood lipids, and homocysteine in sedentary young women. *British Journal of Sports Medicine*, 39(9), 590-593.
- Boutelle, K. N., Jeffery, R. W., Murray, D. M., & Schmitz, M. K. H. (2001). Using signs, artwork and music to promote stair use in a public building. *American Journal of Public Health*, 91(12), 2004-2006.
- Brownell, K. D., Stunkard, A. J., Albaum. (1980). Evaluation and modification of exercise patterns in the natural environment. *American Journal of Psychiatry*, 137(12), 1541-1546.
- Bungum, T., Meacham, M., & Truax, N. (2007). The effects of signage and the physical environment on stair usage. *Journal of Physical Activity and Health*, 4, 237-244.

- California Department of Public Health. (2006). California 5 a day-Be active worksite program: A guide to improving worksite stairwells. Retrieved from <http://www.cdph.ca.gov/programs/cpns/Documents/Network-FV-WP-StairwellsTool.pdf>
- Center for Disease Control and Prevention. (2010). StairWELL to better health. Retrieved from <http://www.cdc.gov/nccdphp/dnpao/hwi/toolkits/stairwell/index.htm>
- Centers for Disease Control and Prevention. (2011a). *How much physical activity do adults need?* Retrieved from <http://www.cdc.gov/physicalactivity/everyone/guidelines/adults.html>
- Centers for Disease Control and Prevention. (2011b). *Preventing weight gain*. Retrieved from <http://www.cdc.gov/healthyweight/prevention/index.html>
- Centers for Disease Control and Prevention. (2012a). *Adult obesity facts*. Retrieved from <http://www.cdc.gov/obesity/data/adult.html>
- Centers for Disease Control and Prevention. (2012b). *Causes and consequences: What causes overweight and obesity?* Retrieved from <http://www.cdc.gov/obesity/adult/causes/index.html>
- Choi, J., McKillop, E., Ward, M., & L'Hirondelle, N. (2006). Sex-specific relationships between route-learning strategies and abilities in a large-scale environment. *Environment and Behavior, 38*(6), 791-801.
- Eckhardt, M. (2013). *Point-of-decision signs and stair use in a university worksite setting: General versus specific messages* (master's thesis). University of Texas, TX.
- Ehlers, A., Hofmann, S. G., Herda, C. A., & Roth, W. T. (1994). Clinical characteristics of driving phobia. *Journal of Anxiety Disorders, 8*(4), 323-339.
- Eves, F. F., Olander, E. K., Nicoll, G., Puig-Ribera, A., & Griffin, C. (2009). Increasing stair climbing in a train station: The effects of contextual variables and visibility. *Journal of Environmental Psychology, 29*(2), 300-303.
- Eves, F. F., & Webb, O. J. (2006). Worksite interventions to increase stair climbing; reasons for caution. *Preventive Medicine, 43*(1), 4-7.
- Eves, F. F., Webb, O. J., & Mutrie, N. (2006). A workplace intervention to promote stair climbing: Greater effects in the overweight. *Obesity, 14*(12), 2210-2216.

- Ford, M. A., & Torok, D. (2008). Motivational signage increases physical activity on a college campus. *Journal of American College Health, 57*(2), 242-244.
- Foster, C., & Hillsdon, M. (2004). Changing the environment to promote health-enhancing physical activity. *Journal of Sports Sciences, 22*(8), 755-769.
- Freedman, M. R., & Rubinstein, R. J. (2010). Obesity and food choices among faculty and staff at a large urban university. *Journal of American College Health, 59*(3), 205-210.
- Friman, P. C., & Poling, A. (1995). Making life easier with effort: Basic findings and applied research on response effort. *Journal of Applied Behavior Analysis, 28*(4), 583-590.
- Galea, L. A. M., & Kimura, D. (1992). Sex differences in route-learning. *Personality and Individual Differences, 14*(1), 53-65.
- Grimstvedt, M. E., Kerr, J., Oswalt, S. B., Fogt, D. L., Vargas-Tonsing, T. M., & Yin, Z. (2010). Using Signage to promote stair use on a university campus in hidden and visible stairwells. *Journal of Physical Activity and Health, 7*(2), 232-238.
- Hakala, H., Siikonen, M., Tyni, T., & Ylinen, J. (2001). Energy-efficient elevators for tall buildings. *KONE, 1*-13.
- Howie, E. K., & Young, D. R. (2011). Step it up: A multicomponent intervention to increase stair use in a university residence build. *American Journal of Health Promotion, 26*(1), 2-5.
- Huitema, B. E. (2011). *Analysis of covariance and alternatives: Statistical methods for experiments, quasi-experiments, and single-case studies*. (2<sup>nd</sup> ed.). Hoboken, NJ: John Wiley & Sons, Inc.
- Huitema, B. E., & McKean, J. W. (2000). A simple and powerful test for autocorrelated errors in OLS intervention models. *Psychological Reports, 87*(1), 3-20.
- Kerr, J., Eves, F. F., & Carroll, D. (2001a). The influence of poster prompts on stair use: The effects of setting, poster size and content. *British Journal of Health Psychology, 6*, 397-405.
- Kerr, J., Eves, F., & Carroll, D. (2001b). Can posters prompt stair use in worksite environment? *Journal of Occupational Health, 43*, 205-207.
- Kerr, J., Eves, F. F., & Carroll, D. (2001c). Getting more people on the stairs: The impact of a new message format. *Journal of Health Psychology, 6*(5), 495-500.

- Kerr, J., Eves, F., & Carroll, D. (2001d). Six-month observational study of prompted stair climbing. *Preventive Medicine, 33*(5), 422-427.
- Kilpatrick, M., Hebert, E., & Bartholomew, J. (2005). College students' motivation for physical activity: Differentiating men's and women's motives for sport participation and exercise. *Journal of American College Health, 54*(2), 87-94.
- Kwak, L., Kremers, S. P. J., van Baak, M. A., & Brug, J. (2007). A poster-based intervention to promote stair use in blue- and white-collar worksites. *Preventive Medicine, 45*(2-3), 177-181.
- LaCaille, L. J., Dauner, K. N., Krambeer, R. J. & Pedersen, J. (2011). Psychosocial and environmental determinants of eating behaviors, physical activity, and weight change among college students: A qualitative analysis. *Journal of American College Health, 59*(6), 531-538.
- Lanningham-Foster, L., Lana, J. N., & Levine, J. A. (2003). Labored saved, calories lost: The energetic impact of domestic labor saving devices. *Obesity Research, 11*(10), 1178-1181.
- Lawton, C. A. (1994). Gender differences in way-finding strategies: Relationship to spatial ability and spatial anxiety. *Sex Roles, 30*(11-12), 765-779.
- Lee, K. K., Perry, A. S., Wolf, S. A., Agawal, R., Rosenblum, R., Fisher, S., Grimshaw, V. E., ... & Silver, L. D. (2012). Promoting routine stair use: Evaluating the impact of a stair prompt across buildings. *American Journal of Preventive Medicine, 42*(2), 136-141.
- Levine, D. M., Krehbiel, T. C., Berenson, M. L., Ng, P. T., & Stephan, D. (2007). *Statistics for Managers: Using Microsoft Excel*. (5<sup>th</sup> ed.). Upper Saddle River, NJ: Prentice Hall.
- Lewis, A., & Eves, F. (2012). Prompt before the choice is made: Effects of a stair-climbing intervention in university buildings. *British Journal of Health Psychology, 17*(3), 631-643.
- Luh, P. B., Michel, L., Santos, E., Yu, D., See, A., Xiong, B., Johnson, G., & Chang, S. C. (2005). Coherent configuration and operation of building transportation systems. *International Conference on Automation Science and Engineering: Institute of Electrical and Electronics Engineers, Canada*, 178-184.
- McKean, J. W. (2010). *Time-series software*. Retrieved from <http://fisher.stat.wmich.edu/joe/TSDB/Timeseries.html>

- Mcknight, S. D., McKean, J. W., & Huitema, B. E. (2000). A double bootstrap method to analyze linear models with autoregressive error terms. *Psychological Methods*, 5(1), 87-101.
- Miltenberger, R. G. (2012). *Behavior modification: Principles and procedures*. Belmont, CA: Wadsworth.
- Moffat, S. D., Hampson, E., & Hatzipantelis, M. (1998). Navigation in a “Virtual” maze. Sex differences and correlation with psychometric measures of spatial ability in humans. *Evolution and Human Behavior*, 19(2), 73-87.
- National Heart, Lung, and Blood Institute of the National Institutes of Health. (2012). *What are overweight and obesity?* Retrieved from <http://www.nhlbi.nih.gov/health/health-topics/topics/obe/>
- New York City Department of Health and Mental Hygiene. (2008). City officials unveil new icon to inspire New Yorkers to take the stairs for better health and a greener NYC. Retrieved from <http://home2.nyc.gov/html/doh/html/pr2008/pr033-08.shtml>
- Nocon, M., Müller-Riemenschneider, F., Nitzschke, K., & Willich, S. N. (2010). Review Article: Increasing physical activity with point of choice prompts—a systematic review. *Scandinavian Journal of Public Health*, 38(1), 633-638.
- Nomura, T., Yoshimoto, Y., Akezaki, Y., & Sato, A. (2009). Changing behavioral patterns to promote physical activity with motivational signs. *Environmental Health and Preventive Medicine*, 14(1), 20-25.
- Olander, E. K., & Eves, F. F. (2011a). Effectiveness and cost of two stair-climbing interventions—less is more. *American Journal of Health Promotion*, 25(4), 231-236.
- Olander, E. K., & Eves, F. E. (2011b). Elevator availability and its impact on stair use in a workplace. *Journal of Environmental Psychology*, 31(2), 200-206.
- Pate, R. R., Pratt, M., Blair, S. N., Haskell, W. L., Macera, C. A., Bouchard, C., Buchner, D., ... & Wilmore, J. H. (1995). Physical activity and public: A recommendation from the Center for Disease Control and Prevention and the American College of Sports Medicine. *Journal of American Medical Association*, 273(5), 402-407. Retrieved from <http://wonder.cdc.gov/wonder/prevguid/p0000391/P0000391.asp>
- Public Health Agency of Canada. (2007). Stairway to health. Retrieved from <http://www.phac-aspc.gc.ca/sth-evs/english/pilots-eng.php>

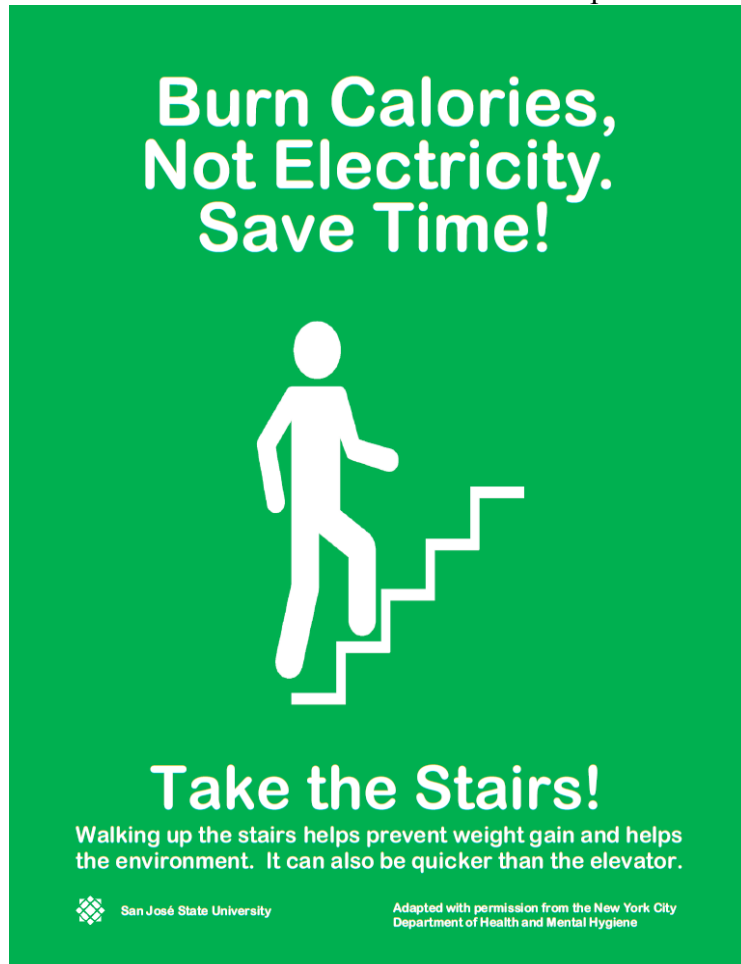


- Reed, C. B. (2006). *Policy statement on energy conservation, sustainable building practices, and physical plant management for the California State University* (Executive order No.987). Retrieved from <http://www.calstate.edu/eo/EO-987.html>
- San Jose State University Facilities Development & Operation. (2011). FD&O's commitment to sustainability. Retrieved from <http://www.sjsu.edu/fdo/energy/sustainability/>
- San Jose State University Office of Institutional Effectiveness & Analytics. (2012a). *Faculty information: Fall Semester 2012*. Retrieved from <http://www.iea.sjsu.edu/Faculty/quickfacts/default.cfm?version=graphic>
- San Jose State University Office of Institutional Effectiveness & Analytics. (2012b). *Student quick facts: Fall 2012/2013 college year*. Retrieved from <http://www.iea.sjsu.edu/Students/QuickFacts/>
- San Jose State University Sustainability at SJSU. (2011). *Sustainability at SJSU*. Retrieved from <http://www.sjsu.edu/sustainability/>
- Shah, S., O Byrne, Wilson, M., & Wilson, T. (2011). Elevators or stairs. *Canadian Medical Association Journal*, 183(18), E1353-E1355.
- Soler, R. E., Leek, K. D., Buchanan, L. R., Brownson, R. C., Heath, G. W., & Hopkins, D. H. (2010). Point-of-decision prompt to increase stair use. A systematic review update. *American Journal of Preventive Medicine*, 38(2S), S292-S300.
- Teh, K. C., & Aziz, A. R. (2002). Heart rate, oxygen uptake, and energy cost of ascending and descending the stairs. *Medicine & Science in Sports & Exercise*, 34(4), 695-699.
- Tlauka, M., Brolese, A., Pomeroy, D., & Hobbs, W. (2005). Gender differences in spatial knowledge acquired through simulated exploration of a virtual shopping centre. *Journal of Environmental Psychology*, 25(1), 111-118.
- Van Houten, R., Nau, P. A., & Merrigan, M. (1981). Reducing elevator energy use: A comparison of posted feedback and reduced elevator convenience. *Journal of Applied Behavior Analysis*, 14(4), 377-387.
- Van Nieuw-Amerongen, M. E., Kremers, S. P. J., de Vries, N. K., & Kok, G. (2011). The use of prompts, increased accessibility, visibility, and aesthetics of the stairwell to promote stair use in a university building. *Environment and Behavior*, 43(1), 131-139.

# APPENDICES

## Appendix A

### Modified NYC DHMH Stair Prompt



## Appendix B

### IRB Form



**SAN JOSÉ STATE  
UNIVERSITY**

To: Nima Chhay

From: Pamela Stacks, Ph.D.  
Associate Vice President  
Graduate Studies and Research

A handwritten signature in black ink that reads "Pamela Stacks".

Date: May 23, 2012

#### Division of Academic Affairs

Associate Vice President  
Graduate Studies & Research  
[www.sjsu.edu/gradstudies](http://www.sjsu.edu/gradstudies)

One Washington Square  
San José, California 95192-0025  
Voice: 408-924-2427  
Fax: 408-924-2612

[www.sjsu.edu](http://www.sjsu.edu)

The Human Subjects-Institutional Review Board has registered your study entitled:

“Using stair prompt to increase physical activity”

This registration, which provides exempt status under Exemption Category 2 of SJSU Policy S08-7, is contingent upon the subjects included in your research project being appropriately protected from risk. This includes the protection of the confidentiality of the subjects' identity when they participate in your research project, and with regard to all data that may be collected from the subjects. The approval includes continued monitoring of your research by the Board to assure that the subjects are being adequately and properly protected from risks. If at any time a subject becomes injured or complains of injury, you must notify Dr. Pamela Stacks, Ph.D. immediately. Injury includes but is not limited to bodily harm, psychological trauma, and release of potentially damaging personal information. This approval for the human subject's portion of your project is in effect for one year, and data collection beyond May 23, 2013 requires an extension request.

If you have any questions, please contact me at (408) 924-2427.

Protocol #: S1202151

cc. Sean Laraway 0120

## Appendix C

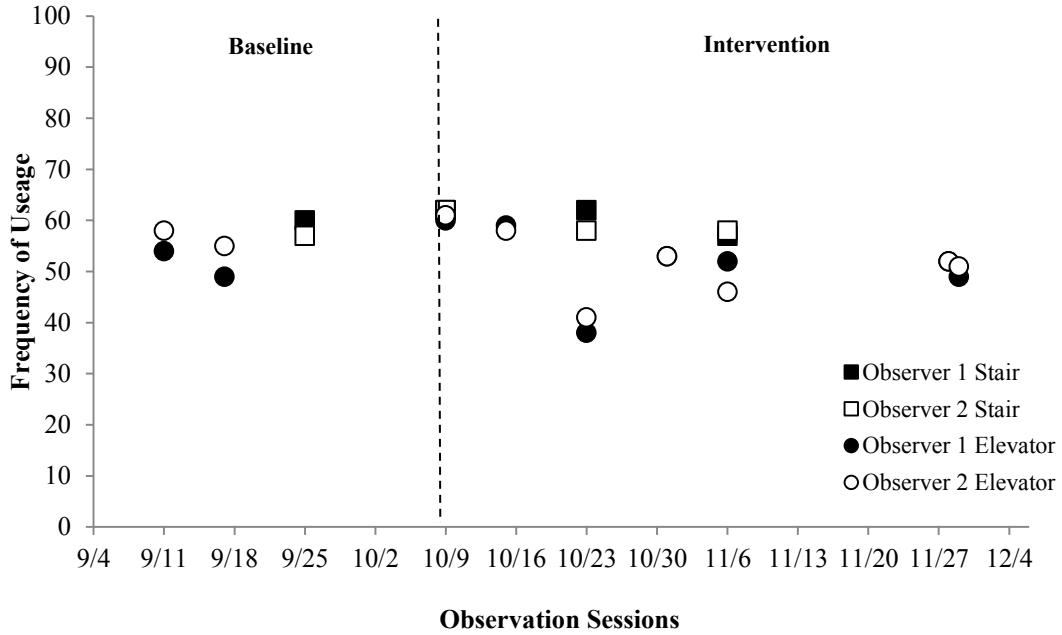
### *Demographics for Students and Faculty*

	Total	Percent	Male	Percent	Female	Percent
Student	30448	100	14690	100	15758	100
American Indian	59	0.19	21	0.14	38	0.24
African American	1040	3.42	502	3.42	538	3.41
Asian	10026	32.93	5303	36.10	4723	29.97
Hispanic	6491	21.32	2761	18.80	3730	23.67
White	7789	25.58	3715	25.29	4074	25.85
Foreign national	2159	7.09	1064	7.24	1095	6.95
Other	2884	9.47	1324	9.01	1560	9.90
Faculty	1674	100	833	100	841	100
American Indian	13	0.78	5	0.60	8	0.95
African American	49	2.93	23	2.76	26	3.09
Asian	294	17.56	153	18.37	141	16.77
Hispanic	108	6.45	52	6.24	56	6.66
White	1023	61.11	507	60.86	516	61.36
Other	187	11.17	93	11.16	94	11.18

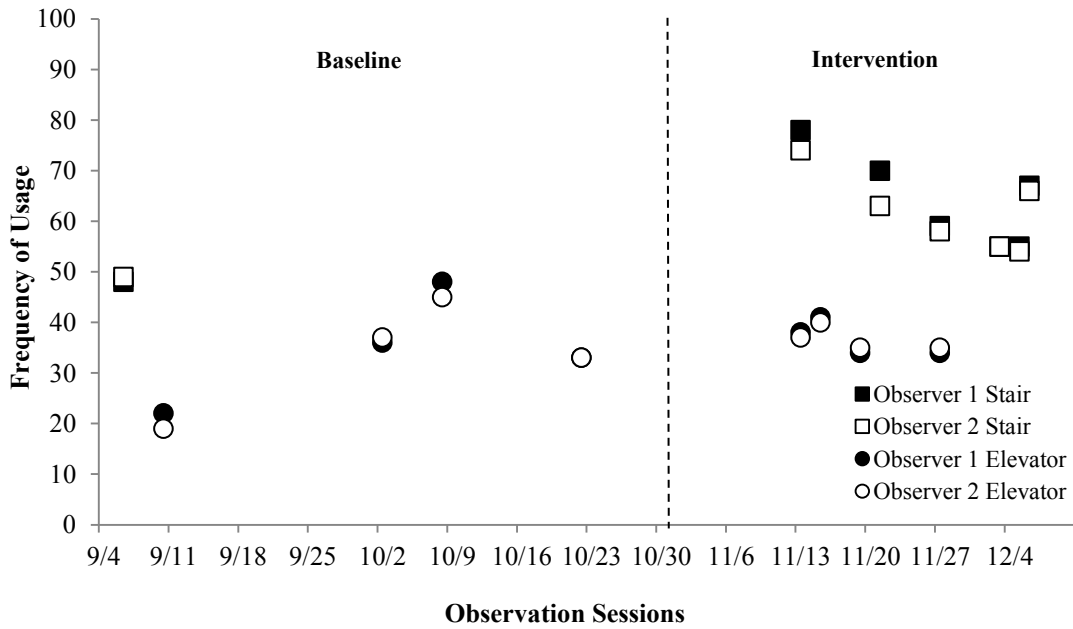
## Appendix D

### Interobserver Agreement Graphs

#### College of Engineering Location



#### North Parking Garage Location



## APPENDIX E

### Time-series Regression Procedures

The time-series regression falls under the General Linear Model category of statistical procedures with the equation below. The  $Y_t$  represents the response value of the observed variable that corresponds with the time of observation on the time-series. Similar to multiple regression, each unstandardized beta coefficient of the time-series regression model is a weighted-slope estimate of each parameter variable: time ( $T$ ), level change ( $LC$ ), and slope change ( $SC$ ). And, epsilon is the error term of variance unaccounted by the unstandardized beta coefficient estimates.

$$Y_t = \beta_0 + \beta_1 T_t + \beta_2 LC_t + \beta_3 SC_t + \varepsilon_t$$

$Y_t$  = Observed variable value at time  $t$ ,

$\beta_0$  = Y-intercept estimate for the first phase,

$\beta_1$  = Time parameter estimate for the time-series,

$\beta_2$  = Level change parameter estimate between the observational phase,

$\beta_3$  = Slope change parameter estimate for the intervention phase.

For using standard OLS regression procedure to analyze the time-series regression model, dummy codes were entered for the time variable and for estimating the level change and slope change parameters. The dummy code values for the time variable was based on the number of observations (e.g.,  $T = 24$  time-series for instance) entered as 1 to 24 using consecutive numbers in the first column of data; for the level change values, zero denoted the baseline phase, and value one denoted the intervention phase. For a time series with 9 baseline observations (e.g.,  $n_1 = 9$ ) and 15 intervention observations (e.g.,  $n_2 = 15$ ), there was a column of 9 values of zero downward, followed by 15 values of one downward.

For the slope change values, another column of baseline observations was denoted with the value zero for  $n_1 + 1$  rows of zero; there were 10 values of zero downward and an extra value of zero (totaling 10 values of zero downward for baseline observations), followed by consecutive numbers with starting formulations of  $n_2 - 1$  (so 1 to 14, for intervention observations). The observed variables were either total stair ascend, men stair ascend, or women stair ascend, entered as percentages with a decimal point (e.g., 45% = 0.45) because the count frequencies of stair use were summed and divided by the total observed frequencies of both stair and elevator ascend. Separate time-series regression analysis was performed for each observed variable, thus yielding three analyses using the same dummy coding value for the parameter variables: time, level change, and slope change at each setting. Thus, the length of dummy code values for the parameter variables differs, based on the length of the time series for each setting.

Y	Time	LC	SC
0.536	1	0	0
0.603	2	0	0
0.470	3	0	0
.	.	.	.
.	.	.	.
.	.	.	.
0.532	8	0	0
0.442	9	0	0
0.508	10	1	0
0.574	11	1	1
0.525	12	1	2
0.569	13	1	3
.	.	.	.
.	.	.	.
.	.	.	.
0.591	22	1	12
0.617	23	1	13
0.532	24	1	14