POINT-OF-CHOICE PROMPTS AS TOOLS OF BEHAVIOUR CHANGE; MODERATORS OF IMPACT

by

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ABSTRACT

Point-of-choice prompts consistently increase stair climbing in public access settings. Comparison of message content, however, is rare. Chapter two reports that, after controlling for the effects of traffic, similar effects on stair climbing were evident for a more specific and a simpler heart-health message. Chapters three to five demonstrate that specific, calorific expenditure messages were associated with significantly increased stair climbing in public access and workplace settings, with greater increases in overweight than normal weight individuals (chapter four).

Chapter three investigated the single and combined effects of volitional and motivational intervention components, in a tram station, to test the theory underpinning the success of point-of-choice prompts. Both components positioned simultaneously were required to increase stair climbing where choosing the stairs resulted in a time delay for pedestrians due to the site layout. Similarly, a motivational intervention alone did not increase stair climbing in the workplace (chapter five). When supplemented with a volitional, point-of-choice prompt at the time the choice of ascent method is made, a significant increase in stair climbing occurred.

Analysis should adjust for potential moderating effects of pedestrian traffic, time of day, demographics and building characteristics; failure to do so may mask the true impact of the intervention.

DEDICATION

To my family and close friends who have supported me through the highs and lows of this journey.

A special mention goes to those with whom so much was sacrificed along the way; despite the change in paths along the way, the final destination has been reached. A new journey now commences, hopefully bringing fresh adventures for all concerned.

I dedicate this PhD to you all as you’ve each played an instrumental part.
I wouldn’t be who, or where, I am without you.

ACKNOWLEDGEMENTS

Dr. Frank Eves: You had immense patience and offered continued support through a very difficult period of time. Most of all you placed your faith in me to 'still produce the goods' when many others would not have. This will never be forgotten and I am very thankful.

Undergrads.: Without these willing bodies my data would not exist – thank you for standing in the cold!

Family, Loved-Ones and Friends: It is very simple – I would not be here if it were not for you. None of you have ever doubted me, rather you have provided endless support and encouragement. 'Thank you' just does not seem substantial enough to describe my gratitude, but 'THANK YOU'!

PhD Twitter Sisters: "Sanity - the ability to think and behave in a normal and rational manner (Online Dictionary)". I think we just about kept each other within the boundaries… or did we?

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LIST OF PUBLICATIONS

The following four empirical papers form the basis of this thesis:

Lewis, A.L. & Eves, F.F. Prompts to Increase Stair Climbing in Stations; The Effect of Message Complexity. *In Press. Journal of Physical Activity and Health.*

Lewis, A.L. & Eves, F.F. (2012). Testing the Theory Underlying the Success of Point-of-Choice Prompts: A Multi-Component Stair Climbing Intervention. *Psychology of Sport and Exercise, 13,* 126-132. DOI: 10.1016/j.psychsport.2011.10.001.

Lewis, A.L. & Eves, F.F. (2011). Specific Effects of a Calorie-Based Intervention on Stair Climbing in Overweight Commuters. *Annals of Behavioral Medicine*, *42(2),* 257-261. DOI: 10.1007/s12160-011-9283-z.

Lewis, A.L. & Eves, F.F. Prompt Before the Choice is Made; Effects of a Stair Climbing Intervention in University Buildings. *Submitted.*

In addition, data from the current thesis resulted in the following abstracts:

Lewis, A.L. & Eves, F.F. (2009). The Effect of Message Specificity on Increase in Stair Climbing in a Station. *Psychology & Health, 24(S1)*, S247.

During the period of postgraduate study at the University of Birmingham, the following paper and abstract were also published:

Eves, F.F., Lewis, A.L. & Griffin, C. (2008). Modelling Effects of Stair Width on Rates of Stair Climbing in a Train Station. *Preventive Medicine, 47*, 270-272.

Eves, F.F. & Lewis, A.L. (2009). Lift This Way: Effects of Simple Signage on Choice of Stairs or the Lift. *Psychology & Health, 24(S1)*, S166.

CHAPTER ONE

INTRODUCTION

1.0 Introduction

1.1 Physical Inactivity

Physical activity, defined as any bodily movement produced by skeletal muscles that results in energy expenditure (Caspersen, Powell & Christenson, 1985), encompasses numerous activities that can be completed as part of daily living, leisure, occupation and active transport (Department of Health [DOH], 2011; Garber et al., 2011). Movement is an integral component of our human design, however the recent development of industrialised countries encourages sedentary lifestyles (Katzmarzyk & Mason, 2009). Further, increased pressures of time, work/family expectations and accessibility mean that individuals need to reach destinations quicker than before and travel further (Hill, Wyatt, Reed & Peters, 2003; Sparling, Owen, Lambert & Haskell, 2000). In the past 25-years, the average number of miles travelled by car per year has increased by 70%, whereas those travelled on foot and by cycle have decreased by 25% and 33% respectively (DOH, 2010). Consequently, individuals are not engaging in activity beyond basic daily functioning (World Health Organization [WHO], 2010).

In England, 2008, the Health Survey for England (HSE) identified that 61% of men and 71% of women (≥16 years) failed to meet the recommended amounts of physical activity, which is more than the collective sum of those who misuse alcohol (6-9%), smoke (20%) or are obese (24%) (DOH, 2010). When physical activity was objectively measured, these percentages increased to 94% and 96% for men and women respectively (HSE, 2008). As these differences between self-reported and objectively obtained figures reveal, people appear to believe they are more active than they really are.

Physical inactivity costs the English economy up to an estimated £8.2 billion per year, excluding the contribution of physical inactivity to obesity, estimated at £2.5 billion annually (Stamatakis, Hirani & Rennie, 2009). Furthermore, it contributes to poor health (Haskell, Blair & Hill, 2009) and is responsible for 6% of deaths globally, hence is the fourth leading risk factor for global mortality (WHO, 2010).

1.2 Obesity

Obesity, a consequence of an energy imbalance, is an excess of body fat such that health is compromised. As defined by the National Institute of Clinical Excellence (NICE; 2006), a body mass index (BMI) of 25-29.9 kg/m^2 refers to overweight and ≥30 kg/m^2 to obese. In 2003/2004, the mean BMI of the UK's general adult population was 27 kg/m^2 (Kopelman, 2007). In 2009, nearly a quarter of men (22%) and women (24%) in England were obese, and 66% and 57% of men and women, respectively, were overweight including obese (HSE, 2009). It is estimated that 36% of men and 28% of women (aged between 21 and 60) will be obese by 2015, rising to 47% and 36% respectively by 2025 (Foresight, 2007). Typically, more men than women are overweight and the prevalence is greater with increased age and lower household socioeconomic status (HSE, 2009).

Using national survey data, Hill and colleagues estimated that an excess of even 100 kilocalories per day, through limited expenditure and/or excess intake, could be responsible for the population level weight gain (Hill et al., 2003). The estimated direct and indirect costs of treating overweight and obesity and related morbidity in England 2007, were £4.2 and £15.8 billion respectively (Morgan & Dent, 2010).

Besides financial implications, overweight and obesity combined account for 5% of global mortality (WHO, 2010). A recent meta analysis of 57 international prospective studies found that moderate obesity (BMI 30-35 kg/m^2) reduced average life expectancy by two to four years and morbid obesity (BMI 40-50 kg/m^2) by eight to ten years, which is the equivalent of lifelong smoking (Prospective Studies Collaboration, 2009). In addition, obesity is associated with numerous adverse health consequences, such as increased risk of cardiovascular disease, type 2 diabetes, blood pressure and some cancers, as well as depression and low self-esteem (DOH, 2011; Kopelman, 2007).

1.3 Benefits of Being Physically Active

There is substantial epidemiological and experimental evidence demonstrating the health gains of regular participation in physical activity; additional to reduced mortality, it can reduce the risk of, and help manage, over 20 chronic diseases, including coronary heart disease, stroke, type 2 diabetes, some forms of cancer (e.g. colon and breast cancers) and osteoporosis (see DOH, 2011). It can also enhance emotional well-being, quality of life and cognitive function (DOH, 2010; Garber et al., 2011). Furthermore, physical activity plays a vital role in energy expenditure and consequently weight control; inactivity is associated with an increased risk of being overweight and/or obese due to an insufficient energy deficit against energy intake (DOH, 2011; WHO, 2010). As Table 1.1 shows, there is a clear association between BMI and the percentage of adults meeting the recommended physical activity levels and their average time spent being sedentary (HSE, 2008); the higher a person's BMI, the less likely they are to meet the recommendations and the more likely they are to be more sedentary. Thus, it is vital to find ways of encouraging the least active to engage in regular physical activity (DOH, 2011; NHS Health Scotland, 2004; WHO, 2010).

	% Met physical activity recommendations		Average minutes spent in sedentary time	
	Men	**Women**	**Men**	**Women**
Neither overweight or obese	46	36	591	577
Overweight	41	31	.	.
Obese	32	19	612	585

Table 1.1: Associations between a person's BMI, percentage achieving physical activity recommendations and time spent being sedentary (adapted from HSE, 2008 data).

1.4 Current Physical Activity Recommendations

To attain significant health benefits, adults (aged 19-64 years) within the UK are encouraged to participate in at least 150 minutes of moderate intensity activity per week (e.g. 30 minutes, five days per week). All adults should also minimise the amount of time they spend being sedentary (DOH, 2011). Research suggests that a dose-response relationship between physical activity and health outcomes exists, such that greater participation provides greater health gains (DOH, 2011; Garber et al., 2011). To improve cardiovascular fitness and reduce some disease risk factors, activity of moderate intensity should be engaged in for bouts of at least ten minutes, although recent evidence indicates that short amounts, that is less than ten minutes, of vigorous intensity activity can also be beneficial (DOH, 2011). With reference to weight control, the duration of activity is immaterial; any increased energy expenditure is of significance.

Regarding activity duration, it might be unrealistic to expect people who are currently inactive or felt unable or unwilling to incorporate physical activity into their day, to initially engage in at least ten minutes. Rather, shorter bouts, even to simply disrupt sedentary time, should be encouraged (DOH, 2011). To change behaviour, the adjustment needs to be small and achievable without radically modifying one's current ways of living (DOH, 2011; Hill et al., 2003). A gradual introduction and increased amount of an achievable activity enables the body to adapt without increased risk of injury. Further, a sense of achievement and improved well-being contributes substantially to activity adherence, such that lifelong activity habits can be formed (DOH, 2011; Murphy, Blair & Murtagh, 2009). Hence, the encouragement of lifestyle physical activity (WHO, 2010).

1.5 Lifestyle Physical Activity

Lifestyle physical activity, that is encouraging individuals to accumulate activity throughout their day, is one approach to increasing energy expenditure and helping individuals achieve the recommended physical activity levels (DOH, 2005; Haskell et al., 2007; WHO, 2010). Increasing time pressures negatively influence activity participation; both men (38%) and women (37%) report 'not having enough leisure time' to engage in physical activity (HSE, 2008). Other barriers include 'work commitments', 'not motivated to do more', 'prefer to do other things', 'not the sporty type' and 'a lack of money to spend on physical activity' (Booth, Bauman, Owen & Gore, 1997; HSE, 2008; Zunft et al., 1999). Incorporating physical activity into daily living can help counteract these obstacles (Dunn et al., 1999). Further, lifestyle activities appear to be as effective for weight loss as supervised exercise programmes and due to their 'achievable nature', they are more likely to be maintained (DOH, 2004; MacDonald, Stokes, Cohen, Kofner & Ridgeway, 2010).

Active transportation, such as walking and cycling, is an example of lifestyle physical activity (DOH, 2004, 2011; WHO, 2010). Hill and colleagues suggest that closing the energy gap by as little as 100 kilocalories per day could help prevent population level weight gain

(Hill et al., 2003); increased walking is one example. Frank and colleagues recently calculated that each kilometre (0.6 miles) walked per day is associated with a 4.8% reduction in the likelihood of obesity, contrary to a 6% increase for each hour spent in the car per day (Frank, Andresen & Schmid, 2004). Walking one mile per day, which is equivalent to ~2,000-2,500 steps, expends approximately 100 kilocalories whether it is completed in one go or accumulated throughout the day as part of lifestyle activities (Hill et al., 2003). For example, climbing the stairs instead of using the lift or escalator would contribute towards the total number of steps achieved.

1.6 Stair Climbing as a Lifestyle Physical Activity Model

Stair climbing is also an encouraged model for increasing lifestyle physical activity, which can counteract identified barriers to engaging in activity (DOH, 2004; Mansi, Mansi, Shaker & Banks, 2009; Task Force on Community Preventive Services, 2002). Critically, there are numerous opportunities for most population groups to climb stairs throughout the day (Kerr, Eves & Carroll, 2001a; Webb & Eves, 2005); they can be climbed free of charge and in a variety of settings such as at home, work, shopping centres and in travel contexts such as train stations (Kerr et al., 2001a; Kerr et al., 2003; Webb & Eves, 2007a). Furthermore, for some individuals, in particular those who are overweight/obese, low self-esteem and concern about their appearance or ability are determinants of inactivity (Ball, Crawford & Owen, 2000; Booth et al., 1997; Deforche, De Bourdeaudhuij & Tanghe, 2006). Stair climbing is a discrete way of being active for the benefit of one's health without others knowing, and unlike participating in structured sports, no specialised clothing or equipment is required (Eves, Webb & Mutrie, 2006). Finally, climbing the stairs appears to be an achievable behaviour that does not require major changes to one's current way of living, thus has increased likelihood of adherence (NHS Health Scotland, 2004; Zimring, Joseph, Nicoll & Tsepas, 2005).

1.7 Health Benefits of Stair Climbing

Stair climbing is encouraged within physical activity guidelines (Haskell et al., 2007; DOH, 2004). Besides the ease of incorporating it into daily living, regular stair climbing has been associated with many health benefits, such as improved cholesterol profiles, cardiorespiratory fitness and skeletal health (Boreham, Wallace and Nevill, 2000; Haskell et al., 2007; Meyer et al., 2010). Further, stair climbing has been proposed as a useful tool for weight management (NHS Clinical Knowledge Summaries, 2008). Supporting evidence will now be presented.

1.7.1 Energy Expenditure

Energy expenditure, which is usually expressed in metabolic equivalents (METs), reflects how much energy is expended above the energy required at rest (DOH, 2011). Physical activity is categorised according to its MET intensity level: light (<3.0 METs), moderate (3.0-6.0 METs) or vigorous intensity (>6.0 METs) (Pate et al., 1995). While moderate intensity activity can enhance one's cardiorespiratory, metabolic and musculoskeletal systems (DOH, 2011; Garber et al., 2011), vigorous activity conducted for a certain duration produces greater energy expenditure and health benefits than moderate intensity activity of matching duration (Haskell et al., 2007).

Stair climbing is a vigorous intensity activity as it expends more than six times the energy used at rest (Ainsworth et al., 2000). Bassett and colleagues quantified the energy cost of stair climbing and descent by measuring oxygen uptake of young, lean, physically active individuals (n=20) on a laboratory-based motorised escalator (Bassett et al., 1997). They reported that the gross energy cost of stair climbing and descent is 8.6 METs and 2.9 METs, respectively. Teh and Aziz (2002) assessed similar measures in an 11-floor building rather than the laboratory, and amongst middle-aged individuals who were not lean or active (ascent n=103; descent n=49). Higher gross energy expenditure estimates for stair climbing (9.6 METs) and descent (4.9 METs) were reported. These studies demonstrate that stair climbing results in greater energy expenditure per minute than popular activities such as walking and cycling (see Table 1.2).

Recent estimates suggest that an 80 kilogram man who climbs a standard three metre flight of stairs ten extra times a day would expend approximately 28 kilocalories per day; over a year that adds up to more than 10,000 kilocalories which is the equivalent to three pounds of fat or four days worth of food (Olander & Eves, 2011a). Further, as stair climbing involves raising one's own body weight against gravity, overweight individuals will expend more energy than healthy weight individuals (Eves, Webb, Griffin & Chambers, submitted). Thus, stair climbing may have important implications for energy expenditure and weight control (Eves et al., 2006; Eves et al., submitted; Olander & Eves, 2011a).

	Intensity	**Intensity** (METS)
Ironing	Light	2.3
Cleaning and dusting	Light	2.5
Walking – strolling, 2mph	Light	2.5
Painting/decorating	Moderate	3.0
Walking – 3mph	Moderate	3.3
Hovering	Moderate	3.5
Golf - walking pulling clubs	Moderate	4.3
Badminton – social	Moderate	4.5
Tennis – doubles	Moderate	5.0
Walking – brisk, 4mph	Moderate	5.0
Mowing the lawn - walking, using power-mower	Moderate	5.5
Cycling – 10 –12mph	Moderate	6.0
Aerobic dancing	Vigorous	6.5
Cycling – 12 –14mph	Vigorous	8.0
Swimming – slow crawl, 50 yards per minute	Vigorous	8.0
Tennis – singles	Vigorous	8.0
Stair Climbing	**Vigorous**	**9.6**
Running - 6mph (10 – minutes/mile)	Vigorous	10.0
Running - 7mph (8.5 – minutes/mile)	Vigorous	11.5
Running - 8mph (7.5 – minutes/mile)	Vigorous	13.5

Table 1.2: Intensities and energy expenditure for common types of physical activity (amended from DOH, 2004; Teh & Aziz, 2002).

Recent research also reveals an association between stair climbing and weight loss. In a cross-sectional study, Shenassa and colleagues examined the association between BMI and daily stair climbing measured by the floor on which residents lived (n=2,846) (Shenassa, Frye, Braubach & Daskalakis, 2007). They reported that the BMI of men living on the fourth floor or above was 0.88 lower than men living on the ground floor (p=.003). Further, an uncontrolled study to encourage physical activity by prompting stair climbing alone, increased the number of ascended one-story staircase units (two flights of ten steps) from four to 21 per day (Meyer et al., 2010). In the entire population (n=77), significant reductions in waist circumference (-1.7±2.9%), weight (-0.7±2.6%) and fat-mass (-1.5±8.4%) were reported at 12-weeks. Benefits on fat mass were still evident at six months (-1.4±8.4%, p=.038).

Collectively, these data support recommendations to encourage stair climbing as a tool for weight management (DOH, 2004; NHS Clinical Knowledge Summaries, 2008). Critically, as energy expenditure differs between stair climbing and descent (Bassett et al., 1997; Teh & Aziz, 2002), research evaluating stair use interventions should ensure that direction of travel is separated (Eves & Webb, 2006), especially when examining weight control (Eves et al., 2006).

1.7.2 Cardiorespiratory Fitness, Cholesterol Profiles and Cardiovascular Benefits

Cardiovascular benefits have also been reported following heightened levels of stair climbing, which was first reported in a large epidemiological study by Morris and Crawford (1958). They investigated the relationship between coronary heart disease and exercise, through occupational activity levels; despite being of the same social class, male bus conductors were half as likely to die from a heart attack than the bus drivers. The most obvious difference between them was their daily amounts of physical activity; the conductor of a double-decker bus ascended and descended between 500-750 steps per working day whereas the driver remained sedentary.

More recent experimental research compliments the above findings and also reports improved cholesterol profiles and cardiovascular fitness following participation in a stair climbing intervention. Kennedy and colleagues randomised sedentary office workers (n=45) to 8-weeks of accumulated bouts of stair climbing in a workplace or control status who received no intervention (Kennedy, Boreham, Murphy, Young & Mutrie, 2007). Relative to controls, stair-climbers showed a significant increase of 9.4% in predicted oxygen uptake (or VO_{2max}, $p<.05$). The intervention consisted of approximately six minutes per day, which is considerably less than recommended amount (30 minutes per day, five days per week; DOH, 2011). The VO_{2max} improvement reported here was similar to that seen amongst women who walked for 45-minutes per day (Duncun, Gordon & Scott, 1991). Thus, emphasising the value of stair climbing as a health-enhancing population-level physical activity.

Similarly, Boreham et al. (2000) investigated the effects of a 7-week intervention, based on multiple short bouts of stair climbing performed throughout the working day, on cardiorespiratory fitness and lipid profiles of sedentary women (n=22). Relative to no significant change in the control group, stair-climbers significantly reduced high-density lipoprotein (HDL) cholesterol ratio and improved VO_{2max} and HDL concentration. Using a similar population group (n=15) and intervention, but over 8-weeks, the same research group reported that, relative to controls, stair climbers displayed a 17.7% increase in VO_{2max} and a 7.7% reduction in low density lipoprotein (LDL) cholesterol ($p<.05$) (Boreham, Kennedy, Murphy, Wallace & Young, 2005). Finally, Meyer et al. (2010) conducted an uncontrolled study to encourage physical activity by prompting stair climbing alone, amongst inactive employees (n=77). Following a significant increased number of ascended one-story staircase units (two flights of ten steps) from four to 21 per day, VO_{2max} had increased (9.2±15.1%, p.001) and diastolic blood pressure (-1.8±8.9%) and LDL cholesterol (-3.0±13.5%) had decreased at 12-weeks amongst the sample group. Benefits on VO_{2max} persisted at six months (+5.9±12.2%, p=.001). Importantly, high rates of adherence were reported for each study, indicating that stair climbing is an achievable and liked lifestyle activity, which is important for long-term maintenance and formation of habitual behaviour (DOH, 2011; Murphy et al., 2009).

Collectively, these results show that short bouts of stair climbing, which were accumulated throughout one's daily life over several weeks, resulted in significant health benefits. As limited time is a key self-reported physical activity barrier and people may be unable or willing to engage in lengthier periods of activity (HSE, 2008; DOH, 2011), these studies support the promotion of stair climbing as an effective lifestyle activity.

1.7.3 Premature Death and Stroke

Other health outcomes have also been linked with levels of stair climbing. Data from the Harvard Alumni Studies, an observational cohort investigating the effects of exercise upon multiple chronic diseases, identified that men who climbed fewer than 20 flights of stairs per week had a 23% higher risk of premature death, than those who climbed more (Paffenbarger et al., 1993). Furthermore, men who climbed between 20 and <35 flights of stairs per week had a lower incidence of stroke, than those who climbed less than ten flights (Lee & Paffenbarger, 1998). More recently, data from The Caerphilly study, a prospective cohort study of middle-aged men, suggests that during a 10-year follow-up period, only activities of a heavy/vigorous nature were independently associated with a significantly reduced risk of premature death from cardiovascular disease (Yu, Yarnell, Sweetnam & Murray, 2003). Specifically, they report that men who did the equivalent of seven minutes of stair climbing per day had a 10-year reduced risk of death of 47% and of a coronary death of 62%.

Critically, however, these data are based on self-reported surveys and only represents male populations. As highlighted in section 1.1, individuals appear to over-estimate their levels of physical activity when compared with objectively obtained data, and health outcomes vary between genders (HSE, 2008). Similarly, a recent systematic review reported that people typically under-report their weight (Gorber, Tremblay, Moher & Gorber, 2007). Relative to stair climbing, Engers and colleagues compared self-reported levels of stair climbing in a workplace with objective levels obtained via a swipecard, which recorded stair use as they entered or exited the staircase (Engbers, van Poppel & van Mechlen, 2007). They found that the comparability of self-reported and objectively measured stair use was moderate to poor, in relation to frequency and the number of floors covered each week.

1.7.4 Summary

Collectively the data identifies that regular stair climbing, a vigorous intensity lifestyle activity, is a valuable tool for weight management, as well as being linked with enhanced cardiovascular fitness, lipoprotein profiles and other cardiovascular benefits. Whilst some studies were based on self reported data (e.g. Shenassa et al., 2007; Lee & Paffenbarger, 1998; Paffenbarger et al., 1993; Yu et al., 2003) the presentation of complementary experimental research provides further support for the earlier findings. Thus, it is evident that stair climbing is a suitable model for lifestyle physical activity and interventions to increase population level physical activity, via encouraged stair climbing, are one approach.

Despite this evidence, it appears that individuals (male and female white-collar employees) do not consider stair climbing to be a physical activity with health benefits (NHS Health Scotland, 2004); this may partially explain why only 18% of adults in England report climbing more than 40-steps per day (Heath Education Authority, 1992). A greater understanding of why people may or may not choose to climb the stairs is therefore required.

1.8 The Socio-Ecological Model

To change physical activity behaviour, one must understand the influences surrounding it. Besides motivation, the social-ecological model implies that an individual's ability to adopt a healthy lifestyle, including increasing activity levels, is influenced by a complex interaction of multiple factors. These have been categorised as: individual; social; environmental; and policy factors (see Figure 1.1).

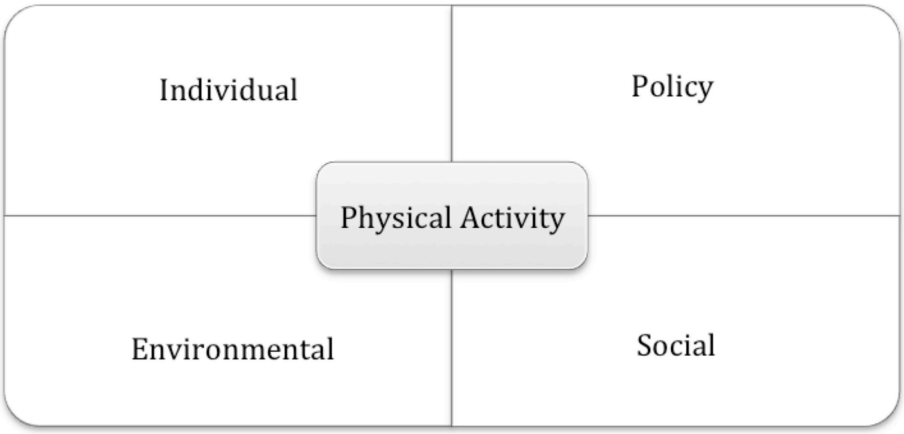

Figure 1.1: The Socio-Ecological Model, adapted from Sallis, Bauman & Pratt (1998).

1.9 Influences upon Stair, Escalator and Lift Choice

To successfully encourage regular stair climbing, it is necessary to identify what might influence an individual choosing the stairs, escalator or lift. Importantly, it is useful to conceptualise stair, escalator and lift choices as part of a journey, with each method of ascent an obstacle to overcome en-route to a destination (Eves, 2008, 2010). Using the constructs of the socio-ecological model, potential influences, that will now be discussed, include: individual factors, e.g. demographics and physical abilities; social factors, e.g. pedestrian traffic and time pressure; and environmental factors, e.g. site/building design and layout.

1.9.1 Individual Influences

1.9.1.1 Energy Minimisation and Personal Comfort

One influence upon choice of ascent method is a person's desire to minimise energy expenditure. Research suggests that during locomotion people minimise the energy consequences of an action subconsciously (Eves, Scott, Hoppé & French, 2007; Kayser, 2005); stair climbing is a form of locomotion. Thus, when faced with a choice of climbing the stairs or taking the escalator or lift, individuals frequently opt for the mechanised option, hence minimising muscle use and the energy cost (Kerr et al., 2001a; Numoro, Yoshimoto, Akezaki & Sato, 2009).

Another consideration is personal comfort. Humid conditions, for example, have been linked with physical activity participation, such that greater levels of exertion and discomfort were reported in high humidity when compared with low humidity at the same temperature (Sheffied-Moore et al., 1997). Eves and Masters (2006) reported that, in Hong Kong, non-Asian pedestrians found walking uphill in high levels of humidity punishing, thus avoided the behaviour. The desire to minimise energy and control comfort, therefore, are likely to influence choice of ascent methods. Further, these factors may explain why people appear more willing to descend, rather than climb, stairs; unlike stair descent, stair climbing is a vigorous intensity activity (Bassett et al., 1997; Teh & Aziz, 2002).

1.9.1.2 Demographic Influences

Research indicates that demographic factors such as gender, age, weight status, ethnicity and socio-economic status, can influence choice of ascent method (Webb, Eves & Kerr, 2011). In public access settings, most studies show that men are more likely to climb the stairs than women and younger people are more likely than older people (Webb et al., 2011). One likely explanation for these differences is that women, as well older and heavier individuals, perceive slopes to be steeper than their counterparts (Proffitt, Bhalla, Gossweiler, & Midgett, 1995). Further, as women and the elderly have lower leg strength than their counterparts (Loy et al., 1994; Novak, Reid, Costigan & Brouwer, 2010), they may find stair climbing more difficult or tiresome. Research within the workplace, however, has reported inconsistent effects of gender (Coleman & Gonzalez, 2001; Kerr et al, 2001b), indicating that there may be other environmental factors besides biological differences, such as the physical environment, which influences behaviour.

Another influential demographic is weight status, as individuals who appear to be of normal weight use the stairs more than overweight individuals (Andersen, Franckowiak, Synder, Bartlett & Fontaine, 1998; Brownell, Stunkard, Albaum, 1980; Eves et al., 2006). Relative to energy minimisation, as stair climbing involves raising one's own body weight against gravity, more energy is expended by heavier individuals. Studies have reported that stair climbing is less likely to occur when individuals are carrying bags larger than an average-sized briefcase (Kerr et al., 2001c; Puig-Ribera & Eves, 2010; Webb & Eves, 2007b).

Finally, ethnicity appears to influence choice of ascent methods; Caucasians usually climb the stairs more than their counterparts (Andersen et al., 1998; Blamey, Mutrie & Aitchison, 1995; Brownell et al., 1980; Webb et al., 2011). Whilst there is no obvious explanation, population physical activity data shows a similar pattern, such that Caucasians are more physically active than their counterparts (HSE, 2008). Sedentary behaviours have been linked with socio-economic status (SES) (HSE, 2008). Specifically, people living in lower SES areas appear less likely to climb the stairs than people from higher SES areas (Ryan, Lyon, Webb, Eves & Ryan, 2011). As people from some ethnic minority groups, but not all, are more likely to be of lower SES, it is possible that SES may be partially responsible for the apparent ethnic differences.

Together these demographic influences identify that choice of ascent method varies between population groups and interventions aiming to encourage stair climbing may need to target specific groups; a 'one size fits all' health promotion approach may not be effective. Tackling obesity is a current public health priority, thus the identified influence of weight status upon stair climbing behaviour is fundamental.

1.9.2. Social Influences

1.9.2.1 Pedestrian Traffic

In public access settings, the choice of ascent is usually between stairs and an adjacent escalator. Pedestrian traffic, which refers to the number of pedestrians using the site, appears to have major influences on an individual's choice of ascent method; as traffic increases the escalator becomes full and pedestrians avoid delay by using the stairs (Eves, Lewis & Griffin, 2008; Eves, Olander, Nicoll, Puig-Ribera, & Griffin, 2009; Kerr et al., 2001a, b; Olander, Eves & Puig-Ribera, 2008; Puig-Ribera & Eves, 2010; Webb & Eves, 2007a, b).

Opposite effects of traffic are seen in the workplace, where the choice of ascent is usually between a lift and stairs (Eves et al., submitted; Olander & Eves, 2011b). Unlike escalators, which are continuously available, lifts usually need to be requested. Role models can influence our behaviour (Adams et al., 2006; Webb, Eves & Smith 2011), therefore, if someone is already waiting for the lift when an individual approaches the ascent methods, they might be more likely to wait with them rather than climb the stairs alone. Furthermore, social interaction between workers may affect the choice of ascent method in favour of the lift, especially if a person you are travelling with is unwilling or unable to take the stairs (Olander & Eves, 2011b). Hence, increases in traffic within the workplace results in reduced stair climbing (Eves et al., submitted; Olander & Eves, 2011b).

1.9.2.2 Time Pressure

Another social influence on choice of ascent is time pressure. Within travel contexts such as train stations, pedestrians will always be travelling elsewhere. When access to the escalator is blocked, pedestrians opt for the stairs seeking the fastest route to their destination (Eves et al., 2008; Eves & Masters, 2006; Eves, Masters et al., 2008; Kerr et al., 2001b). Further, commuters are more likely to take the stairs before 09:00 than after, independently of pedestrian traffic volume (Eves et al., 2009); as 09:00 is the start of the working day for many employees, this effect of time of day may reflect people choosing the quickest route to work. In relation, Kerr and colleagues compared effectiveness of the message 'Stay Healthy, Save Time' in a train station and a shopping centre (Kerr et al. 2001b). Increased levels of stair climbing were reported in the train station, but not in the shopping centre. Thus, increased time pressure results in increased use of the stairs. This is supported by data comparing the baseline rates of stair use in train stations (19.2%; Eves et al., 2009) with shopping centres (5.5%; Eves & Webb, 2006).

Similar effects of time pressure have also been identified within the workplace where the choice of ascent is between a lift and stairs (Kerr et al., 2001c; Nicoll & Zimring, 2009).

Olander and Eves (2011b) recently identified that more people within the workplace climbed the stairs in the morning than in the afternoon. In relation, slow lifts are associated with increased stair usage; one study reports a stair climbing baseline rate of 95% where the lift is slow and far from the main entrance of the building (Titze, Martin, Seiler & Marti, 2001). Further, lifts generally need to be 'requested' which may involve a temporal delay for the individual. A recent systematic review of stair climbing interventions revealed that lift settings had higher baseline rates of stair climbing (range 17-71%) than escalator settings (0.4-41%) (Nocon, Müller-Riemenschneider, Nitzschke & Willich, 2010). The pressure of time combined with temporal delays in choosing the lift may explain the higher levels of stair climbing in lift settings (Eves & Webb, 2006).

Critically, traffic volume and time pressure represent uncontrollable factors that may impact upon a person's choice of ascent method, i.e. moderators. It is important, therefore, to control for traffic volume and time of day, when evaluating intervention success; failure to do so may result in inaccurate interpretation of intervention effects. For example, higher levels of traffic during a baseline stage compared with an intervention stage, might mean the effect of intervention could be masked. In contrast, if traffic levels are higher during the intervention stage, then it could lend itself to exaggerated intervention effects.

1.9.3. Environmental Influences

1.9.3.1 Height of Ascent

Physical activity behaviour can be influenced by the layout and design of our surrounding environments (Sallis, Bauman & Pratt, 1998; Sallis et al., 2006; Zimring et al., 2005). One aspect of building design that may influence choice of ascent method is the height of ascent; the higher the ascent, the less likely individuals are to use the stairs (Bungum, Meachum & Truax, 2007; Olander & Eves, 2011a,b). Eves and Webb (2006) reported a significant correlation of baseline rates of stair climbing with the number of floors in a building; a greater number of floors were associated with lower baseline rates of stair use. Similarly, people were less willing to climb a 24-step staircase than one consisting of 18 steps, which in turn, they were less willing to climb than a 9-step staircase (Kerr et al., 2003).

1.9.3.2 Stair Location and Distance Minimisation

The location of the ascent methods may also influence one's choice of ascent method. As walking-related research reveals, an environment with utilitarian destinations within walking distance will encourage physical activity, whereas restricted connectivity in the street network may impede activity choices (Saelen & Handy, 2008; Sallis et al., 2006). It is reasonable to apply the same to choice of ascent method. In public access settings, stairs and escalators are typically adjacent. Where this is not the case, stair climbing has been more common when stairs were the first method of ascent encountered than vice versa (Kerr et al., 2003). Eves et al. (2009) found that stairs of closer proximity to the train station platform resulted in significantly greater stair use. In a shopping centre, Webb and Eves (2007b) found that pedestrians were five times more likely to use stairs that were in the line of travel; these stairs were closest to the entrance and so reflected distance minimisation of pedestrians, as has been previously reported (Garling & Garling, 1988; Hughes, 2002).

Within the workplace, stair use is more popular when the staircase is reached before the lift (Nicoll, 2007; Olander & Eves, 2011a). Lifts, however, tend to typically be positioned closer to the main entrance than stairs (Hulme, 2007). In contrast, staircases within buildings are mostly built as fire/safety exits and are typically to one side or the rear of the building (Moore, Richter, Patton & Lear, 2006). As such, when stairs are in an inconvenient location, they are not likely to be used as much as a more conveniently positioned alternative (Blake, Lee, Stanton & Gorely, 2008), namely the lift. In summary, the ascent method that is reached first is most likely to be chosen, i.e. stairs are generally chosen more if they are encountered before the escalator (Eves et al., 2009; Kerr et al., 2003) or lift (Olander & Eves, 2011a).

1.9.3.3 Escalator and Lift Availability

The availability of the mechanised option may influence one's choice of ascent. Within a train station, manipulation of the number of ascending escalators saw significantly greater levels of stair climbing when two escalators were ascending (35.2%) compared with one (18.2%) (Faskunger, Poortuliet, Nylund & Rossen, 2003). Thus, reduced availability of the mechanised option resulted in increase activity behaviour (Adams &White, 2002).

Similar effects have been seen within buildings relative to lift availability; fewer available lifts, even just one less lift, have been associated with greater levels of stair climbing (Olander & Eves, 2011b; Russell, Dzewaltowski & Ryan, 1999). Similar associations have been reported when reduced availability of the lift is due to the slow speed of the lift. For example, when the speed at which a lift door opened and closed was purposely slowed, an increase in stair climbing was observed (Van Houten, Nau & Merrigan, 1981). Further, it is likely that the number of individuals in a building at any time point may influence lift usage throughout the building; the more a lift is required, the less likely it is to be available at a particular point-of-choice. Thus, increases in building occupancy would act as a barrier to lift choice and increase the number of individuals choosing the stairs as the quickest option

(Olander & Eves, 2011b).

1.9.3.4 Visibility and Design of the Stairs

Visibility of the stairs may also influence stair use. An inspection of 123 workplace buildings revealed that only 54% had a staircase that was visible from the main entrance, 33% of staircases had locked doors and 18% had stairwell door signs (Moore et al., 2006). These figures are concerning as reduced visibility of the stairs is linked with lower levels of stair use within buildings (Blake et al., 2008; Nicoll, 2007). Similar findings have been found in public access settings. Eves and colleagues identified at a train station, that the platform with the largest area of visibility was associated with significantly greater levels of stair climbing (Eves et al., 2009). Similarly, in a shopping centre, higher levels of stair climbing were observed on a staircase where pedestrians reported seeing the intervention, compared with lower levels on a staircase when building design reportedly obscured visibility of the intervention (Webb & Eves, 2007b). Thus, stairs need to be clearly visible if they are to be considered as an ascent method.

Staircase design also appears influential. In their inspection of 123 workplace buildings, Moore et al. (2006) also identified that of 83 accessible staircases, only 36% were spacious enough for two people and 54% were considered brightly lit. Narrow staircases do not encourage usage within a building where colleagues may interactively travel together (Moore et al., 2006; Nicoll, 2007). Further, calculations from a UK train station reveal that a doubling of the width of those stairs could maximally increase stair use by 17.2% (Eves et al., 2008). This is three times the aggregated effect seen following the installation of health promotion messages in stations (6.6%; Eves et al, submitted). In addition, greater stair use is likely when the staircases are appealing, that is they have good lighting, include artwork and do not simply represent an emergency exit (Boutelle, Jeffery, Murray & Schmitz, 2001; Kerr, Yore, Ham & Dietz, 2004; Moore et al., 2006).

1.9.4 Summary

In accordance with the socio-ecological model, it appears that individual, social and environmental factors may influence one's choice to use the stairs, escalator or lift. Influences may be context specific so a 'one size fits all' approach to behaviour change interventions might not be appropriate. Considering these potential moderators of intervention success, it is important that: a) enough statistical power is sought to assess the effectiveness of any stair climbing intervention (Eves & Webb, 2006; Webb et al., 2011); and b) as some of these factors could not easily be manipulated to encourage greater stair use, they should, where possible, be controlled for in analysis to avoid misinterpretation of intervention effects (Eves et al., 2006).

Whilst some environments may encourage stair use, others may not. Further, for greater health rewards, regular, rather than occasional bouts of stair climbing is encouraged (DOH, 2004). It is important, therefore, that stair climbing becomes a habitual physical activity behaviour, such that people opt for the stairs whenever they are encountered.

1.10 The Role of Habit and Behaviour Change

As detailed, stair climbing has many associated health benefits. Whilst energy expenditure is achieved through the slightest of movement, stair climbing should be performed regularly to reap greater rewards. Thus, one aim of engaging an individual in physical activity is that it also becomes habitual.

From an operant conditioning perspective, habit develops through the repeated positive reinforcement of performing a particular behaviour to achieve a goal in a stable context (Aarts & Dijksterhuis, 2000; Verplanken & Aarts, 1999). Stair climbing is an active transport and energy minimisation during locomotion is inherent (Eves, submitted; Kayser, 2005). When faced with choosing an escalator/lift or climbing the stairs, opting for the mechanised option is rewarding due to reduced energy expenditure (Kerr et al., 2001a; Numoro et al., 2009; Webb & Eves, 2007a). Over time, the consistent reward of energy minimisation becomes habitual; each time one faces an escalator/lift and stairs, limited deliberation, if any, is required to choose the method of ascent (Kerr et al., 2001a; Webb & Eves, 2007b). Rather the process becomes one of automaticity that is guided by situational or environmental cues preceding the behaviour (Aarts, Paulussen & Schaalma, 1997; Verplanken, 2005; Verplanken & Orbell, 2003).

1.10.1 Changing Habitual Behaviour

When considering behaviour change, it is vital to contemplate one's motivation towards a goal in terms of direction and intensity, or their 'intentions' (Sheeran, 2002; Sniehotta, Scholz & Schwarzer, 2005; Sniehotta, Schwarzer, Scholz & Schu, 2005). Intentions are a strong predictor of one's activity levels (Giles-Corti & Donnovan, 2003). Within the Theory of Planned Behaviour model (Ajzen, 1991), attitudes reportedly account for 30-40% of the variance in intentions and intentions share ~30% of the variance in physical activity behaviours (Waumsley & Mutrie, 2011). Forming intentions to be active, however, does not always result in increased activity, hence the ‘intention-behaviour’ gap remains problematic for health promotion (Obell & Sheeran, 1998; Sheeran, 2002; Waumsley & Mutrie, 2011).

To change behaviour, two central intervention approaches are proposed; motivational interventions that aim to change attitudes and intentions, e.g. information-based mass media campaigns, and volitional interventions that aim to translate intentions into actions, e.g. interventions based on planning and implementation intentions (Gollwitzer & Sheeran, 2006; Milne, Orbell & Sheeran, 2002; Sniehotta, Scholz et al., 2005; Sniehotta, Schwarzer et al., 2005; Sutton, 2002). When targeting habitual behaviour, however, it is important to consider the strength of the habit (Jager, 2003); the more frequently a habitual behaviour is performed, the greater the automaticity of choice (habit) will be. Whilst motivational interventions are effective at changing attitudes and intentions, they may be an ineffective approach to change an established habit, as individuals are unlikely to be aware of new information targeting the behaviour (Gollwitzer, 1999).

An alternative way to alter habitual behaviour may be to change the context/situation where it occurs (Holland, Aarts & Langendam, 2006; Jager, 2003; Wood & Neal, 2009). Volitional interventions based on implementation-intentions may be effective; they aim to initiate the behaviour when the envisaged context and cue(s) are encountered, such that individuals can specify the time, place and how to act upon their intentions (Gollwitzer & Sheeran, 2006; Milne et al., 2002). This approach has been effective for various health behaviours such as healthy eating (Verplanken & Faes, 1999), breast examination and medication practices (see Orbell & Sheeran, 2002). It has also been associated with increased stair climbing within a workplace (Kwak, Kremers, Baak & Brug, 2007). Thus, volitional interventions based on implementation intentions may help overcome the established habit of choosing the escalator/lift when faced with alternate stairs.

1.10.2 Point-of-Choice Prompts

Point-of-choice prompts are a possible tool for behaviour change; they are similar to volitional interventions for action initiation (Gollwitzer & Sheeran, 2006). Point-of-choice prompts function by interrupting habitual behaviour, such as choosing the escalator/lift at the point of its occurrence, allowing substitution of a health-enhancing alternative (Kerr et al., 2001a; Webb & Eves, 2007a). Critically the prompts encourage the traveller to self-regulate and consciously consider which ascent method to choose by changing the contextual cues associated with the behaviour. As exposure to the point-of-choice prompt is typically fleeting and an incidental part of a journey, it may not change attitudes and intentions towards physical activity (Olander & Eves, 2011a). Rather, the prompt may remind individuals of their prior intentions to be more active at a time and place where they can fulfill them, helping translate intentions into actual behaviour (Puig-Ribera & Eves, 2010). In essence, point-of-choice prompts are likely to be post-decisional aids to healthy behaviour; a prior intention to be more active may be a prerequisite for point-of-choice prompts to change behaviour (Olander & Eves, 2011a).

Whilst levels of physical inactivity within the UK are startling, 66% of the English population reportedly intend to be more active (HSE, 2008). Point-of-choice prompts may be an effective way to help translate prior intentions into actual behaviour. One approach to increasing activity is to encourage stair climbing, a vigorous intensity active transport that can easily be incorporated into daily living. Subsequently, NICE proposes that stair climbing should be encouraged through the use of posters and/or stair-riser banners, which should be positioned at strategic points (NICE, 2006, 2008). Due to their potential value, therefore, the effectiveness of point-of-choice prompts as tools for changing stair climbing behaviour will be reviewed below.

1.11 Interventions to Increase Stair Climbing: The Effectiveness of Point of Choice Prompts

1.11.1 Brief Overview and Aims of Review

A recent systematic review of 25 stair climbing studies reporting 42 results, demonstrates that point-of-choice prompts increase rates of stair climbing; 31 results were significant increases, one was a significant decrease and ten had no significant change (Nocon et al., 2010). The significant increases in the prevalence of stair climbing ranged from 0.3% to 10.6% (OR range 1.05-2.93). Contextual variables and the intervention component(s) used may explain this variation (Nocon et al., 2010). Whether the choice of ascent method is between stairs and an escalator or a lift moderates the effectiveness of an intervention (Eves, 2008, 2010; Eves & Webb, 2006; Nocon et al., 2010; see also section 1.9). While interventions have examined the issue of prompt size and type (see Nocon et al., 2010 for summary), message content appears to have been freely generated by investigators and very few studies have compared different messages (Webb & Eves, 2007c; Nocon et al., 2010). Thus, more efficient messages may remain untested. Further, intervention success was typically assessed separately amongst men and women, but is limited amongst other population groups, such as those varying in weight status and of ethnic minority groups (Soler et al., 2010).

This review aims to assess the effectiveness of point-of-choice prompts as a tool for changing stair climbing behaviour, with a particular focus on the intervention components used, especially message content. Given the current obesity epidemic and the urgent need to increase activity levels amongst this group, this review will consider whether point-of-choice prompts can engage individuals differing in weight status and whether the message content influences responsiveness to the intervention. In line with current recommendations (DOH, 2004) and the evidence supporting the heightened value of stair ascent especially relative to weight control, this review focuses on stair climbing, rather than descent. Main findings will be presented within three categories: 1) point-of-choice prompts alone; 2) multi-component campaigns; and 3) interventions and message content relative to weight status.

1.11.2 Review Methods

Computerised searches were conducted using Embase, PubMed, Web of Science, PsycInfo and Medline. Keywords included: stairs; point-of-choice prompts; point of decision; stair climbing; and lifestyle physical activity. Results were limited to English language and peer-reviewed journal articles. Further literature was sourced using references from papers initially identified. Inclusion criteria were: stair climbing as an outcome measure; a point-of-choice prompt was an intervention tool; and results had baseline and post-intervention stair climbing rates. Unless stated otherwise, all studies presented used a quasi-experimental, interrupted time-series design.

1.11.3 Point-of-Choice Prompt(s) Alone

1.11.3.1 Comparison of Different Messages

Despite the growing number of stair climbing interventions, only five have statistically compared messages differing in content. Methods and results of these are presented in Table 1.3. As shown, mixed results were identified. In summary, Andersen et al., (1998), Kerr et al., (2001b [study 1]) and Russell and Hutchinson (2000) all report a significant increase in stair climbing post-intervention, with equivalent effects for each message used. Thus, it appears that within a shopping centre or airport no particular message content or message theme had greater effects upon stair climbing. In addition, Coleman and Gonzalez (2001) installed a culturally tailored, family-orientated message and an individual, heart health message in four different settings throughout a predominately Hispanic Community (n=115,153). Messages were never compared statically, thus no firm conclusions can be made. The authors stated that neither message appeared to have greater effects than the other, as reported by the previous studies.

In contrast, Kerr et al. (2001b [study 2]) compared the same messages from their prior study (Kerr et al., (2001b [study 1]) in a train station; both messages were associated with increased stair use, however, the message with the additional phrase ‘save time’ had a significantly greater increase than the first message. Similarly, Andersen and colleagues (2006) compared a message about time to exercise accompanied by a culturally sensitive role model with a generic heart-health message in a subway station. The message about time had greater effects on African-American stair users than the heart-health message. In travel settings such as stations, therefore, where people are pressured by time to reach their

Authors, Year, Country	Setting	No. of Observations	Message Content	Intervention Duration	Baseline Stair Climbing	Key Findings for Stair Climbing (relative to baseline)
Andersen et al. (1998), USA.	Shopping Centre	17,901	1) Your heart needs exercise, use the stairs 2) Improve your waistline, use the stairs	Int1: 1 mth Int2: 1 mth	4.8%	Equivalent effects for both: 1) +2.1% (CI 1.3-2.8 percentage points) 2) +2.4% (CI 1.5-3.2 percentage points)
Kerr et al. (2001b), UK.	Shopping Centre	12,588	1) Stay healthy, use the stairs 2) Stay healthy, save time, use the stairs	Int1: 2 wks Int2: 2 wks	7.4%	Equivalent effects for both (OR=0.91, 95% CI 0.78-1.06): 1) +3.6% (OR=1.49, 95% CI 1.26-1.76) 2) +2.9% (OR=1.39, 95% CI 1.19-1.64)
Russell & Hutchinson (2000), USA.	Airport	3,369	1) Save time, keep your heart healthy, use the stairs 2) Please limit escalator use to staff and those unable to use the stairs	Int1: 1wk Int2: 1 wk	10.6%	Equivalent effects for both ($\aleph_1^2$=.06): 1) +6.67% 2) +6.18%,
Kerr et al. (2001b), UK.	Train station	25,319	1) Stay healthy, use the stairs 2) Stay healthy, save time, use the stairs	Int1: 2 wks Int2: 2 wks	38.1%	Greater increase for message #2 (OR=1.09, 95% CI 1.02-1.15, p<.01): 1) +3.8% (OR=1.12, 95% CI 1.05-1.20) 2) +7.6% (OR=1.22, 95% CI 1.15-1.31)
Andersen et al. (2006), USA.	Subway station	16,035	1) Your heart needs exercise…, use the stairs 2) No time to exercise? Try the stairs	Int1: 1 wk Int2: 2 wks	6.9% 10.3%	Greater increase for message #2 on African-American stair users: 1) -2.0% (95% CI 3.8-9.6%) 2) +6.1% (95% CI 15.1-17.7%)

Notes: BL – baseline; Int1/2 – Intervention Stage; mth – month; wk(s) – week(s)

Table 1.3: Studies, using a quasi-experimental interrupted time series design, that have statistically compared messages differing in content.

destination, time-related message content may result in heightened increases in stair climbing. These findings suggest that intervention success may depend upon the message(s) used.

In each study messages were tested one after the other, so effects of prior intervention history may have transferred from one intervention to the other. Also, none compared messages within the same theme. Clearly further research should compare messages of different content and in different settings to identify more efficient messages. Ideally message comparisons should be simultaneous to avoid the potential confound of prior intervention history.

1.11.3 Point-of-Choice Prompt(s) Alone

Intervention success may depend upon the message used. To date, 40 interventions have used point-of-choice prompts by themselves as the tool for behaviour change within the intervention; main findings and study characteristics of these are presented in Nocon et al.'s (2010) systematic review. Of those studies using only point-of-choice prompts, 31 reported a significant increase in stair climbing post-intervention, therefore the nine unsuccessful interventions will be reviewed in an attempt to identify why they failed to significantly increase stair climbing.

1.11.3.2 Unsuccessful Interventions

Eves and colleagues attempted to encourage pedestrians in Hong Kong to walk up a travelator system (Eves & Masters, 2006; Eves, Masters et al., 2008). Both studies reported no significant change in rates of stair climbing post-intervention, however increased temperatures and humidity potentially deterred pedestrians as personal discomfort may have occurred from increased activity in these conditions (see section 1.9.1.1). Previous studies were conducted in the UK and USA where temperatures and humidity are lower (Eves et al., 2008; Eves & Masters, 2006). Further, Kerr et al. (2001b; two studies) assessed the effectiveness of prompt sizes in a shopping centre. They reported significant increases in stair climbing when A1- (80x60cm) and A2- (60x42cm) sized posters were positioned, but not following an A3- (42x30cm) sized poster. Whilst these four studies reported no significant increase in stair climbing, high temperatures and humidity and inappropriate prompt sizes may be responsible.

Of the five remaining unsuccessful interventions, four reported no significant changes in stair climbing rates post-intervention (Kerr et al. 2001b [two studies]; Coleman & Gonzalez, 2001 [library study 1]; Colley, Foley & Magnussen, 2008) and one reported a significant decrease (Coleman & Gonzalez, 2001 [office study 2]); Table 1.4 presents study characteristics and key findings. Two reasons may explain these findings. Firstly, all were conducted in a building where the choice of ascent was between the stairs and a lift (see Eves, 2008, 2010; Eves & Webb, 2006; Nocon et al., 2010). Contextual factors such as building height, the number of lifts and social interactions of travellers within buildings appear to encourage greater lift use and potentially act as barriers towards stair climbing (see section 1.9.3). Thus, it is important to distinguish between these settings and consider the impact of uncontrollable contextual factors when designing interventions and assessing effectiveness (Eves, 2008, 2010; Nocon et al., 2010; Soler et al., 2010).

Author, Year, Country	Setting	No. of Observations	Intervention Description	Intervention Duration	Baseline Stair Climbing	Key Findings for Stair Climbing (relative to baseline)
Coleman & Gonzalez (2001), USA	Office building	8,361	Do it for the life of your family! Watch your step, use the stairs (family-orientated)	4 weeks	66.6%	Significant decrease in stair climbing (61.3% [-5.3%], OR=0.80, 95% CI 0.72-0.89)
Coleman & Gonzalez (2001), USA	University library	15,233	Do it for the life of your family! Watch your step, use the stairs (family-orientated)	4 weeks	71.4%	No significant change in stair climbing (72.1%, OR=1.04, 95% CI 0.95-1.13, ns)
Cooley et al. (2008), Australia	Office building	62,732	1) Free exercise machine, step up to a healthier life 2) Not taking the stairs? If you're like a lot of Tasmanians…it'll be the only exercise you get today	6 weeks	n/a	Neither poster resulted in significantly increased stair climbing. 1) OR=0.6, 95% CI 0.3-1.1 2) OR=1.0, 95% CI 0.5-1.9
Kerr et al. (2001c), Study 1, UK	Office building	12,288	Stay healthy, use the stairs	2 weeks	20.7%	No significant increase in stair climbing (21.5%; OR 1.04, 95% CI 0.92-1.18)
Kerr et al. (2001c), Study 2, UK	Office building	2,694	Stay healthy, use the stairs	4 weeks	19.0%	No significant increase in stair climbing (23.2%; OR 1.22, 95% CI 0.96-1.55)

Table 1.4: Unsuccessful interventions within the workplace using a conventional point-of-choice prompt (all of quasi-experimental, interrupted time-series design).

Secondly, examination of message content reveals a common theme, such that all the messages presented general outcomes of stair climbing (see Table 1.4); these messages may not have been persuasive to counteract the potential barriers within these settings and subsequently failed to encourage individuals to choose the stairs. Webb and Eves (2007c) identified only one stair climbing intervention at the time that had pre-tested materials in the field (Kerr et al., 2001a); other messages were freely created by investigators, with little, if any feedback from the target audience, and were re-used if they were previously successful (Webb & Eves, 2007c). Further inspection of message content by Webb and Eves (2007c) showed that intervention messages generally fit into two categories: some provide general descriptions of stair climbing (e.g. '*easy exercise', 'free exercise'*), whereas others emphasise specific consequences (e.g. '*exercises your heart', 'keeps you fit'*). Thus, using a replicated design to control for random sampling effects, Webb and Eves (2007c) conducted a large interview study (n=1,200; two separate samples of 600) to establish whether one message type was more persuasive. Results suggest that messages emphasising specific consequences may have superior motivational properties than those providing general descriptions.

In summary, these unsuccessful interventions, combined with indications from the earlier comparison of message content (section 1.11.3.1), reiterate that intervention success may depend on message content. Although point-of-choice interventions have been consistently effective where the choice of ascent is between an escalator and stairs (see Nocon et al., 2010), the true potential of point-of-choice prompts in these settings may not have yet been seen; messages outlining the specific consequences of stair climbing may have greater persuasiveness than those that previously used general descriptors. Findings of Webb and Eves (2007c) were based on interviews, thus studies observing actual behaviour should assess whether messages differing in specificity within the same theme, have differential effects upon stair climbing behaviour.

1.11.4 Multi-Component Campaigns

Whilst point-of-choice prompts alone have reliably shown positive results when the choice of ascent has been between an escalator and the stairs (i.e. public access settings), this consistent success has not transferred to settings where a lift is present (i.e. workplace and community settings). It is possible that messages providing general outcomes of stair climbing are not persuasive enough to counteract contextual factors within this environment.

Unlike previous stair climbing interventions, Eves et al. (2006), designed a multi-component campaign (see Table 1.5 for details); the main, A2-sized intervention poster within the campaign incorporated an explicit target for the amount of stair climbing required to achieve the outcome to encourage regular use of the stairs, that is it contained 'an extended message'. Further, messages within the stairwells also outlined brief, yet specific health outcomes of stair climbing. Thus, this multi-component campaign consisted of conventional point-of-choice prompts and additional components positioned after the choice of ascent had been made. Subsequently, rates of stair climbing significantly increased post-intervention, providing an original result for interventions within the workplace setting.

Following this success, Eves et al. (submitted [sites one & two]) explored the use of multi-component campaigns further in two worksites. The core campaign of both interventions contained an extended message that specified the amount of stair climbing required to achieve the outcome and point-of-choice prompts displaying a different, yet specific health outcome message and arrow pointing to the stairs were positioned by the external control panel of the lift. In the second site, additional messages detailing specific consequences of stair climbing were positioned within the stairwells. Both interventions reported significant increases in stair climbing relative to no intervention (see Table 1.5), with larger increases in the second site. Whilst promising, effectiveness of each component alone was unknown; during intervention periods, Eves et al. (2006) and Eves et al. (submitted) positioned all components simultaneously.

Olander and Eves (2011a) also compared the effectiveness of two interventions for promoting stair climbing within the workplace (see Table 1.5). An extended message was displayed on a poster at a stand encouraging stair climbing, which formed part of a health information day, called Workplace Wellbeing Day, on a university campus. This poster was supplemented with the provision of leaflets listing eight specific benefits associated with regular stair climbing. Next, the same poster was displayed at the point-of-choice between the stairs and the lift(s) within four university buildings, which were supplemented with a smaller poster and arrow pointing to the stairs, positioned by the external lift control panels. No significant change in stair climbing following the Workplace Wellbeing Day was reported, whereas the addition of the point-of-choice prompts was associated with a significant increase (see Table 1.5). Olander and Eves (2011a) suggested that the ineffectiveness of the initial extended message, however, was due to poor dissemination; only 3.2% of employees in the buildings being observed, attended the location of the intervention, thus it failed to reach the target audience. The effectiveness of each component alone, therefore, remains inconclusive.

Authors, Year, Country	Building	No. of Observations	Intervention Description	Intervention Duration	Baseline Stair Climbing	Key Findings (relative to baseline)
Eves et al. (2006), UK.	Worksite	15,662	3 components: a) A2 poster (specific heart health message) in lobby, A4 arrow pointing to stairs & A4 poster (specific message) by lift button; b) 6 additional messages in stairwells c) A2 poster (same as part A) at top of the climb	6 weeks	29.1%	Greater effects of the intervention in overweight persons (+5.4%, OR=1.33, $p<.001$) than normal weight persons (+2.5%, OR=1.12, $p=.02$)
Eves et al. (submitted), Site 1, UK.	Offices	17,561	2 components: a) A2 poster (specific calorific expenditure message) b) A4 arrow pointing to stairs & A4 poster (specific message) by lift button	3 weeks	37.0%	Increased stair climbing following intervention (OR=1.24, 95% CI 1.15-1.34, $p<.001$)
Eves et al. (submitted), Site 2, UK.	Offices	11,293	3 components: a) A2 poster (specific calorific expenditure message) b) A4 arrow pointing to stairs & A4 poster (specific message) by lift button c) x6 additional messages in stairwells	3 weeks	53.8%	Increased stair climbing following intervention (OR=1.52, 95% CI 1.40-1.66, $p<.001$)

Olander & Eves (2011a), UK.	x4 University Buildings	4,279	2 components: a) A2 poster (specific calorific expenditure message [same as Eves et al. submitted]) & leaflets promoting benefits of regular stair climbing; b) A2 poster (specific calorific expenditure message [same as part A]), A4 arrow pointing to stairs & A4 poster by lift button	 1 day 5 days	47.9%	No significant difference between baseline and Workplace Wellbeing Day (A) (48.8%; OR=1.02, 95% CI 0.88-1.19), compared with significant increase following point-of-choice prompts (B) (52.6%; OR=1.20, 95% CI=1.06-1.37, p<.01)
Adams & White (2002), UK.	University building	5,293	3 components (x4 different, A3 posters were designed): a) x1 each of the health, calories and speed posters next to the lift buttons on each floor (i.e. 3 posters in total) b) x1 sign inside each lift c) x1 sign positioned in the stairwell	4 weeks	20.1%	No significant change in stair climbing following the intervention at 1-week (20.6%, p=0.77) or at 4-weeks (19.5, p=0.74)

Table 1.5: Interventions using multi-component campaigns (all of quasi-experimental, interrupted time-series design).

It should be mentioned that Adams and White (2002) utilised a multi-component intervention within a workplace, however no significant change in stair climbing was seen (see Table 1.5). Multiple messages, containing specific outcomes of stair climbing were installed by the external lift control panel and within the stairwells, that is after the choice of ascent has been made, which may be too late to change actual behaviour. Further all prompts were A3-sized. Previous research suggests that prompts of this size are insufficient due to restricted visibility of the prompt and content (Kerr et al., 2001b). In addition, 29 of the 39 posters were removed throughout the intervention, therefore findings of this study do not seem representative of the intervention components, rather the failing of the messages to reach the target audience.

In summary, these studies show that that a multi-component approach incorporating an extended message targeting the specific amount of stair climbing required to achieve the presented outcome, provided novel results for stair climbing interventions in the workplace. These are contrary to previous studies presenting simple, general descriptor messages. Whilst promising for settings where the choice of ascent is between a lift and the stairs, it is possible that this novel approach may augment the impact of a point-of-choice prompt alone where the choice is between an escalator and the stairs. As such, the true potential of interventions to increase stair climbing may not have been seen and future studies should explore this. Further, comparisons of the single and combined effects of these components should be investigated to understand the theoretical underpinnings behind the success of each of these components.

1.11.5 Interventions and Message Content related to Weight Status

Following installation of a 4-week stair climbing campaign, Kerr et al. (2000) asked shoppers (n=658) whether they saw the intervention and enquired about their stage of change for exercise. Analysis of the stage of change data suggested that pre-contemplators saw the intervention less than participants in other stages (8.6% vs. 40.1%, p=.0003). In relation, research suggests that individuals appearing to be overweight take the stairs less than normal weight individuals pre-intervention (Andersen et al., 1998, 2006; Brownell et al., 1980 [two studies]; Eves et al., 2006). Given the current obesity and inactivity crisis, it is important to identify whether point-of-choice prompts can effectively target and engage specific population groups, such as the overweight/obese.

1.11.5.1 Intervention Effectiveness

Five stair climbing studies have measured the weight status of participants. Brownell et al. (1980) evaluated the effectiveness of a heart-health point-of-choice prompt on rates of stair climbing amongst commuters in two studies. In study one (n=21,091), a similar increase in stair use was reported for those classified as obese (+6.3%) and non-obese (+8.2%, both <.0001). In study two (n=24,603), however, stair use amongst the obese remained stable across all stages (4.9%) unlike a greater response by the non-obese (16.1% [+4.3%], p<.0001). Further, Andersen et al. (2006) measured stair use following installation of a time-related prompt (n=16,035). An increase in stair use post-intervention was recorded amongst overweight (+5.1%) and non-overweight (+5.7%) individuals. There is no clear explanation for the difference between groups reported by Brownell et al. (1980, study 2). The other studies, however, indicate equivalent intervention effectiveness between weight status groups (Brownell, 1980 [study one]; Andersen et al., 2006).

Two additional studies reported a greater intervention response amongst overweight than normal weight individuals. Andersen et al. (1998) compared the effectiveness of a heart-health and a weight control message amongst shoppers (n=17,901). A greater increase in stair use was reported in overweight individuals following the weight control message versus the non-overweight (+3.9% vs. +1.5%, respectively). Further Eves et al. (2006) investigated the effects of a comprehensive campaign amongst overweight and normal-weight employees (n=26,806). The main campaign heart-health message and supplementary messages about weight control each highlighted a specific health consequence of stair climbing. Post-intervention, a significant increase in stair climbing was reported, with larger increases amongst those coded as overweight (+5.4%, OR=1.33) than normal weight individuals (+2.5%, OR=1.12). Unlike the earlier studies, which assessed weight status from personal judgment, Eves et al. (2006) used validated silhouettes reflecting different weight categories and via video recordings, resulting in a 94% inter-observer reliability.

Comparisons of the studies identified above reveal two issues. Greater increase in stair use amongst overweight than normal weight individuals was reported following installation of a weight control prompt (Andersen et al., 1998; Eves et al., 2006). Further, these messages outlined a specific weight-related benefit of climbing the stairs, which are likely to be more motivating than general consequences (Webb & Eves, 2007c), which the other studies used (Andersen et al., 2006; Brownell et al., 1980 [two studies]). Thus, point-of-choice prompts outlining a specific weight-related outcome that is achievable from stair climbing appear effective. Further they may have heightened outcomes amongst overweight individuals, a target population group, although further research is needed to confirm this.

1.11.5.2 Message Content

Besides the studies noted above, three other studies displayed a message detailing a specific, weight-related outcome of stair climbing (Eves et al., submitted; Olander et al., 2008; Olander & Eves, 2011a). Specifically each utilised a message based on calorific expenditure, e.g. *'Stair climbing burns more calories per minute than jogging...',* and reported a significant increase in rates of stair climbing following installation of the point-of-choice prompt (OR range = 1.20-1.52). While Eves et al. (submitted; site one) report comparable effects to those of Eves et al. (2006) and Olander and Eves (2011a), the addition of weight-control stairwell messages saw a greater increase in stair climbing (OR=1.52, CIs 1.40-1.66; site two) when compared with Eves et al., (2006) who used a heart-health message (OR=1.12, CIs 1.02-1.23). Thus, messages based on calorific expenditure may be rewarding, however none of these three studies measured weight status. Consequently, it would be informative to compare the impact of this theme amongst groups differing in weight status.

1.11.6 Summary of Interventions to Increase Stair Climbing

As demonstrated, there is a large amount of evidence indicating that point-of-choice prompts are an effective tool to encourage increased stair climbing. Message content, however, appears to influence the success of an intervention. Whilst point-of-choice prompts have regularly increased stair climbing in public access settings, improved message content may offer greater rewards than previously reported, especially amongst the overweight/obese. Further, similar improvements may be seen if improved message content is combined with additional interventions components, as used by the Eves et al. (2006), Eves et al (submitted) and Olander and Eves (2011a). Although, point-of-choice prompts are successful, the theoretical underpinnings of their positive impact and that of the novel additional components, that is an extended message targeting attitudes, have not been examined.

This thesis, therefore, aims to investigate message content, as well as the impact of multi-component campaigns, including the examination of the theoretical underpinnings behind these intervention components. Research will primarily be conducted in public access settings; venues that large amounts of people regularly use and could therefore help encourage increased lifestyle physical activity at a population level. Further, in one study, success will be assessed amongst those differing in weight status.

1.12 Purposes of the Current Thesis

1) Compare the impact of two messages differing in specificity about the health outcomes obtainable from stair climbing (chapter 2)

Point-of-choice prompts are regularly associated with increased rates of stair climbing in public access settings. Formal comparison of message content, however, is rare. A recent interview study indicated that messages outlining specific health outcomes might have superior motivational properties than more general statements (Webb & Eves, 2007c). This study will simultaneously compare the impact of two messages differing in specificity with which they detail a possible outcome of stair climbing on the actual behaviour, in a public access setting. Each message will be based on heart health.

2) Test the theory underlying the success of point-of-choice prompts (chapter 3)

Whilst point-of-choice prompts are regularly associated with increased stair climbing, especially within public access settings, the theoretical underpinnings behind their success have not been formally tested. A recent worksite intervention added an extended message targeting attitudes to a conventional point-of-choice prompt (Eves et al., 2006). This multi-component approach resulted in increased stair climbing, which was an original result for stair climbing interventions within the workplace. This study will adapt the multi-component approach for use in a public-access setting. Specifically, the single and combined impact of volitional and motivational components of a stair climbing intervention will be compared in a public access setting, using a cross-over design. A calorie expenditure-based message will be used.

3) Assess the success of a calorie-based, multi-component campaign on stair climbing in overweight commuters (chapter 4)

Conventional point-of-choice interventions use a single prompt positioned as the base of the stairs and escalator. A recent multi-component worksite campaign increased stair climbing more in overweight than normal weight employees implying that stair climbing may be an appealing lifestyle activity for the overweight (Eves et al., 2006). This study will adapt the multi-component intervention approach for use in a public access setting. Using standardised measures, pedestrian weight status will also recorded. The messages will be based on weight control and calorific expenditure.

4) Compare the impact of motivational and volitional components of a stair climbing intervention in the workplace (chapter 5)

Recent stair climbing interventions within the workplace have successfully utilised a multi-component campaign, however, the single and combined impact of these components is unknown. This study will compare the impact of motivational and volitional components of a stair climbing intervention in the workplace. A calorific expenditure message will be used for each component.

5) General discussion and conclusion (chapter 6)

This final chapter will discuss and compare the findings of the previous four chapters. The implications of these findings will be highlighted and suggestions for future research will be provided.

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CHAPTER TWO

PROMPTS TO INCREASE STAIR CLIMBING IN STATIONS; THE EFFECT OF MESSAGE COMPLEXITY.

Lewis, A.L. & Eves, F.F. (in press). *Journal of Physical Activity and Health*.

2.0 Prompts To Increase Stair Climbing In Stations; The Effect Of Message Complexity

2.1 Abstract

Background/Objective: While point-of-choice prompts consistently increase stair climbing, experimental comparisons of message content are rare. Here, the effects of two messages differing in complexity about the health outcomes obtainable from stair climbing were compared.

Methods: In a UK train station with two independent platforms exited by identical 39-step staircases and adjacent escalators, observers recorded travellers ascent method and gender 08:00-10:00 on two weekdays during February/March 2008 (n=48,697). Baseline observations (2-weeks) preceded a 3-week poster phase. Two posters (594x841mm) that differed in the complexity of the message were positioned at the point-of-choice between ascent methods, with one placed on each side of the station simultaneously. Logistic regression analysis was conducted in April 2010.

Results: Omnibus analysis contained main effects of the intervention (OR=1.07, CI=1.02-1.13, p=0.01) and pedestrian traffic volume (OR=5.42, CI=3.05-9.62, p<0.001). Similar effects occurred for complex (OR=1.10, CI=1.02-1.18, p=0.01) and simpler messages (OR=1.07, CI=1.01-1.13, p=0.02) when analyses controlled for the influence of pedestrian traffic volume. There was reduced efficacy for the complex message during busier periods (OR=0.36, CI=0.20-0.66, p=0.001), whereas the simple message was immune to these effects of traffic volume.

Conclusions: Pedestrian traffic flow in stations can influence message effectiveness. Simple messages appear more suitable for busy sites.

2.2 Introduction

Physical inactivity, a risk for many diseases, is a continuing public health concern (World Health Organization [WHO], 2002). Current approaches focus on the accumulation of physical activity as part of daily living (Department of Health [DOH], 2005; USDHHS, 2010). Much of the research targeting lifestyle physical activity has adopted a socio-ecological model that incorporates effects of the physical environment and the social milieu, as well as intra-individual processes such as intention (Giles-Corti & Donovan, 2003; Sallis, Bauman & Pratt, 1998). One effective way to increase lifestyle physical activity is to increase the use of active transport, e.g. walking to destinations (Frank et al., 2006; Sallis et al., 1998). Unlike walking, stair climbing is a physiologically vigorous lifestyle activity, with field estimates of 9.6 Metabolic Equivalents of Tasks (METs), i.e. 9.6 times the energy requirements of the resting state (Teh & Aziz, 2002).

Whilst experimental findings show that regular bouts of stair climbing have been associated with improved cholesterol profile, respiratory fitness and weight loss (Boreham et al., 2005; Kennedy, Borehman, Murphy, Young & Mutrie, 2007; Meyer, Kayser & Kossovsky, 2010), climbing a single set of stairs is unlikely to result in substantial health gains. Nonetheless, the accumulation of stair climbing throughout the day increases energy expenditure; an 80kg man who climbs a standard 3m flight of stairs in his own home ten extra times a day would expend approximately 28 kcals per day, which, if repeated daily for a year, is energy expenditure equivalent to 3lbs of fat (Olander & Eves, 2011a). Thus, increased regular use of the stairs rather than the mechanised alternative during active transport is one of a number of current public health targets aiming to increase lifestyle physical activity (DOH, 2005; USDHHS, 2010). Like other types of active transport, stair climbing can be influenced by the social environment; the volume of pedestrian traffic at a particular site and time can have major influences on the behavior (Eves, Lewis & Griffin, 2008).

To increase stair climbing, point-of-choice prompts are positioned between the stairs and escalators encouraging pedestrians to take the stairs for their health. Point-of-choice prompts interrupt habitual choice of the escalator at the point of occurrence and provoke deliberation about the alternatives (Kerr, Eves & Carroll, 2001a; Webb & Eves, 2007a). These active environmental interventions have proved an effective strategy to increase the accumulation of stair climbing in public access settings (Andersen, Franckowiak, Synder, Barlett & Fontaine, 1998; Andersen et al., 2006; Brownell, Stunkard & Albaum, 1980; Coleman & Gonzalez, 2001; Eves, 2010; Kerr et al., 2001a, 2001b; Olander, Eves & Puig-Ribera, 2008; Soler et al., 2010; Webb & Eves, 2007a, 2001b). Nonetheless, most messages are freely generated by investigators or focus groups, with limited testing of message content on the target audience (Webb & Eves, 2007c). A recent interview study (n=1200), however, suggested that messages outlining specific health outcomes may have superior motivational properties than more general statements (Webb & Eves, 2007c). Here, we test the effects of two messages differing in the specificity with which they detailed a possible outcome of stair climbing on the actual behaviour, rather than self-reported motivation.

Five previous formal comparisons of messages differing in content for public access settings report mixed results. Equivalent effects occurred for messages about heart health and weight control (Andersen et al., 1998) and the addition of the phrase 'Save time' to the message 'Stay healthy' (Kerr et al., 2001b) in shopping malls. Similarly, a heart health sign and one aimed at restricting escalator use had equivalent effects in an airport (Russell & Hutchinson, 2000). In contrast, addition of the 'Save time' phrase to the 'Stay healthy' message increased stair climbing in a station (Kerr et al., 2001b). Further, a message about time to exercise accompanied by a culturally sensitive role model had greater effects on African-American users of a station than a generic sign for heart health tested in pilot work (Andersen et al., 2006). Finally, a larger aggregated response occurred for a family-oriented message for heart health (+2.3%) than one focused on the individual (+0.9%) in an airport (Coleman & Gonzalez, 2001). Nonetheless, the family-oriented message preceded the individual sign and the two were never statistically compared. Importantly, sequential testing of message content in all these studies does not control for the possible effects of different histories prior to each intervention; carry over effects from one intervention to another and adaptation to *any* attempt to increase stair climbing are possible. Further, no study has compared messages with the same theme, a necessary approach to assessing the effects of specificity of the outcome communicated in the message. Therefore, this study *simultaneously* compared the effects of two messages differing in specificity in a train station with matched staircases. Crucially the possibility of an individual being exposed to both messages was negligible at this site due to the operational structure of train arrival. Trains from the same location always arrived at the same platform on a daily basis. We hypothesised that the more specific health outcome message would have greater effects on stair climbing than the more general one.

As noted earlier, socio-ecological models include effects of physical and social environments. Here, matched staircases in the same station equated potential effects of the physical environment. Concerning the social environment, pedestrian movement within stations influences stair climbing. Unlike shopping malls, pedestrian traffic flow in stations is pulsatile in nature as the disembarking passengers from a particular train try to leave the station simultaneously. For example, an average of 18.9% on the stairs when 25 passengers left a train rose to 43.0% when 150 passengers left a train in the same station (n=82,347) (Eves et al., 2008). Thus, pedestrian traffic in stations has major effects on the choice between stairs and escalators; as traffic increases, stair climbing increases (Eves, Olander, Nicoll, Puig-Ribera & Griffin, 2009; Kerr et al., 2001b; Olander et al., 2008; Puig-Ribera & Eves, 2010). Here, we quantify the effects of traffic in the station to facilitate comparison between the effects of interventions and the social environment. Importantly, two recent studies in stations reported an interaction between pedestrian traffic volume and the intervention such that it was *less* effective at higher traffic volumes (Olander et al., 2008; Puig-Ribera & Eves, 2010). One parsimonious explanation for effects of pedestrian traffic is time pressure; when the escalator is full, some passengers avoid delay by opting for the stairs (Eves et al., 2008). It is possible, however, that time pressure in commuters may also affect processing of the message itself. When commuters encounter a point-of-choice prompt, exposure to the message is fleeting and occurs as an incidental part of their journey. A commuter seeking the quickest route out of the station may require more mental resources for this task at higher traffic volumes and hence processing of any incidental message could be impeded. Thus, analyses tested for an interaction between message content and pedestrian traffic volume.

2.3 Methods

2.3.1 Intervention Site

The intervention site was a UK train station with two independent platforms exited by identical 39-step staircases and adjacent escalators (height=6.64 m). Each platform received trains from differing locations, which remained the same for both platforms throughout the duration of the study. Thus, regular passengers arrived at the same platform each day and, hence, could only be exposed to both messages if they set off from different locations on different days. This scenario would be a possible, but we suspect uncommon, journey to work. The intervention site was selected as its layout enabled a simultaneous comparison of point-of-choice prompts. Figure 2.1 illustrates the station layout. Trains stopped opposite the station buildings and passengers walked along the platform to reach the stairs and escalator to exit the station. Pillars supporting the concourse overhead were the only fixed obstacles present at each platform that might impede a pedestrian's view of the posters.

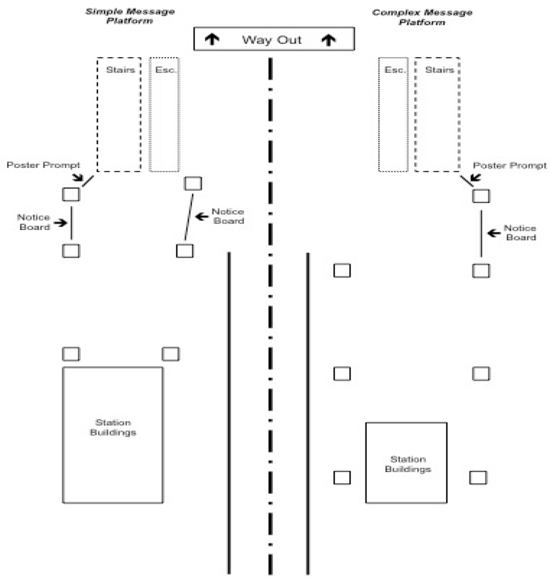

Figure 2.1: Schematic of the station floor plan (approximate scale). Trains stopped opposite the station buildings at the bottom of the figure, requiring passengers to walk along the platform to reach the stair and escalator (esc.) complexes depicted at the top of the figure. Train tracks are positioned between the two platforms (thick dashed line).

2.3.2 Procedure

During February and March 2008, four observers (inter-observer reliability: average kappa=0.97, kappa range 0.94-1.00) recorded stair/escalator choices of ascending travellers, coded by gender, as they left each train between 08:00 and 10:00, on Tuesday and Thursday each week; coding for gender alone reflected the high levels of pedestrian traffic (Eves et al., 2009; Kerr et al., 2001b; Olander et al., 2008). Specifically, two observers were discretely positioned on each platform; one recorded male and females ascending the stairs and the other recorded males and females ascending the escalator. Travellers constrained in their ability to use the stairs by a physical incapacity, large bags (larger than a briefcase or medium-sized bag) or accompanying children (head below shoulder height of accompanying adult) were not recorded (Kerr et al., 2001b; Olander et al., 2008). Thus, our sample represented all individuals exiting a station between 08:00-10:00 who could ascend the stairs and were not encumbered. In a quasi-experimental, interrupted time series design, a 2-week baseline phase was followed by a 3-week poster phase. Two A1-sized posters (594 x 841 mm) were simultaneously tested, one on each side of the station. Positioning of the posters on stands meant that the bottom of the text was 2.37m above the ground and hence clearly visible to approaching pedestrians (see Appendix 7.1).

A specific message '*Regular stair climbing for 7 minutes per day protects your heart*' was compared with the more general message '*Regular stair climbing protects your heart*'. In pilot work, the first message (mean=6.3±1.9) was rated more specific than the second (mean=3.9±1.9; t_{39}=4.96 p<0.001) on a 10 point scale with the anchors not at all (1) and very much (10). It should be noted here that the greater specificity of the first message comes from additional words. The phrase '*for 7 minutes per day*' states the amount of stair climbing required to achieve the outcome. The specific message's origin was from a more extended message that aimed to encourage regular stair climbing in a worksite, by incorporating an explicit target for the amount of stair climbing required to achieve health benefits (Eves, Webb & Mutrie, 2006). Previously, Yu and colleagues estimated that the amount of vigorous exercise required to reduce the risk of heart attack by two thirds was equivalent to seven minutes of stair climbing a day (Yu, Yarnell, Sweetnam & Murray, 2003). Focus groups suggested this would be an effective message theme (Eves et al., 2006). The shortened version employed here was previously successful in a UK shopping mall (Webb & Eves, 2007b) and, when translated, in a station in Barcelona, Spain (Puig-Ribera & Eves, 2010). The additional phrase of the specific message, '*for 7 minutes per day*', increased the length and also the complexity of the message and we refer to it with the term 'complex' in the remainder of the manuscript. As a consequence, the more general message is termed 'simple'. We return to this issue in the discussion. Ethical approval was obtained from the ethics subcommittee of the School of Sport and Exercise Sciences, University of Birmingham, Birmingham, UK.

2.3.3 Statistical Analyses

Logistic regression analysis was conducted in April 2010, with the dichotomous outcome variable of stair/escalator choice and the dichotomous predictors of intervention, message platform and gender. Pedestrian traffic volume, i.e. the total number of pedestrians leaving each train, was entered as a continuous variable. Prior to analysis, this variable was subjected to a natural logarithm transformation and standardised in the range 0-1 by dividing by the highest value to facilitate comparison with effects for binary variables (Eves et al., 2009). Preliminary inspection revealed higher levels of traffic at the simple message platform (mean=161.6±87.3 pedestrians.train^{-1}) than the complex one (mean=130.7±85.6 pedestrians.train^{-1}; t(336)=3.25, p=0.001). To allow assessment of the effects of message platform unconfounded by differences in traffic volume, the data were mean centred for each message platform.

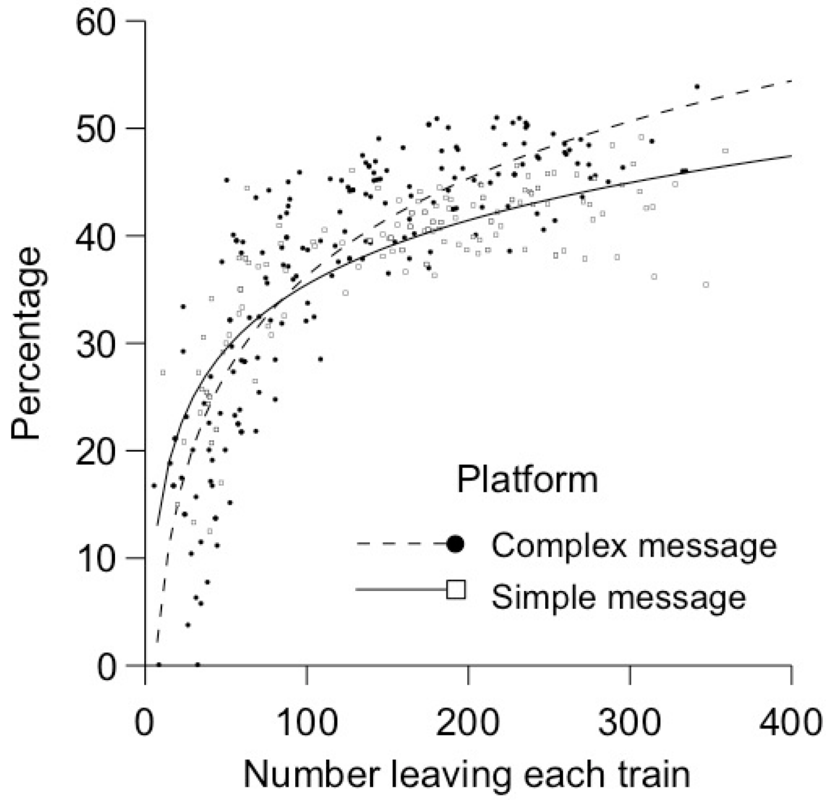

Figure 2.2: The overall relationship between pedestrian traffic volume, i.e. the number of pedestrians leaving each train, and percentage climbing the stairs at the complex (broken line) and simple message platforms (unbroken line).

2.4 Results

A total of 48,697 pedestrians were coded (54.7% female overall); simple message platform, n=23,626, 56.7% female; complex message platform n=25,071, 52.9% female). Figure 2.2 depicts the relationship between pedestrian traffic volume and the percentage climbing stairs overall for the complex and simple message platforms. The fitted lines reflect the natural log of the relationship between the traffic volume and stair climbing. As can be seen, there was a large magnitude effect of pedestrian traffic on stair use at both platforms, with the greater effects at the complex message platform (log slope=13.1, 95% Confidence Interval (CI)=11.9-14.3) than the simple one (log slope=8.6, CI=7.7-9.5) reflected in non-overlapping confidence intervals.

The omnibus analysis contained main effects of the intervention (Odds Ratio (OR)=1.07, CI=1.02-1.13, $p=0.01$) and pedestrian traffic volume (OR=5.42, CI=3.05-9.62, $p<0.001$). While there was no differential effect of the intervention between the message platforms (OR=1.04, CI=0.94-1.14, $p=0.46$), a main effect of message platform (OR=0.68, CI=0.80-0.93, $p<0.001$) interacted with pedestrian traffic (OR=6.51, CI=3.26-12.97, $p<0.001$) and there was a three way interaction involving message platform, the intervention and pedestrian traffic volume (OR=0.29, CI=0.13-0.64, $p=0.002$).

Initial follow-up analyses for each message platform without including an interaction between the intervention and pedestrian traffic, revealed an effect of the intervention at the simple message platform (baseline stairs = 39.5%, intervention stair = 41.4%: OR=1.07, CI=1.01-1.13, $p=0.02$). In contrast, the analysis for the more complex message platform suggested no effect (baseline stairs = 41.9%, intervention stair = 42.4%: OR=0.99, CI=0.94-1.04, $p=0.63$) when the analysis did not include the possible interaction between intervention and pedestrian traffic. Importantly, however, the effects of standardised traffic were large at both platforms (Simple OR=6.95, CI= 4.97-9.71; Complex OR=18.75, CI=14.19-24.78). The smaller effects of standardised traffic at the simple message platform reflect higher average pedestrian traffic levels at this platform (161.6±87.3 pedestrians.train^{-1}) than the complex message one (130.7±85.6 pedestrians.train^{-1}). Effects of pedestrian traffic plateau at levels around 150-200 (see Figure 2.2) as the stairs become saturated with pedestrians (see Eves et al., 2008). Hence, the effects of pedestrian traffic will be reduced when overall traffic is high, i.e. the simple message platform.

Figure 3: a) Simple Message Platform

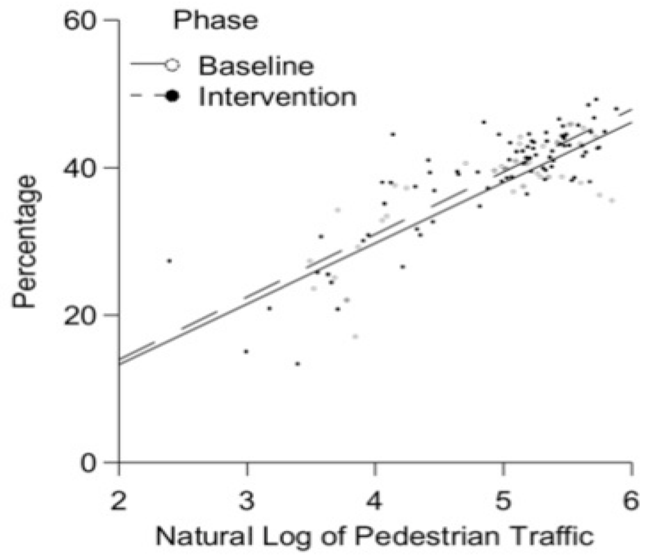

Figure 3: b) Complex Message Platform

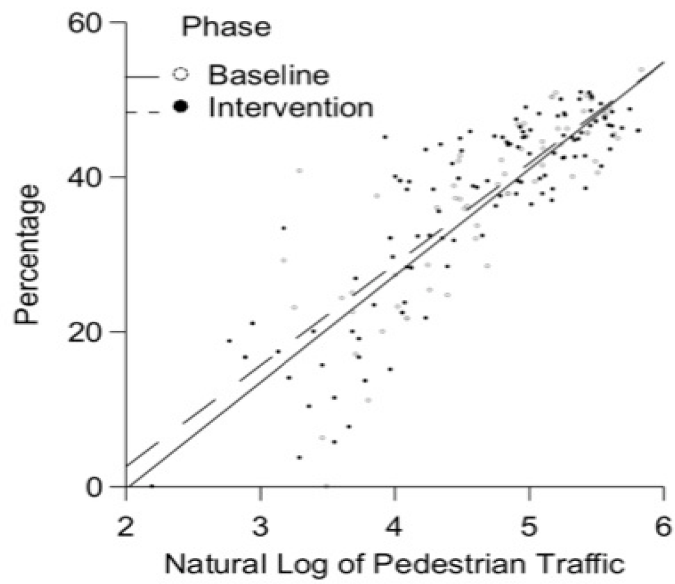

Figure 2.3: Effects of pedestrian traffic volume on percentage climbing the stairs during the baseline and intervention for the simple message (2.3a) and complex message platforms (2.3b).

Figure 2.3 depicts the relationship between percentage stair climbing and the natural log of pedestrian traffic during the baseline and intervention periods at each platform. Inclusion of the interaction of the intervention with pedestrian traffic revealed that pedestrian traffic influenced intervention effectiveness for the complex message (OR=0.36, CI=0.20-0.66, p=0.001). As can be seen from Figure 2.3b effects of the intervention were reduced at higher traffic volumes, i.e. busier periods. In contrast, there was no interaction between pedestrian traffic and the intervention for the simple message (OR=1.48, CI=0.72-3.02, p=0.28) and this interaction term was removed for the final models for each platform summarised in Table 2.1. As can be seen, similar effects for the two messages were apparent when effects of pedestrian traffic were controlled. Additionally, males chose the stairs more than females at the simple message platform but not the complex message one. Follow-up analyses revealed no significant changes in the effects of the intervention over successive weeks for either the simple message (OR=0.97, CI=0.93-1.02, p=0.25) or the more complex one (OR = 1.00, CI = 0.94-1.06, p=0.99).

	Complex Message *n=25,071 (52.9% female)*		**Simple Message** *n=23,626 (56.7% female)*	
	OR	95% CIs	OR	95% CIs
Intervention (Intervention>Baseline)	1.10*	1.02-1.18	1.07*	1.01-1.13
Gender (Male>Female)	0.99	0.94-1.04	1.29***	1.23-1.36
Pedestrian Traffic Volume	39.05***	23.7-64.4	6.95***	4.97-9.71
Pedestrian Traffic Volume x Intervention	0.36*	0.20-0.66	n/a	n/a

**p<0.05; ***p<0.001*

Table 2.1: Odds ratios and confidence intervals for stair climbing, according to message type, at a UK train station (n=48,697, 54.7% female overall; data collected February/March 2008).

2.5 Discussion

This study compared the effects of two messages differing in complexity brought about by the greater specificity of one of the messages. Similar effects on stair climbing were evident for the more specific, but also more complex, health outcome message and a simpler one, when the effects of pedestrian traffic were controlled. Thus, direct auditing of the target behaviour in the context of a station does not confirm self-reports that specific outcome messages would be more motivating than general messages (Webb & Eves, 2007c). While effects of the intervention were small, effects of pedestrian traffic were large and the interaction between traffic volume and the intervention for the more complex message indicates its effects were diluted during busier periods.

Similar reductions in the efficacy of prompts detailing specific outcomes at higher traffic volumes have been observed previously in train stations in the UK (Olander et al., 2008) and Spain (Puig-Ribera & Eves, 2010), attesting to the robustness of this effect. In contrast, analysis of a recent study in a subway station in Glasgow, Scotland contained no interaction between pedestrian traffic and the intervention message 'Stay healthy, save time, use the stairs' (Ryan, Lyon, Webb, Eves & Ryan, 2011). Concerning differences between the messages, the more complex message here contained the additional phrase 'for 7 minutes per day'. This addition not only increased the specificity of the outcome but also the length and the complexity of the message. Both of these increases would have required more processing resources. A longer message would take longer to read whereas time pressure to leave the station may have impeded adequate deliberation about a more complex message. Preoccupation with finding the quickest route out of the station could only exacerbate these effects. Concerning message length, the six-word, simple message here and one of the same length in Glasgow (Ryan et al., 2011), were not associated with an interaction between traffic and the intervention. In contrast, the specific, and hence more complex, message here contained eleven words, with the two previous studies with interactions between the intervention and pedestrian traffic using twelve (Olander et al., 2008) and ten (Puig-Ribera & Eves, 2010) word messages respectively. While the data here cannot distinguish effects of complexity from length *per se*, taken together, the results suggest that simpler messages may be more suitable for busy public access sites. In the different behavioural contexts provided by worksites or shopping malls, however, processing and elaboration of a more specific and hence complex message may not be impeded by either pedestrian traffic or time pressure.

Although it is common to aggregate data from studies in meta-analyses, a note of caution is appropriate; raw data are uncorrected for the influence of other, relevant variables. Effects of pedestrian traffic volume on stair climbing are almost ubiquitous. In shopping malls, increased traffic is also associated with increased stair climbing (Webb, Eves & Kerr, 2011) though the pulsatile nature of traffic results in greater absolute effects in train stations (Eves et al., 2008). For worksites where the choice is between stairs and an elevator, the 'business' of the building, i.e. its occupancy, can reduce the availability of the elevator to incoming pedestrians (Olander & Eves, 2011b). As a result crude traffic measures, i.e. over 15 minute periods, show similar positive relationships between stair climbing and pedestrian traffic (Lewis and Eves, submitted). When pedestrian traffic is measured every minute, however, the relationship with stair use in buildings is negative; increased traffic is associated with reduced stair climbing (Eves, Webb, Griffin and Chambers, submitted; Olander & Eves, 2011b). To illustrate the importance of pedestrian traffic, Figure 2.4 depicts the overall percentage stair climbing, i.e. averaged across platforms, plotted against the natural logarithm of traffic during baseline and interventions periods. The preponderance of high traffic values at the simple message platform when the intervention was effective partially compensates for the ineffectiveness of the complex message at the same traffic level. What Figure 2.4 illustrates is an effect of the intervention superimposed on a large magnitude effect of pedestrian traffic. These effects of pedestrian traffic represent uncontrolled sources of variation in stair climbing. Inclusion of traffic in analyses aims to avoid effects of contextual variables that could change independently of the intervention. The point here is that any meta-analysis that uses raw data and, hence does not include the effects of traffic, risks misleading researchers and being less informative than the primary research allows (see Webb et al., 2011).

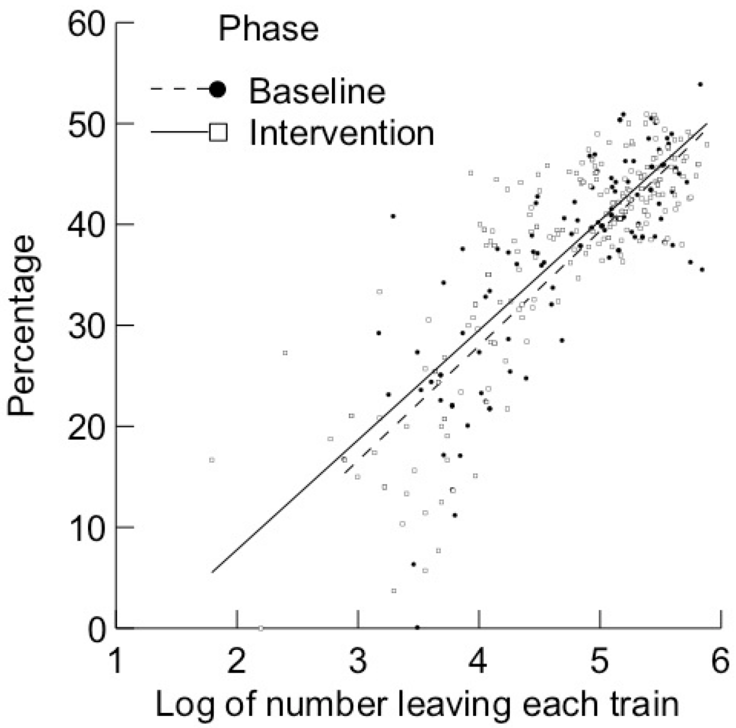

Figure 2.4: The overall relationship between pedestrian traffic volume, i.e. the number of pedestrians leaving each train, and percentage climbing the stairs during the baseline (broken line) and intervention periods (unbroken line).

2.5.1 Limitations and Future Directions

The absence of a non-intervention control site is a limitation. Nonetheless, the simultaneous comparison of differing messages and their differing effects, reduces the plausibility of any explanation for responses to the intervention based on uncontrolled factors. In this station, trains from the same locations arrived at the same platform on a daily basis and the risk of passengers seeing both intervention messages and hence, intervention contamination was minimised. Importantly, a major potential confound, pedestrian traffic volume, was controlled in analyses. Further, direct auditing of the target behaviour with excellent inter-observer reliability (average kappa=0.97) provides stronger evidence than self-reports in the previous study (Webb & Eves, 2007c). While the moderation of the effects of message by pedestrian traffic is informative, some caution is appropriate; the results could be station-specific. Males chose the stairs more than females at the general message platform in stations as expected (Eves et al., 2009; Kerr et al., 2001b; Olander et al., 2008; Puig-Ribera & Eves, 2010). Hence, the absence of gender differences at the complex message platform appears anomalous but has been reported previously (Andersen et al., 2006). Set against a station specific explanation, many stations, especially during the rush to work, have pedestrian traffic flows that are pulsatile in nature. Thus, the key factor may not be traffic volume per se but rather traffic type. The fact that similar interactions between pedestrian traffic and a point-of-choice intervention occur elsewhere suggests the moderating effects of traffic volume will generalise to other station settings. In shopping malls, however, traffic flows are more evenly distributed over time. As a result, response to a more complex message may not be affected by pedestrian traffic in such a setting.

In any observational study, coding is extremely important. Whilst we were able to code gender, the high levels of pedestrian traffic coupled with the pulsatile nature of traffic flow, meant that with only four coders, i.e. two per platform, we were unable to code additional demographic information. Age, ethnicity and encumbrances such as large bags or accompanying children, can all influence stair/escalator choice (cf Kerr et al., 2001b; Olander et al., 2008). More coders would be required if future studies wished to assess the effects of messages on different population subgroups. Furthermore, our observations were limited to two weekdays per week, between 08:00 and 10:00. Future research that included different days and times would describe more completely the effects of these interventions. Finally, this short-term study set-out to formally compare the effects of two messages differing in content in a setting that minimised alternative explanations of any differing efficacy. There were no changes in efficacy of either message over the three-week period as reported previously for a poster (Olander et al., 2008). Only longer term studies, however, with subsequent removal of the message, could address issues of maintenance of the effects.

2.5.2 Conclusion

Prompted increases in stair climbing is one of a range of approaches to the problem of physical inactivity. While messages detailing more specific outcomes of stair climbing can be effective in public access settings, health promoters should note that processing of complex or long messages may be impaired at busy sites. Further, effects of pedestrian traffic were of large magnitude and should be controlled in analyses.

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CHAPTER THREE

TESTING THE THEORY UNDERLYING THE SUCCESS OF POINT-OF-CHOICE PROMPTS: A MULTI-COMPONENT STAIR CLIMBING INTERVENTION.

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3.0 Testing The Theory Underlying The Success Of Point-Of-Choice Prompts: A Multi-Component Stair Climbing Intervention.

3.1 Abstract

Objectives: Point-of-choice prompts consistently increase stair climbing in public access settings. This study investigated the single and combined effects of a volitional and motivational component of a stair climbing intervention to test the theory underlying the success of point-of-choice prompts.

Design: Quasi-experimental, interrupted time series cross-over design.

Methods: Ascending stair/escalator choices were observed in a UK tram station (n=38,187). Baseline observations (2 weeks; stage 1) preceded a 2-week point-of-choice prompt positioned alone (stage 2) followed by an additional message positioned at the top of each climb (6 weeks; stage 3). Four weeks after message removal, another baseline (2-weeks; stage 4) preceded installation of the intervention components in reverse order. Thus, the message positioned alone at the top of each climb (4-weeks, stage 5) was supplemented with the point-of-choice prompt (2-weeks, stage 6). Logistic regression analyses of stair/escalator choice included the independent variables of intervention components, gender, time of morning and pedestrian traffic volume.

Results: There was no change in stair climbing percentages when only one intervention component was used, i.e. only the point-of-choice or the message at the top of each climb. In contrast, stair climbing increased when both components of the intervention were installed.

Additionally, men took the stairs more than women and stair climbing was more common earlier in the morning and at higher pedestrian traffic volumes.

Conclusions: A motivational component targeting intentions increased the effectiveness of a volitional point-of-choice prompt for stair climbing in a setting where choice of the stairs incurred a time penalty for pedestrians due to the site layout.

3.2 Introduction

Physical inactivity is responsible for 6% of deaths globally such that it is the fourth leading risk factor for global mortality (World Health Organization [WHO], 2010). Overweight and obesity account for 5% of global mortality (as cited in WHO, 2010). Regular participation in physical activity not only reduces the risk of non-communicable diseases, such as hypertension, coronary heart disease and stroke and diabetes, but is a significant contributor to energy expenditure and subsequently weight control. However, levels of physical inactivity are continuing to rise. Critically, the accumulation of physical activity during daily living is one current public health approach to increase energy expenditure and help achieve the recommended amounts of activity per week (Department of Health [DOH], 2005; Haskell et al., 2007; WHO, 2010).

Active transport is one way of integrating physical activity into daily living. Unlike walking, an activity of moderate-intensity, stair climbing is a *vigorous* lifestyle activity that may have important implications for the accumulation of calorific expenditure during daily living. For example, an 80 kg man who climbs a standard 3 m flight of stairs in his own home ten extra times a day would expend approximately 28 kcal.d^{-1}. Over a year that adds up to more than 10,000 kcals which is equivalent to 3 lbs of fat (Olander & Eves, 2011). As stair climbing involves raising one's weight against gravity, more energy is expended by overweight than normal weight individuals. Furthermore, stair climbing opportunities are abundant and available to most population groups, enabling it to be readily incorporated into daily life. Besides the increase in energy expenditure, stair climbing has been linked to improved cholesterol profile, cardio-respiratory fitness and weight loss (Boreham et al., 2005; Kennedy, Boreham, Murphy, Young & Mutrie, 2007; Meyer et al., 2010).

One effective way to increase stair climbing is a point-of-choice prompt, i.e. a message positioned at the point-of-choice between methods of ascent encouraging individuals to take the stairs for their health. Point-of-choice prompts have proved consistently effective in a travel context such as train stations (Andersen et al., 2006; Blamey, Mutrie & Aitchinson,1995; Boen, Maurissen & Opdenacker, 2010; Brownell, Stunkard & Albaum,1980; Eves, Olander, Nicoll, Puig-Ribera, & Griffin, 2009; Iversen, Handel, Jensen, Fredriksen & Heitmann, 2007; Kerr, Eves & Carroll, 2001a; Nomura, Yoshmimoto, Akezaki & Sato, 2009; Olander, Eves & Puig-Ribera, 2008; Puig-Ribera & Eves, 2010). Thus, increased population levels of stair climbing as a means of increasing physical activity as a part of daily life is a realistic public health goal and a current UK government guideline (DOH, 2011). This paper tests the theoretical mechanisms underlying the success of point-of-choice interventions.

It is well established that a person's motivation towards a goal in terms of direction and intensity, i.e. their intentions, is an essential requirement for lifestyle changes (Sheeran, 2002; Sniehotta, Scholz & Schwarzer, 2005; Sniehotta, Schwarzer, Scholz & Schu, 2005). The formation of intentions, however, does not always result in successful changes, i.e. positive intentions are not always translated into behaviour (Orbell & Sheeran, 1998). This has been termed 'the intention-behaviour gap' (Sheeran, 2002). Thus, when attempting to change behaviour, it is imperative to differentiate between motivational interventions that aim to change one's attitude and intention and volitional interventions that aim to transform prior intentions into behaviour (Gollwitzer, 1999). Motivational approaches, e.g. mass media campaigns that provide information about the benefits of physical activity, target attitude and intentions. In contrast, volitional interventions that function to narrow the gap between intention and behaviour take two main forms (Sniehotta, Scholz et al., 2005; Sniehotta, Schwarzer et al., 2005). Coping planning aims to prevent the derailment of positive intentions by barriers to behaviour such as tiredness or insufficient time. Thus, they involve planning, in advance, to cope with potential barriers when they are encountered. In contrast, interventions based on implementation intentions aim to initiate the behaviour when the envisaged context and cues are encountered (Gollwitzer & Sheeran, 2006; Milne, Orbell & Sheeran, 2002). Thus, individuals specify the time and place for acting on their intentions. For example, as part of a worksite intervention to prevent weight gain, Kwak and colleagues asked participants to specify when and where at work they would take the stairs instead of the lift (Kwak, Kremers, Baak & Brug, 2007). Participants forming such an implementation intention about stairs were more likely to choose the stairs than those who were asked to make an implementation intention about cycling in leisure time (83.3% and 66.7%, respectively), despite equivalent levels of general intentions to be more active.

Concerning stair climbing, it has been argued that point-of-choice prompts change the contextual cues at the place where the behaviour occurs with the aim of disrupting habitual behaviour (Kerr et al., 2001b). Choice of escalators and lifts is rewarded by energy conservation, and hence, the choice of the escalator and lift, over time, becomes habitual. This choice will be linked to the contextual cues associated with successful energy conservation and requires minimal conscious deliberation (Aarts, Paulussen & Schaalma, 1997; Verplanken & Aarts, 1999). By changing the contextual cues, point-of-choice prompts provoke deliberation by pedestrians about the behaviour rather than choosing the escalator in a ‘mindless’ manner (Webb & Eves, 2007a). This allows substitution of a health enhancing alternative to the habitual choice of the escalator. Nonetheless, exposure to a prompt is brief, almost an incidental part of the overall journey and it seems unlikely that point-of-choice prompts change attitudes to physical activity per se and intentions to be more physically active when encountered. Rather, when an individual already has an intention to be more physically active, the prompt to take the stairs for their health ‘reminds’ them of their intentions and enables them to be fulfilled. Hence, point-of-choice prompts are similar to volitional interventions for action initiation; a <u>prior</u> intention to be more physically active is required for the prompt to be effective. In effect, point-of-choice prompts enable individuals to select health-promoting alternatives <u>after</u> they have opted to improve their health, i.e. they are <u>post-decisional</u> aids to health behaviour (Olander & Eves, 2011). To change intentions for stair use, a different approach is required.

One frequently employed approach to modelling intentions is the Theory of Planned Behaviour (Ajzen, 1991). Within this model, attitudes, i.e. the positive and negative consequences of the behaviour, and perceived behavioural control, i.e. the perception that one has control over the behaviour, have strong influences upon intentions to be physically active (Hagger, Chatzisarantis & Biddle, 2002; Hardeman et al., 2002; Sutton, 2002). Mass media interventions, a common public health approach to increase population levels of physical activity, target attitudes by providing information about the possible benefits of behaviour or costs of health threats (Sutton, 2002). While 66% of the UK population would like to be more physically active (Health Survey for England, 2008), qualitative research has indicated that individuals do not consider stair climbing to be a physical activity with health benefits (NHS Health Scotland, 2004). Thus, a motivational approach that targeted attitudes by detailing the specific benefits obtainable from stair climbing (Webb & Eves, 2007b) might increase intentions to climb stairs. As a result, a subsequent encounter with a point-of-choice prompt could translate any new or modified intentions into behaviour.

In this paper, we report an intervention that assessed the effects of volitional and motivational components of a stair climbing intervention in a public access setting. A recent worksite intervention added an extended message targeting attitudes to a conventional point-of-choice prompt (Eves, Webb & Mutrie, 2006). In contrast to simple point-of-choice prompts, the extended message quantified the amount of stair climbing required to achieve the desired outcome with an aim of increasing regular use of the stairs. This multi-component approach produced an increase specific to stair climbing that has proved elusive in worksite interventions (Eves, 2008, 2010; Eves & Webb, 2006). Here, we adapted this multi-component approach for use in a public access setting, i.e. a tram station.

This study investigated the single and combined effects of an extended message, positioned at the top of the stairs and a conventional point-of-choice prompt positioned at the base of the stairs. Initially a simple point-of-choice prompt, i.e. a volitional intervention, which read *"Regular stair climbing helps to prevent weight gain"* was positioned, alone, at the bottom of the climb. Two weeks later, an extended message was added at the top of each climb for six weeks; the message *"Well Done Stair Climbers! You have just burnt a 16th of the calories needed to avoid weight gain"* was employed. This novel component, i.e. a motivational intervention targeting attitudes and intentions, translated the science underlying the calorific consequences of stair climbing into lay terms (Eves et al., 2006; Olander & Eves, 2011). The origin of this message was the estimate by Hill and colleagues that daily excess intake relative to energy expenditure of 100 kcals.d^{-1} produced 95% of the weight gain of the US population over eight years (Hill, Wyatt, Reed & Peters, 2003). Stair climbing is a vigorous activity that expends 9.6 times the energy used at rest (Teh & Aziz, 2002). The height of the stairs at this station (6.45 m), coupled with 34.2 m of walking on the level, meant that a single ascent would expend approximately 6.25 kcals. Hence, choosing the stairs once, based on the estimates of Hill et al. (2003), would expend approximately a 16th of the daily energy expenditure required to avoid weight gain. The message specified an achievable behaviour, i.e. a single ascent, which we hoped represented meaningful progress towards the desired outcome of weight control.

It was envisaged that the extended message, i.e. the additional component, would provide a 'take-away' message about the specific benefits of the climb that travellers had or could have completed. Thus, travellers could contemplate the calorific consequences of stair climbing as they continued their journey and, hopefully, change their intentions. Importantly, the position of this message at the top of the climb meant that information was provided after the choice of stairs or escalator had been made. Hence, it could only affect a *subsequent* decision to use the stairs. As such, it functioned as an educational tool in the natural environment, i.e. a motivational intervention, which might require the volitional elements of a point-of-choice prompt to translate any changed intentions into the desired behaviour. All intervention components were then removed for six weeks (four weeks plus two weeks additional baseline observations). In the second phase, the order in which the posters were installed was reversed. The extended message was repositioned alone, at the top of each climb, for four weeks, and then supplemented with the point-of-choice prompt, at the bottom of the climb, for a further two weeks. This reversal of the order of the components tested whether the motivational component alone, which we hoped would increase intentions, was sufficient to increase stair climbing or whether it required the volitional element at the bottom of the climb for its effectiveness. Overall, the study aimed to augment the effects of the point-of-choice prompt by providing specific information about the benefits of stair climbing. Hence, we predicted greater effects for the two components than either component alone.

Current approaches to increased lifestyle physical activity employ a socio-ecological model that incorporates effects of the physical environment and the social milieu, as well as intra-individual processes such as intention (Giles-Corti & Donovan, 2003; Sallis, Bauman & Pratt 1998; Sallis et al., 2006). For example, a physical environment with utilitarian destinations within walking distance will encourage physical activity whereas restricted connectivity in the street network may impede activity choices (Saelens & Handy, 2008; Sallis et al., 2006). Similarly, stairs are more likely to be chosen if they are encountered before the escalator (Eves et al., 2009; Kerr et al., 2003) and represent the quickest route to the destination (Webb & Eves, 2007c). Like other types of lifestyle activity, stair climbing can also be influenced by the social environment. Pedestrian traffic flow, i.e. the number of pedestrian using the site, has major influences on the behaviour; as traffic increases the escalator becomes full and pedestrians can avoid delay by opting for the stairs (Eves et al., 2009; Eves, Lewis & Griffin, 2008; Kerr et al., 2001a,b; Olander et al., 2008; Puig-Ribera & Eves, 2010; Webb & Eves, 2007a,c). Furthermore, in travel contexts, time of day can influence stair choice (Eves & Masters, 2006; Eves, Masters et al., 2008; Eves et al., 2009). In particular, commuters in the UK were more likely to take the stairs before 09:00 than after, independently of pedestrian traffic volume (Eves et al., 2009). As 09:00 is the start of the working day for many employees in the UK, these effects of time of morning may reflect people choosing the quickest route to work. If the escalator is full, stair climbing could be quicker than waiting. Here, we quantified the effects of traffic in the tram station and standardised it within the range 0-1 to facilitate comparison between the effects of the interventions and the social environment.

3.3 Methods

Ethical approval was obtained from the ethics subcommittee of the School of Sport and Exercise Sciences, University of Birmingham, Birmingham, UK. The intervention site was a UK tram station with a 43-step staircase (height=6.45 m) positioned 16.5 m beyond the escalator. In 2008/2009, two observers (inter-observer reliability: average kappa=0.97, range=0.95-0.98) recorded stair/escalator choices of ascending travellers, coded by gender, between 08:00-09:59 on Tuesday and Thursday each week. Travellers constrained in their ability to use the stairs by large bags (larger than a briefcase or medium-sized bag), accompanying children (head below shoulder height of accompanying adult), or a physical incapacity were not recorded (Kerr et al., 2001a; Olander et al., 2008).

In a quasi-experimental, interrupted time series cross-over design, baseline observations (2-weeks; stage 1) were followed by a 2-week point-of-choice prompt positioned alone at the base of the escalator (stage 2), presenting the message "*Regular stair climbing helps to prevent weight gain*" on an A1-sized (594 x 841 mm) poster. Following this stage, an additional, A1-sized poster was positioned at the top of each climb (stage 3) for six further weeks with the message "*Well Done Stair Climbers! You have just burnt a 16th of the calories needed to avoid weight gain*" (see Appendix 7.2). All intervention posters were removed for 4-weeks after which a second 2-week baseline stage (stage 4) commenced. Next, the order in which the intervention posters were installed was reversed; the A1-sized poster from stage 3, i.e. the extended message, was positioned at the top of each climb, alone, for 4-weeks (stage 5). For a further and final two weeks, the original point-of-choice prompt (see stage 2) was added at the bottom of the climb (stage 6)[1]. While no pilot work was undertaken with the messages, point-of-choice prompts based on calorific expenditure and weight control have been successful in previous research and we expected success with our intervention (Andersen, Franckowiak, Snyder, Bartlett & Fontaine, 1998; Eves, Webb, Griffin & Chambers, unpublished results; Olander et al., 2008; Olander & Eves, 2011).

3.3.1 Data Reduction and Statistics

The pulsatile nature of pedestrian flow in stations means that a negatively accelerated function can describe the relationship between traffic and stair climbing such that a logarithmic transformation of traffic is appropriate (see Eves et al., 2008; Lewis & Eves,

[1] The differences in length of the stages for the second phase of testing relative to the first reflected operational decisions based on access to the site and availability of coders.

unpublished results). Preliminary inspection of the baseline data for this site, however, revealed that the relationship between the number leaving each tram and the number using the stairs was essentially linear (Adjusted R^2=0.77 (F(1,126)=430.04 p<.001), with no additional contribution from the natural log of traffic (Change R^2=0.01, F(1,125)=1.67 ns). Hence, a logarithmic transformation was not required in this study. While there were no differences in traffic levels between successive stages of the study (all comparisons p>.20), pedestrian traffic was greater in the early morning period (08:00-08:59; Mean=90.43±24.63 pedestrians.tram^{-1}: 09:00-09:59; Mean=58.96±22.75 pedestrians.tram^{-1}, t(498)=15.14 p<.001). To allow assessment of the effects of time of morning unconfounded by differences in overall traffic volume, the data were mean centred for each time period prior to analysis. Mean centring of data retains the variability in the data but removes any average differences between time periods or sites in traffic volume (Eves et al., 2009; Webb, Eves & Kerr, 2011). The net outcome for this study is that effects of pedestrian traffic volume could be assessed independently of time of morning as the data for each time period had the same average value, i.e. zero, when the mean of each period was subtracted from the data.

Logistic regression analyses used stair/escalator choice as the dichotomous dependent variable and, intervention stage, gender and time of morning (08:00-08:59 vs. 09:00-09:59) as dichotomous predictor variables. Pedestrian traffic was entered as a continuous variable, with traffic standardised to range 0-1 by dividing by the highest value to facilitate comparison with the binary variables.

3.4 Results

A total of 38,187 pedestrians were coded (58.0% female). Table 3.1 summarises the results of analyses for the first half of the study (stage 1-3). For these analyses, each stage was compared to the preceding one. As can be seen from the table, there was no significant change in stair climbing when the point-of-choice prompt was positioned alone (stage 2). In contrast, addition of the extended message at the top of the climb (stage 3) to the point-of-choice prompt resulted in a significant increase in stair climbing. Consistent with previous studies, stair climbing was more common during the first half of observation sessions (i.e. 08:00-08:59; Eves et al., 2009) and at higher traffic volumes (Eves et al., 2009; Kerr et al., 2001a; Olander et al., 2008; Puig-Ribera & Eves, 2010). Further, an effect of gender was present for the comparison between stage 2 and 3, such that men were more likely to take the stairs than women as in previous studies (Eves et al., 2009; Kerr et al., 2001a; Olander et al., 2008; Puig-Ribera & Eves, 2010). While effects of gender were not statistically reliable for the comparison between the baseline and the point-of-choice prompt alone, it is possible that the smaller sample size, relative to previous studies, is responsible. Follow-up analyses revealed no interaction between the intervention components and gender, time of morning or pedestrian traffic volume (all $p>.20$). Percentage stair climbing overall, and broken down by gender for each stage of the intervention, is presented as supplementary material with explanatory notes (see Figure 3.2, section 3.7).

	Point-of-Choice Prompt Alone ***(stage 1 vs. 2)*** (n=8,434)	**Point-of-Choice Prompt + Extended message** ***(stage 2 vs. 3)*** (n=18,702)
	OR (95% CI)[a]	**OR (95% CI)**
Intervention	0.99 (0.87-1.13)	1.20***[b] (1.08-1.33)
Gender (Men > Women)	1.08 (0.94-1.23)	1.19*** (1.09-1.29)
Time of Morning (08:00-08:59 > 09:00-09:59)	1.71*** (1.46-2.00)	1.61*** (1.47-1.77)
Traffic (continuous)	3.98*** (2.49-6.36)	3.30*** (2.52-4.31)

a: OR indicates odds ratio, CI, confidence interval
*b: *p<0.05; ** p<0.01; ***p<0.001*

Table 3.1: Odds ratios and confidence intervals for stair climbing for intervention stages 1, 2 and 3 (n=27,136).

Comparison between the first and second baseline stages (stages 1 and 4), showed that stair climbing remained elevated four weeks after the intervention was removed (Odds Ratio [OR]=1.17, 95% Confidence Interval [CI]=1.03-1.31 p=.02). Further, comparison between stages 3 and 4, i.e. the point-of-choice prompt and extended message vs. the second baseline, revealed that there was no significant difference in stair climbing (OR=0.99, 95% CI=0.90-1.09 p=.86). Table 3.2 summarises the results of analyses of the second half of the study, when the order of installation of the different intervention components was reversed. There was no significant change in stair climbing when the extended message was positioned alone at the top of the climb (stage 4 vs. 5). Furthermore, there was no significant difference in stair climbing between stages 1 and 5, i.e. the first baseline stage and the motivational component positioned alone (OR=1.07, 95% CI=0.94-1.22 p=.33). As in the first half of the study, however, there was a significant increase in stair climbing when both intervention components were positioned simultaneously (i.e. stage 5 vs. 6). Consistent with previous research and earlier stages, stair climbing was more common during the first half of observation sessions (i.e. 08:00-08:59) and at higher traffic levels. A significant effect of gender (i.e. men were more likely to take the stairs than women) was also present throughout. Once again, follow-up analyses revealed no interaction between intervention components and gender, time of morning or pedestrian traffic volume (all p>.27).

	Extended Message Alone *(stage 4 vs. 5)* (n=9,457)	**Extended Message + Point-of-Choice Prompt** *(stage 5 vs. 6)* (n=11,181)
	OR (95% CI)[a]	**OR (95% CI)**
Intervention	0.93 (0.82-1.05)	1.15*[b] (1.02-1.29)
Gender (Men > Women)	1.36*** (1.21-1.54)	1.30*** (1.16-1.45)
Time of Morning (08:00-08:59 > 09:00-09:59)	1.53*** (1.34-1.75)	1.52*** (1.35-1.71)
Traffic (continuous)	2.98*** (2.10-4.24)	2.88*** (2.03-4.09)

a: OR indicates odds ratio, CI, confidence interval
*b: *p<0.05; ** p<0.01; ***p<0.001*

Table 3.2: Odds ratios and confidence intervals for stair climbing for intervention stages 4, 5 and 6 (n=20,638).

3.5 Discussion

This study assessed the effects of volitional and motivational components of a stair climbing intervention in a public access setting, i.e. a tram station. We tested the single and combined effects of a conventional point-of-choice prompt at the base of the stairs (volitional) and an extended message positioned at the top of each climb (motivational) in a cross-over design. The data revealed no effect upon behaviour when either intervention component was positioned alone. In contrast, the simultaneous positioning of both components increased stair climbing.

Point-of-choice prompts are similar to volitional interventions for action initiation in that they are post-decisional aids to health behaviour; they function to convert prior intentions to be physically active into behaviour. To change habits, the situation in which the behaviour occurs needs to be altered to facilitate alternative responses (Holland, Aarts & Langendam, 2006; Wood & Neal, 2009). Point-of-choice prompts change the contextual cues linked to habitual choice of the escalator, promoting a more deliberative mindset (Kerr et al., 2001b; Webb & Eves, 2007a). When an individual intends to be more active, the health-promoting prompt both 'reminds' them of their intentions and provides an immediate opportunity for their fulfilment. This later point, we believe, is critical; whilst point-of-choice prompts can disrupt habits and encourage people to think about their actions, new choices are guided by prior intentions (Verplanken & Wood, 2006). Without a prior intention to be more active, a prompt encouraging stair climbing as one way to achieve increased activity would have no effect. In this travel context, it is likely that commuters were regularly exposed to the point-of-choice prompt. This repeated exposure to the message could, in theory, improve attitudes, and hence intentions, towards stair climbing. Prior research, however, reveals no change with repeated exposure to point-of-choice prompts alone in stations consistent with any incremental effects on intentions (Lewis & Eves, unpublished results; Olander et al, 2008). Indeed, in shopping malls, repeated exposure to prompts is associated with a modest diminution in responsiveness (Webb et al, 2011). Hence, repeated incremental effects of the prompt component on intentions seem unlikely.

The new component of this study, the extended message positioned at the top of the ascent, differed from a conventional point-of-choice prompt in that it functioned as a motivational intervention in the environment. Critically, however, the extended message was installed *after* the method of ascent has been chosen. Hence, it could only affect a *subsequent* encounter with the choice-point. It seems likely that this new component increased intentions to use the stairs, which could subsequently be converted into behaviour by the conventional point-of-choice prompt. Attitudes, one determinant of intentions within the Theory of Planned Behaviour, describe the outcomes that result from the behaviour (Ajzen, 1991; Eves & Hoppé, 2009; Hagger et al., 2002). The extended message about the calorific consequence of a single ascent detailed a specific outcome obtainable from stair climbing, a message format that has been reported as more likely to motivate stair climbing (Webb & Eves, 2007b). Both stair and escalator users were exposed to this message and could contemplate it as they continued their journey. While the extended message targeted attitudes towards stair climbing, and hence intentions, only a subsequent encounter with the point-of-choice prompt could translate any more positive intentions into behaviour.

Importantly, in this setting, both elements of the intervention were required to change stair climbing. Unlike other studies in the travel context of train stations, the point-of-choice prompt alone was ineffective here (Andersen et al., 2006; Blamey et al., 1995; Boen et al., 2010; Brownell et al., 1980; Eves et al., 2009; Iversen et al., 2007; Kerr et al., 2001a; Nomura et al., 2009; Olander et al., 2008; Puig-Ribera & Eves, 2010). Visibility of the prompt cannot be an issue as it was effective when combined with the message at the top of the stairs (c.f. Olander et al., 2008). It is possible that the message on the prompt itself was sub-optimal; it had not been tested previously. Nonetheless, the weight control message here, "*Regular stair* *climbing helps to prevent weight gain*", is conceptually similar to one successful in a US shopping mall, "*Improve your waistline, use the stairs*" (Andersen et al., 1998). Further, a prompt with the weight control message "*Stair climbing burns more calories per minute than jogging. Take the stairs*" was successful in a UK train station (Olander et al., 2008). Hence, the message theme and type of behavioural context, i.e. shopping vs. travel, seem unlikely explanations of the anomalous result. One plausible explanation for the ineffectiveness of the prompt alone concerns how the layout of this tram station, i.e. the physical environment, constrains stair choice.

It is helpful to conceptualise stair and escalator choices as part of a journey, with both methods of ascent as hurdles to be overcome on the way to the destination (Eves, 2008, 2010). Disembarking passengers in travel contexts such as stations will always be traveling elsewhere. Time to complete the journey is an important consideration in both public access settings (Eves et al., 2008; Kerr et al., 2001c) and worksites (Kerr et al., 2001d; Nicoll & Zimring, 2009). For most public access settings, the escalators and stairs are adjacent and immediately available, though choice of the escalator may entail a small temporal delay at busy times. The site used here differed from most public access sites in that the stairs were situated some 16.5 m behind the escalator. Pedestrians are more likely to choose the first method of ascent that they reach (Eves et al., 2009; Kerr et al., 2003) as they minimise the time and distance of the journey (Eves et al., 2009; Webb & Eves, 2007c). Choice of the escalator here would minimise both aspects of the journey relative to use of the stairs situated 16.5 m behind it. Data from the site provide evidence consistent with layout acting as a barrier to stair choice. Thus, baseline percentages of stair climbing (12.4%) were considerably lower than percentages seen at the same traffic levels in a nearby train station where the equivalent height stairs and escalators (6.45 m) were adjacent (33.0%; Eves et al., 2008). The stairs on this site were wrapped around a lift block requiring an additional 17.7 m of level walking, further increasing the time penalty for stair choice. To quantify this penalty, follow-up observations timed the first individuals choosing the stairs leaving successive trams from the base of the escalator to the top of the stairs using a stop-watch. Time to reach the top of the stairs (n=41, mean=50.3s, 95% CI= 47.8-52.8) was appreciably slower than the time for ascent in the nearby station of the same height (n=26, mean=21.3s, 95% CI= 20.0-22.5; Eves, Lewis & Griffin, unpublished results), and two shopping malls with stair heights of 4.08 m (n=117, mean=14.4s, 95% CI= 13.8-15.0; Webb, Eves & Smith, 2011: n=34, mean=14.0s, 95% CI= 13.2-14.8; Eves, Hoppé & Kerr, unpublished results). Clearly, choice of the stairs at this site incurs a time penalty for the pedestrian.

There are important corollaries of this time barrier to stair climbing. First, the potential effects of either component alone may be masked by an inability of single components to counteract the time barrier to stair choice. Thus, the effects of either component alone may not have been adequately tested at this site. What cannot be questioned, however, is the finding that two components were superior to one at this site; this finding occurred twice in the cross-over design. Indeed, effectiveness of the multi-component intervention may be greater where adjacent methods of ascent facilitate choice of the health enhancing alternative when pedestrians are prompted to do so. One further point related to the cross-over design merits comment. Stair climbing remained elevated after the intervention was removed for four weeks, i.e. stage 4, which did not differ significantly from stage 3. Elevated stair climbing relative to the original baseline after intervention removal has been reported previously in train stations (e.g. Blamey et al., 1995; Puig-Ribera & Eves, 2010). This evidence of maintenance of the intervention effects means that the motivational intervention alone (stage 5) may be unable to increase stair climbing levels above the increase that had already occurred in stage 3, i.e. when both components were positioned together. Nonetheless, reintroduction of the volitional component (stage 6) increased stair climbing, confirming the superiority of both components over either one alone. As the motivational component can only affect future choices, and only does so when accompanied by the prompt, it is likely that changed intentions to choose the stairs subsequently encounter the prompt in the future.

In addition to testing the intervention components, this study standardised the effects of contextual variables in the range 0-1 to facilitate comparison with the effects of the intervention. Throughout the study, more pedestrians took the stairs before 09:00 than after (c.f. Eves et al., 2009), and at higher traffic volumes. Further, both contextual variables had larger magnitude effects than the intervention. Increased stair climbing as pedestrian traffic increases is almost ubiquitous for public access staircases (Webb et al., 2011); any delay to the journey incurred by a full escalator can be avoided by opting for the stairs. To illustrate the magnitude of the effect of traffic, Figure 3.1 depicts the number climbing stairs plotted against pedestrian traffic for the effective intervention periods here, i.e. installation of both components, and the remainder of the data. The lines on the figure represent the linear relationship between the two variables[2].

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[2] It should be noted that the overlapping confidence intervals for the slopes for the linear fit in each phase indicates that they do not differ, consistent with the absence of interactions between the intervention components and traffic in the logistic regression

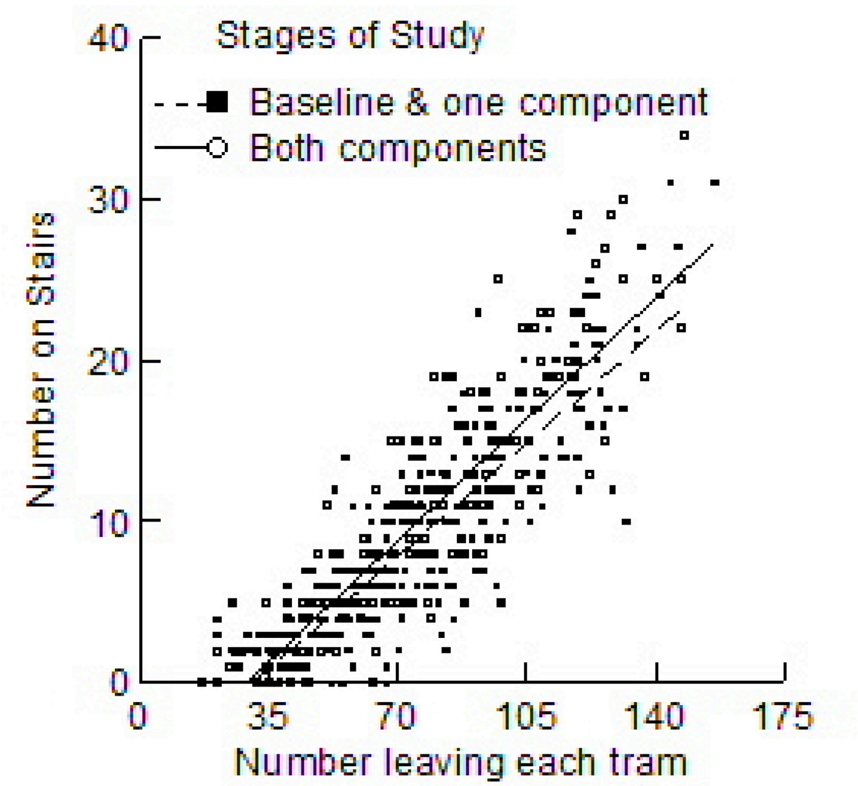

Figure 3.1: The number climbing stairs plotted against pedestrian traffic for the effective intervention periods, i.e. installation of both components, and the remainder of the data.

This figure reveals two things. First, effects of the intervention were superimposed on a large magnitude effect of pedestrian traffic. Researchers attempting to increase lifestyle activity need to consider the context in which it occurs. Failure to include the effects of contextual variables in analyses, risks misleading conclusions should these contextual variables change independently of the intervention. Second, from the 500 different trams depicted in the figure, stair climbing first appears after 21 pedestrians have left one of the trams. Overall, the number on stairs, y = traffic x 0.209 – 6.272. Solving this equation for

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analyses (Both components, Slope = 0.217, 95% CI = 0.20-0.23; Baseline and one component, Slope = 0.202, 95% CI = 0.19-0.22).

one person on the stairs suggests that, on average, 35 pedestrians would need to leave a tram for one of them to take the stairs. Clearly, methods of ascent were biased towards the escalator and the layout of the station, such that stairs were situated behind the escalator, could only exacerbate this bias.

Finally, men took the stairs more than women in three of the four analyses. The absence of a statistically reliable gender difference for the comparison between stages 1 and 2 (i.e. the point-of-choice prompt alone) was anomalous. Whilst two studies have reported an absence of gender differences (Andersen et al., 2006; Lewis & Eves, unpublished results), men typically take the stairs more than women in public access settings (see Webb et al. 2011). The relatively small sample size of this analysis compared to previous studies, coupled with some random variation may account for the anomalous result. It should be noted that there was no evidence that men and women differed in their response to this calorific expenditure intervention.

3.5.1 Study Limitations

One limitation of this study is that a single tram station was used, without a control site. The contrast between increased stair climbing when both intervention components were installed and ineffectiveness of single components makes it unlikely that spontaneous changes in behaviour could be responsible. Additionally, some effects may be station specific. As noted earlier, the layout of the station influenced the response to this intervention and effects may differ in settings where stairs and escalators are adjacent. Whilst this new, multi-component intervention provides an insight into the mechanisms underlying point-of-choice interventions, future research should seek alternative settings to test the magnitude of the effects of each component alone. Further, where stairs are lower than in this setting, the reduced calorific cost of an ascent, may reduce effectiveness of the motivational message whereas higher stairs may increase its effectiveness. Concerning message content, a message based on calorific expenditure would not have universal appeal, as is true for any message; one size rarely fits all. Nonetheless, success with messages relevant to weight control (Anderson et al., 1998; Eves et al, 2006; Olander et al., 2008; Olander & Eves, 2011) suggest that the topic is a useful intervention target.

3.5.2 Conclusion

In summary, this paper tested the theoretical mechanisms underlying the success of point-of-choice interventions for stair climbing by adding a motivational component targeting intentions to a conventional volitional point-of-choice prompt. Simultaneous positioning of both components was required to increase stair climbing at this site. It is likely that the motivational component targeting intentions increased effectiveness of a volitional point-of-choice prompt for stair climbing, where choice of the stairs incurred a time penalty for pedestrians due to the layout, i.e. the physical environment. In addition, pedestrian traffic volume, i.e. the social environment, had large magnitude effects on the behaviour.

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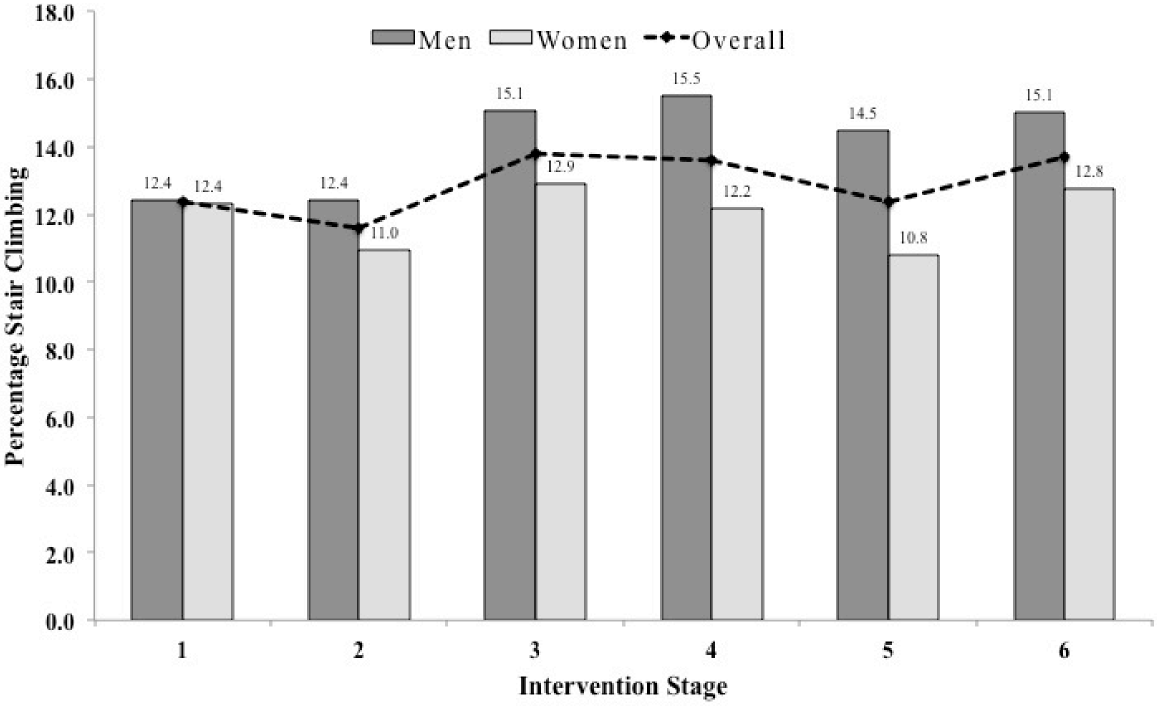
3.7 Supplementary Material



Note: Stage 1-baseline 1; Stage 2 – point-of-choice prompt alone; Stage 3 – point-of-choice prompt + additional message at the top of each climb; Stage 4 – baseline 2; Stage 5 – message at the top of each climb alone; Stage 6 - message at the top of each climb + point-of-choice prompt.

Figure 3.2: Percentage stair climbing overall, and broken down by gender for each stage of the intervention.

This supplementary figure depicts the percentage of stair climbing overall, and broken down by gender for each stage of the intervention. The dashed line shows the overall percentage of stair climbing, which illustrates the increased levels when both the motivational and volitional intervention components were positioned together, i.e. stages 3 and 6. While the figure portrays the pattern of stair climbing, the data are the raw percentages, uncorrected for the effects of pedestrian traffic volume, time of morning or gender composition of the sample. The table below contains the data for these uncontrolled variables that can influence stair climbing.

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
Overall % stair climbing	12.4	11.6	13.8	13.6	12.4	13.7
Average traffic 08:00-08:59	94.7	88.5	94.8	90.4	81.8	84.7
Average traffic 09:00-09:59	56.8	55.8	62.4	52.6	68.4	52.9
% of passengers 08:00-08:59	69.8	63.1	62.6	66.7	51.2	63.5
% of Males	42.4	41.9	42.0	42.2	42.1	41.8

Table 3.3 Overall stair climbing, average pedestrian traffic volumes, percentage of passengers in the earlier period (08:00-08:59) and percentage of male passengers.

While there were no differences in gender composition across the stages (Chi Square (5)= 0.59 p=.99), there were significant differences between the stages in the traffic volume in the later time period (09:00-09:59; $F(5,221)=2.94$, $p=.02$) and some weak evidence of variation in traffic in the earlier time period ($F(5,267)=2.16$, $p=.06$). In addition, there were differences between the stages in the percentage of sample in the earlier time period when passengers might choose the stairs as the quicker route to work (Chi Square (5)= 379.3 $p<.001$). The important point here is that there was variation in these uncontrolled influences on stair climbing that severely limits the conclusions one can draw from the raw data. As made explicit in the paper, pedestrian traffic volume and time of morning can have large magnitude effects on stair climbing that are independent of any intervention that is installed. Whereas the analyses presented in the paper control for these variables, the raw data do not. Thus, any interpretation of stair climbing percentages should be made with caution.

3.8 Note for Consideration

The study presented in chapter three compared the single and combined impact of volitional and motivational components of a stair climbing intervention, using a cross-over design, to test the theory underlying the success of point-of-choice prompts. Unlike the results that follow in chapter four, those presented in chapter three did not include a key grouping-variable, namely weight status, in the analysis despite it being recorded. These data were excluded for one simple reason; there was a drift in the weight status coding during the study.

Intervention Stage	**% Overweight**	**% Female**
1	23.24	57.57
2	23.56	58.10
3	21.84	57.96
4	19.60	57.88
5	17.99	57.94
6	18.49	58.24

Note: Stage 1 = Baseline 1; Stage 2 = Volitional Component Alone; Stage 3 = Volitional + Motivational Component; Stage 4 = Baseline 2; Stage 5 = Motivational Component Alone; Stage 6 = Motivational and Volitional Component.

Table 3.4 Percentage of individuals coded as overweight (n=39,305) and female (n=39,388) according to each intervention stage.

Table 3.4 shows the percentage of individuals coded as overweight and female during each intervention stage of the study recorded by trained observers. To assess weight status, silhouettes with a pre-defined criterion of ‘overweight’ (including obese) were used by observers; a method that has been previously successful (Eves, Webb & Mutrie, 2006). Initial inspection of these percentages suggested that there was a change in the coding of weight status but not of gender. Subsequent Chi-square tests revealed a significant overall change in the percentage of individuals coded as overweight (χ^2[5, n=39,305]=93.09, p<0.001). In contrast, the percentage of individuals coded as female did not differ (χ^2[5, n=39,388]=0.51, p=0.992).

Consequently, a series of 2x2 Chi square tests were computed to test for differences between weight status and successive stages of the study. As there were five comparisons, Bonferroni corrected probabilities were employed. As a result, only comparisons significant with p≤0.01 were considered evidence for a change in coding. These tests revealed that there was a significant change in the coding of weight status between stages three and four, such that there was a decline in the percentage of individuals coded as overweight at stage four (χ^2[1, n=19,439]=11.02, p=0.001). This clear decline threatened the ability to compare the impact of intervention components pre-second baseline (e.g. stages 1-3) with post-second baseline (e.g. stages 4-6) according to weight status. Hence, weight status was excluded from the overall analysis. Nonetheless, the potential effects of weight status on responsivity to an intervention targeting weight control were of considerable interest. Thus, the next chapter uses the data from the first three stages of the intervention to test for moderation of the effects of the intervention by weight status.

3.8.1 Reference

Eves, F. F., Webb, O. J. & Mutrie, N. (2006). A workplace intervention to promote stair climbing: Greater effects in the overweight. *Obesity, 14*, 2210-2216.

CHAPTER FOUR

SPECIFIC EFFECTS OF A CALORIE-BASED INTERVENTION ON STAIR CLIMBING IN OVERWEIGHT COMMUTERS.

Lewis, A.L. & Eves, F.F. (2011). *Annals of Behavioral Medicine*, *42(2),* 257-261. DOI: 10.1007/s12160-011-9283-z.

4.0 Specific Effects Of A Calorie-Based Intervention On Stair Climbing In Overweight Commuters.

4.1 Abstract

Background: Point-of-choice prompts consistently increase stair climbing; a greater increase in overweight than normal weight individuals was reported in a multi-component worksite campaign.

Purpose: Investigate effects of a multi-component campaign, on stair climbing, in a public access setting.

Methods: In an interrupted-time-series-design, baseline observations (2-weeks) preceded a 2-week point-of-choice prompt. An additional message, positioned at the top of the climb for a further 6-week period, summarised the calorific consequences of a single ascent. Inconspicuous observers recorded traveller's methods of ascent, coded by sex and weight status, twice a week between 08:00 and 09:59.

Results: At baseline, the overweight chose stairs less than normal weight individuals. The multi-component campaign targeting weight control reversed this bias, increasing stair climbing *only* in overweight individuals.

Conclusions: The specificity of the effect confirms the appeal of this lifestyle activity for the overweight. The discussion focuses on how intentions to control weight may be converted into behaviour.

4.2 Introduction

Obesity, and the associated physical inactivity, are major public health concerns (Wang, Beydoun, Liang, Caballero & Kumanyika, 2008), with accumulation of activity during daily living one current public health solution (Boreham et al., 2005; Frank, Andresen & Schmid, 2004; Haskell et al., 2007). Unlike walking, stair climbing is a physiologically vigorous lifestyle activity and its intensity can have important implications for the accumulation of calorific expenditure during daily living. For example, an 80 kg man, i.e. overweight, who climbs a standard 3 m flight of stairs in his own home ten times a day would expend approximately 28 kcal per day. Over a year that adds up to more than 10,000 kcals which is equivalent to 3 lbs of fat (Olander & Eves, 2011). Further, as stair climbing involves raising one's weight against gravity, more energy is expended by overweight than normal weight individuals when they climb the stairs.

To increase stair climbing, typically a sign is positioned at the point-of-choice between stairs and escalators encouraging pedestrians to take the stairs for their health. This approach is consistently successful in public access settings (Andersen, Franckowiak, Snyder & Bartlett, 1998; Blamey, Mutrie & Aitchison, 1995; Brownell, Stunkard & Albaum, 1980; Kerr, Eves & Carroll, 2001a, 2001b, 2001c; Olander, Eves & Puig-Ribera, 2008;Webb & Eves, 2007, 2007b), with 24 out of 26 point-of-choice interventions producing an increase in stair climbing (Olander & Eves, 2011). The evidence included in a recent systematic review indicated a median increase in stair climbing of + 5.9% and, relative to baseline, a median change of + 77.4 percentage points (see Eves, 2010). These simple interventions function by interrupting habitual choice of the escalator at the point of its occurrence, allowing substitution of a health-enhancing alternative (Kerr et al., 2001b; Webb & Eves, 2007b). For a prompt to be successful, however, a *prior* intention to be more active is required; the prompt simply 'reminds' an individual of their prior goal of more physical activity (Puig-Ribera & Eves, 2010). Thus, any intervention that increases intentions to climb stairs should augment the effects of a point-of-choice prompt.

Conventional point-of-choice interventions use a single prompt positioned at the base of the escalator and stairs. Recently, however, multi-component interventions for worksites have supplemented the prompt at the choice point with an extended message that gives more detailed information about the *amount* of stair climbing associated with health benefits; these extended messages aim to change attitudes and hence intentions to use the stairs (see Eves, Webb & Mutrie, 2006; Eves, Webb, Griffin & Chambers, submitted). We reasoned that if regular stair climbing was to be encouraged, then potential responders required information about the amount of stair climbing that would produce health benefits. Intriguingly, a multi-component campaign increased stair climbing more in overweight than normal weight employees (+ 5.4% vs. + 2.5%) suggesting stair climbing may be an appealing lifestyle activity for the overweight (Eves et al., 2006). For this study, we adapted the multi-component intervention approach for use in a public access setting, i.e. a metro station.

The new campaign message aimed to summarise the science underlying the calorific consequences of stair climbing in simple terms. We took as our starting point the estimate that 100 kcals of additional daily expenditure would have avoided 90% of the weight gain in the US over an eight-year period (Hill, Wyatt, Redd & Peters, 2003). As noted above, stair climbing is a calorie hungry behaviour, with field estimates of 9.6 Metabolic Equivalents of Tasks (METs), i.e. 9.6 times the energy requirement of resting (Teh & Aziz, 2002). The height of the stairs at this station (6.45 m), coupled with the level approach, meant that a single ascent would use approximately 6.25 kcals. Hence, choosing the stairs once would expend approximately a 16^{th} of the daily energy expenditure required to avoid weight gain. Thus, the supplementary message for this multi-component campaign informed stair climbers that they had *'just burnt a 16^{th} of the calories needed to avoid weight gain*'. This message specified the outcome of an achievable behaviour, i.e. a single ascent, which we hoped represented meaningful progress towards the overall goal of weight control for potential responders. Our overarching aim was to encourage further use of stairs when presented with a subsequent choice. Importantly, previous research had revealed that the effects of point-of-choice interventions generalise to subsequent choices where there is no signage to prompt the behaviour (Webb & Eves, 2007, 2007b).

In this study, a conventional prompt was positioned at the point-of-choice at the bottom of the climb and two weeks later, the extended message, quantifying the calorific consequences of a single ascent, was added at the top of the climb. It was envisaged that both stair and escalator users could contemplate the calorific value of the behaviour as they continued their journey. The 2-week gap between the conventional point-of-choice prompt and the additional component in the time series aimed to provide information about the added contribution of the second component of the intervention. Hence, we aimed to augment the effects of the point-of-choice prompt by providing specific information about the benefits of stair climbing and predicted greater effects for the two components than for the point-of-choice prompt alone. Weight status was coded in the field from silhouettes using previously employed criteria (Eves et al., 2006). We predicted greater effects of the intervention would be seen in overweight pedestrians.

4.3 Methods

The intervention site was a UK metro station with a 43-step staircase (height = 6.45 m) positioned 16.5 m beyond the escalator. In 2008, four observers recorded stair/escalator choices of ascending travellers, between 08:00 - 09:59, on Tuesday and Thursday each week. Two observers counted male and female stair and escalator users whereas two further observers counted only overweight men and women on each method of ascent using 10.5 inch-high silhouettes and the previously employed cut-off for overweight (see Eves et al., 2006 [see Appendix 7.3]). The latter coding would include both overweight and obese individuals. The same pair of observers coded weight status throughout and practiced to criterion prior to the study (4 x 30 minute sessions). Double coding for two, 30-minute observation periods, which included 372 commuters, confirmed excellent agreement for method of ascent (Kappas [κ] = 0.98, 0.98), sex (κ = 0.97, 0.98) and weight status (κ = 0.95, 0.96).

Travellers constrained in their ability to use the stairs by large bags (larger than a briefcase or medium-sized bag), accompanying children (head below shoulder height of accompanying adult), or a physical incapacity were not recorded (Kerr et al., 2001c; Olander et al., 2008). In a quasi-experimental, interrupted-time-series-design, baseline observations (two weeks; stage 1) were followed by the sole positioning of a conventional point-of-choice prompt at the base of the stairs for two weeks (stage 2). The point-of-choice prompt, i.e. an A1-sized (594 x 841 mm) poster, presented the message "*Regular stair climbing helps to prevent weight gain*". The point-of-choice prompt was then supplemented with an extended message positioned at the top of the climb for six further weeks (stage 3); the supplementary message on two, A1-sized posters positioned at the exit was "*Well Done Stair Climbers! You have just burnt a 16th of the calories needed to avoid weight gain*".

Logistic regression analyses, conducted in December 2008, used stair/escalator choice as the dichotomous dependent variable and sex, weight status and time of morning (08:00 - 08:59 vs. 09:00 - 09:59) as dichotomous predictor variables. Pedestrian traffic volume, i.e. the total number of pedestrians leaving each tram that met the observation criteria, regardless of their ascent method, was entered as a continuous variable (mean = 78 pedestrians per tram, range 21 - 156) (Kerr et al., 2001c; Olander et al., 2008). Previous research indicates a modest reduction in effects of stair climbing interventions between the first and second half of their installation in public access settings (Webb Eves & Kerr, 2011) and worksites (Eves et al., 2006). Therefore, stage 3, i.e. the 6-week multi-component stage, was separated into consecutive 3-week periods for analysis such that stage was an ordered variable from 1 (baseline) to 4 (2nd, 3-week period).

4.4 Results

A total of 23,121 pedestrians were coded (57.9% female, 22.4% overweight). Figure 4.1 depicts the percentage stair climbing of normal and overweight individuals during the four stages of the study; percentage stair climbing, according to weight status for each week of the study, is presented as supplementary material (see Figure 4.2 and explanatory note in section 4.7). The omnibus analysis, i.e. one containing all the data, revealed a main effect of intervention stage, Odds Ratio (OR) = 1.33, 95% Confidence Interval [CI] [1.22, 1.44], $p < .001$, that interacted with weight status, OR = 0.76 [0.69, 0.83]. Effects of stage in overweight pedestrians, OR = 1.32 [1.22, 1.44], $p < .001$, contrasted with no significant effect in normal weight individuals, OR = 1.01 [0.97, 1.05]. Follow-up analyses for each stage, summarised in Table 4.1, revealed a progression from greater stair climbing for normal weight individuals at baseline (OR = 1.94) to the reverse effect in the final intervention stage (OR = 0.79). It should be noted that formal comparison between the baseline (stage 1) and point-of-choice prompt alone (stage 2) revealed neither a significant effect of the intervention overall, OR = 1.30 [0.94, 1.80], p = .11, nor a significant interaction with weight status, OR = 0.71 [0.50, 1.01], p = .06.

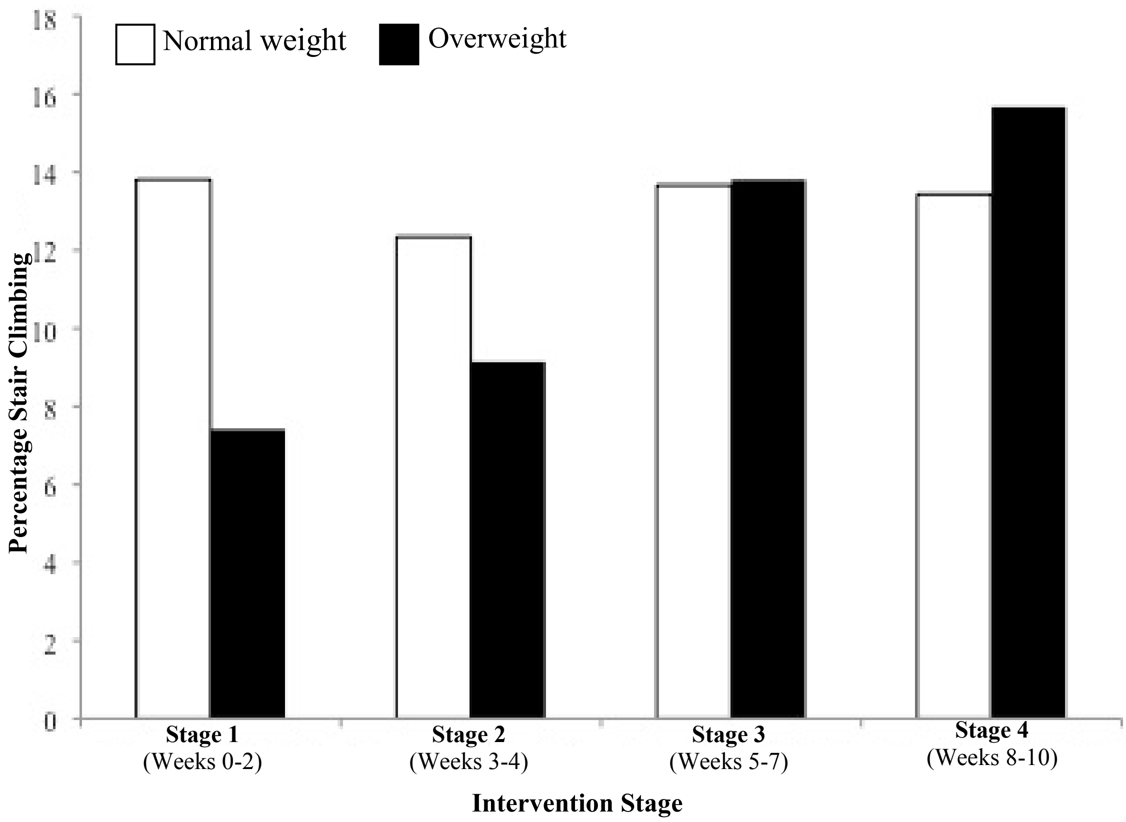


Figure 4.1. Percentage stair climbing of normal and overweight individuals during four stages of the study.

Consistent with previous studies, overall stair climbing was more common during the earlier morning session (08:00 - 08:59) and at higher traffic volumes. While the overall analysis contained a main effect of gender, OR = 1.16 [1.07, 1.26], $p < .001$, the smaller sample sizes of each phase meant that effects of gender were significant only for the final intervention stage, OR = 1.39 [1.22, 1.58], $p < .001$.

Variables	**Baseline stage 1**[a] *n* =3,829 OR [95% CI]	**Intervention stage 2** *n* =4,737 OR [95% CI]	**Intervention stage 3** *n* =6,766 OR [95% CI]	**Intervention stage 4** *n* =7,789 OR [95% CI]
Sex (M>F)	0.97 [0.80-1.18]	1.14 [0.95-1.36]	1.04 [0.91-1.20]	1.39*** [1.22-1.58]
Weight Status (NW > OW)	1.94*** [1.47-2.55]	1.34* [1.07-1.69]	0.97 [0.82-1.15]	0.79** [0.68-0.92]
Time of Day (08:00-08:59 > 09:00-09:59)	1.66*** [1.31-2.09]	1.96*** [1.59-2.40]	1.86*** [1.59-2.16]	1.54*** [1.34-1.78]
Pedestrian Traffic Volume (Continuous Variable)	1.008*** [1.004-1.012]	1.009*** [1.005-1.013]	1.008*** [1.005-1.011]	1.008*** [1.005-1.011]

Note. OR = odds ratio; CI = confidence interval; M = male; F = female; NW = normal weight; OW = overweight.
[a]Stage 1 = Baseline; Intervention stage 2 = Point-of-choice prompt alone; Intervention stage 3 = Point-of-choice prompt + additional message at the top of the climb, weeks 5-7; Intervention stage 4 = Point-of-choice prompt + additional message at the top of the climb, weeks 8-10.

Table 4.1: Odds ratios and confidence intervals for stair climbing according to intervention stage (n=23,121).

4.5 Discussion

Consistent with previous research, the overweight chose stairs less than normal weight individuals at baseline (Andersen et al., 1998; Brownell et al., 1980; Eves et al., 2006). The multi-component campaign targeting weight control reversed this bias, increasing stair climbing only in overweight individuals. The specificity of effect confirms the appeal of this lifestyle activity for the overweight (Eves et al., 2006) and may reflect heightened awareness of weight issues in this group. The progressive increase in the overweight is encouraging. Previous research with a calorific expenditure prompt revealed no change over the three weeks of its installation (Olander et al., 2008). Further, modest diminution of effectiveness over time seems characteristic of point-of-choice prompts in public access settings (Webb et al., 2011). Hence the increase over time is unlike previous research using only a point-of-choice prompt. While the data here revealed no statistically reliable effect of the point-of-choice component of the intervention, reduced power relative to previous studies may be responsible. Formal tests suggest that a sample size of 2,420 is required to detect an effect of a point-of-choice intervention in shopping malls (Webb et al., 2011). For the first two stages of the study here, there were 2,006 overweight commuters, i.e. less potential responders to the intervention than might be required. Further, unlike shopping malls, the flow of pedestrian traffic in stations is concentrated over a short period of time as disembarking passengers seek to leave the station simultaneously (see Eves, Lewis & Griffin, 2008). The net result is that increased traffic is associated with increased commuters on the stairs, independently of any intervention. Thus, greater sample sizes may be required in travel contexts to detect effects of an intervention that can be reduced during high levels of traffic (Olander et al., 2008; Puig-Ribera & Eves, 2010).

Point-of-choice prompts function to convert *prior* intentions to be more active into behaviour by interrupting unhealthy choices at the point of their occurrence (see Kerr et al., 2001b; Olander & Eves, 2011; Puig-Ribera & Eves, 2010; Webb & Eves, 2007b). At baseline, overweight individuals may not have realised stair climbing could influence weight control. During stage 2, i.e. only the point-of-choice prompt, the effects of weight status on stair climbing were reduced, but nonetheless overlapped with the baseline stage. Adding information about the calorific consequences of a single climb at the top of each method of ascent, however, removed any differential effects of weight status. It is likely that the additional message increased intentions to choose stairs; individuals could consider the calorific benefit as they continued their journey. The additional message could only affect a subsequent encounter with the choice-point. At the next encounter, the point-of-choice prompt could convert any changed intentions into behaviour. This process could account for the progressive increase in stair climbing across stages in overweight individuals.

Coding is an important issue in observational studies. Weight status here was coded by matching appearance to silhouettes rather than objectively and some errors are likely; the excellent inter-observer reliability (average $\kappa = .955$) suggests any errors are relatively small. Nonetheless, coders were not blind to the study aims. Thus, a subtle bias to code an individual on the stairs as overweight during the intervention phase could confirm the coders' expectations, despite the use of silhouettes, and masquerade as an effect of the intervention. Any such coding bias, however, would likely result in greater percentages of overweight in the sample overall during the intervention stages. While a comparison between the proportion of overweight coded in the four stages was significant (stage 1 = 23.2%, stage 2 = 23.6%, stage 3= 21.6%, stage 4 = 22.1%; Chi Square (3) = 8.58, $p = .04$), follow-up tests revealed that a *reduction* in the percentage of overweight between stage 2 and 3 ($p = .01$) was the only significant effect. This change in the opposite direction from any expectations the coders might have held, militates against biased coding as an explanation for the increased stair climbing seen in overweight commuters. Overall, we believe that the use of silhouettes to standardise coding was a strength of this study. Coding for weight status, however, with only four coders meant that we did not code apparent age, ethnicity and encumbrances such as large bags or accompanying children that have been shown to influence stair/escalator choice in less busy settings such as shopping malls (Webb et al., 2011). The pulsatile nature of traffic flow when disembarking passengers seek to leave a station simultaneously at busy times can preclude the coding of detailed demographic information for each passenger (cf Kerr et al., 2001c; Olander et al., 2008). Additionally, we excluded travellers constrained in their ability to use the stairs by large bags, accompanying children or a physical incapacity but did not record the number of exclusions. As a result, we will have underestimated pedestrian traffic volume. Nonetheless, our inclusion of pedestrian traffic in modelling was a strength of this study as it has almost ubiquitous effects on stair climbing yet is often omitted (see Webb et al., 2011). Studies employing more coders to audit the demographic grouping of individuals or off-line coding from video-recording would be required to clarify some of these issues around coding.

The long-term effect of this intervention is unknown. While this is a limitation, it is important here to distinguish between tests of the effects of an intervention on a target behaviour and the longer term consequences of an intervention. This is the first test of the effects on behaviour of a multi-component campaign in a public access setting. Thus we sought to establish the effects of the multi-component intervention. Nonetheless, previous research has revealed that point-of-choice prompts in public access settings can increase stair use at a subsequent choice point where there is no visible signage to prompt the behavior (Webb & Eves, 2007a, 2007b). Hence, the true effect of the combined signage at one set of stairs on population levels of physical activity in overweight individuals is unknown but could be greater than revealed at this site. Further research should investigate maintenance of the behaviour when signage is removed and the longer-term effects of this approach.

Whilst the absence of a no-intervention control site is a concern, the effects we report were confined to overweight pedestrians, with no changes in stair climbing in normal weight individuals. The latter result makes it unlikely that a spontaneous change in stair climbing due to uncontrolled factors can account for the results. Importantly, variations in stair climbing that result from natural variations in pedestrian traffic were controlled in the analysis, reducing the likelihood of 'spontaneous' changes in the behaviour. Another possible limitation of this study is that effects may be station specific. Only one metro station was used for this first test of a multi-component intervention and the effects in other stations would be of interest. Future research might also test the potential of this approach in other settings where point-of-choice interventions have been successful, e.g. shopping malls. As the height of stairs in malls (4 m) is typically lower than the 6.45 m of this site, the reduced calorific cost of a single ascent may alter effects of a similar intervention. Furthermore, our observations were confined to the morning period and findings may differ during other times of the day. For this site, however, commuters returning home, i.e. between 16:00 and 18:00, would be descending the stairs to reach the platform and effects on stair climbing could not be assessed. Research elsewhere, however, has shown that point-of-choice interventions can increase stair climbing during the evening commute, i.e. 16:00 – 18:30 (Ryan, Lyon, Webb, Eves & Ryan, unpublished work).

In summary, stair climbing is a vigorous lifestyle activity. This study demonstrates that the addition of a message at the top of the stairs, which provided information about the calorific consequences of the single ascent, progressively increased stair climbing in overweight individuals, with no effects in normal weight individuals. The specificity of this effect confirms the appeal of stair climbing as a lifestyle activity for overweight individuals, one group who would benefit from increased lifestyle activity. It is likely that the multi-component approach can increase intentions to take the stairs, as well as convert new intentions into actual behaviour. It is possible that the full potential of interventions to increase stair climbing has yet to be reached.

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4.7 Supplementary Material

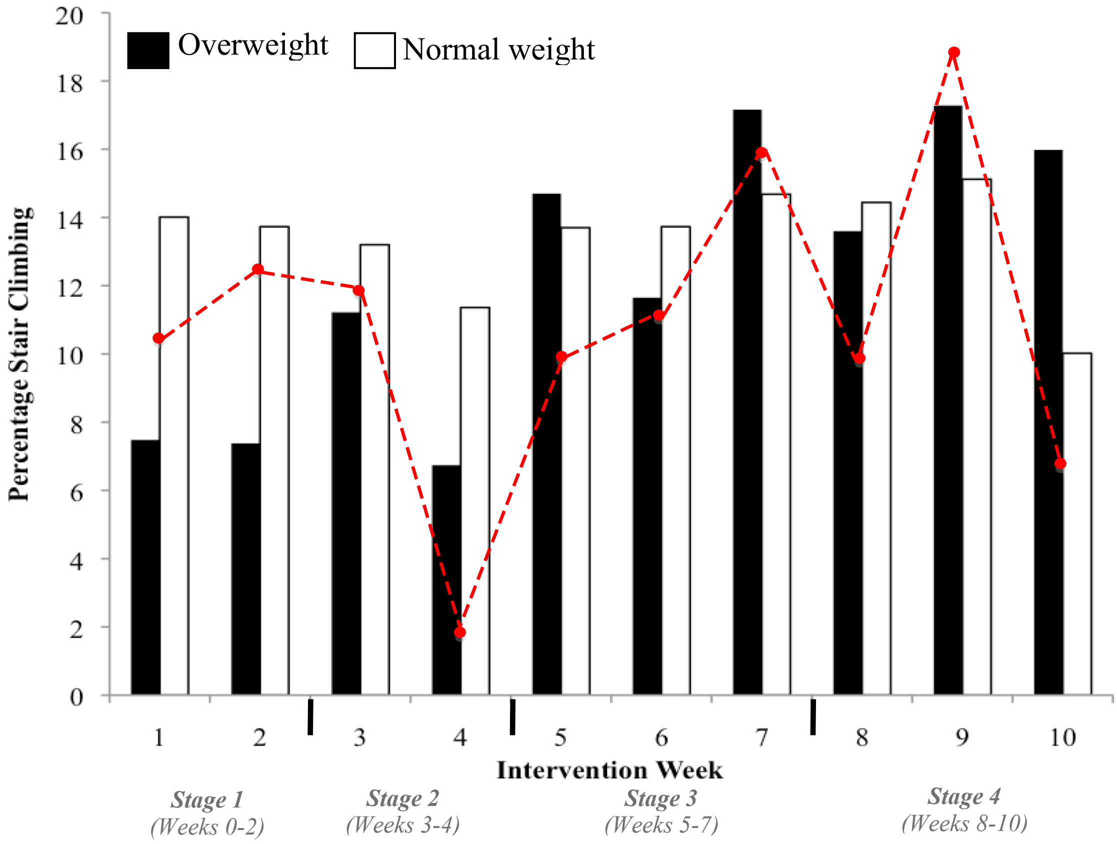

Figure 4.2: Percentage stair climbing in normal weight and overweight commuters over successive weeks of a calorie-based intervention.

	Wk 1	**Wk 2**	**Wk 3**	**Wk 4**	**Wk 5**	**Wk 6**	**Wk 7**	**Wk 8**	**Wk 9**	**Wk 10**
Average traffic (Rank)	74.0 (2.5)	74.0 (2.5)	77.1 (6)	71.4 (1)	81.3 (8)	77.6 (7)	82.1 (9)	75.9 (5)	84.6 (10)	74.5 (4)
% traffic in early period (Rank)	68.5 (8)	70.5 (10)	66.9 (6)	58.6 (1)	58.7 (2)	60.8 (4)	67.1 (7)	63.2 (5)	68.6 (9)	59.8 (3)

Table 4.2: Average traffic and the percentage of traffic in the early period (08:00-08:59) across intervention weeks.

This supplementary figure depicts stair climbing in normal weight and overweight commuters over successive weeks of the study. While it shows the overall pattern of the data averaged across longer time intervals in the paper, i.e. an increase in the percentage stair climbing for the overweight commuters, there is a lot more variability. The table below the figure presents the average traffic in each week and the percentage of the traffic occurring in the earlier morning period (08:00-08:59) during which stair climbing is more likely. These data have been ranked across weeks from 1 (low) to 10 (high) for each of the variables (see below).

It is important to note that the raw percentages presented in this figure are uncorrected for the influence of other, relevant variables summarised in the table. Effects of pedestrian traffic volume on stair climbing are almost ubiquitous; increased traffic is almost invariably associated with increased stair climbing (Webb, Eves & Kerr, 2011). At busy times, a pedestrian approaching the choice-point may find the escalator full and choose the stairs as the quicker alternative. Importantly, in travel contexts such as stations, the pulsatile nature of traffic flow as many disembarking travellers seek to leave the station at the same time results in large magnitude effects on stair climbing. For example, in a busy station with up to 300+ passengers leaving each train, the stairs became saturated with passengers such that 45% chose the stairs as traffic rates reached 150-200. This represented an increase of some 25% in absolute terms relative to the least busy trains (Eves, Lewis & Griffin, 2008). The net outcome is that any spontaneous variation in traffic flows between weeks will not be accounted for in a figure depicting the raw percentages. Similarly, this figure is not corrected for any variation between weeks in the percentage of the passengers travelling in the earlier morning period (08:00-08.59) relative to the later one (09:00-09:59), which had a large magnitude effect on overall rates of stair climbing in this data set, or the ratio of males to females, which had less of an influence here. The point is that greater variation is to be expected when data are depicted over shorter time periods as spontaneous variations in the usage of the station between weeks will have greater leverage at smaller sample sizes. To provide a simple graphic illustration of the potential magnitude of the effects of these uncontrolled variables, the ranks for each week have been summed across the two uncontrolled variables and the resultant sum plotted for each week on the figure (broken line). As can be seen, the variability in stair climbing, in part, matches the effect of these uncontrolled variables that reflect natural variation in the use of the site across weeks.

One further point is worth noting from the data presented in the table. During week four, i.e. the second week of the point-of-choice prompt, average traffic and the percentage of it occurring in the earlier period were at the lowest point for both variables. Consequently, the 'spontaneous' variations in usage of the station during week four would be biased against stair climbing and may, in part, contribute to the absence of an overall effect for the point-of-choice prompt alone in this data set.

4.7.1 References

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CHAPTER FIVE

PROMPT BEFORE THE CHOICE IS MADE; EFFECTS OF A STAIR CLIMBING INTERVENTION IN UNIVERSITY BUILDINGS.

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5.0 Prompt Before The Choice Is Made; Effects Of A Stair Climbing Intervention In University Buildings.

5.1 Abstract

Objectives: Recent interventions report positive results following a multi-component campaign to increase stair climbing. This study investigated the effectiveness of volitional and motivational components of a stair climbing intervention in the workplace.

Design: Interrupted time-series design.

Methods: Ascending stair/lift choices, coded by gender, were observed between 08:00 and 10:00 and 14:15-16:15 on weekdays, in four university buildings (n=14,138; 46% female). Baseline observations (stage 1; 5-days) preceded a motivational intervention, i.e. a poster positioned inside the lift(s), that was positioned in each building (stage 2; 5-days). Next a volitional intervention, i.e. point-of-choice prompt, supplemented the motivational one (stage 3; 8-days). Logistic regression analysis of stair/lift choices included the independent variables of intervention components, gender, time of day, building height, number of lifts and pedestrian traffic.

Results: There was no significant change in stair climbing when the motivational component was positioned alone (OR=0.93, 95% CI = 0.85-1.02, p=.123). In contrast, stair climbing increased significantly when the volitional component, i.e. the point-of-choice prompt, was added (OR=1.23, 95% CI = 1.14-1.32, p<.001). During both stages, building height, number

of lifts, time of day and pedestrian traffic were all associated with stair climbing. No significant gender effects were seen.

Conclusions: A motivational component positioned alone, inside the lift(s) did not increase stair climbing. When a volitional component was added, i.e. point-of-choice prompt positioned at the time and place where individuals choose their method of ascent, stair climbing increased significantly. Visibility of a prompt at the time behavioural choice is made appears necessary to change actual behaviour.

5.2 Introduction

Obesity, typically a consequence of an energy imbalance (Hill, Wyatt, Reed & Peters, 2003), is a public health dilemma affecting around a quarter of adults in the UK (Health Survey for England [HSE], 2008). Overweight and obesity combined are responsible for 5% of global mortality (World Health Organization [WHO], 2010). Participating in physical activity plays a critical role in energy expenditure and consequently weight control. Furthermore, regular physical activity participation is associated with multiple health benefits, such as reduced risks of coronary heart disease and stroke, hypertension, diabetes, cancers and increased mental wellbeing. Rates of physical inactivity, however, are rising and recommended levels of physical activity are not being met by the majority of adults (WHO, 2010); the accumulation of daily lifestyle physical activity is one current public health approach to increase energy expenditure (Department of Health [DOH], 2011; Haskell et al., 2007; WHO, 2010).

Critically, lifestyle activities appear to be as effective for weight loss as supervised exercise programmes and due to their 'achievable nature', they are more likely to be maintained (DOH, 2004; MacDonald, Stokes, Cohen, Kofner & Ridgeway, 2010). Active transportation, e.g. walking and cycling, is one way to incorporate physical activity into daily living (DOH, 2011; Frank, Andresen & Schmid, 2004). In addition, encouraging individuals to choose the stairs rather than the lift is a current public health target (DOH, 2005). Unlike walking, stair climbing is a vigorous-intensity lifestyle activity, i.e. it expends 9.6 times the energy used at rest (Teh & Aziz, 2002). Opportunities for stair climbing are plentiful, particularly at work, and it can be readily integrated into daily life. Furthermore, stair climbing may have important implications for the accumulation of energy expenditure throughout one's day (Hill et al., 2003). In particular, as stair climbing involves raising one's own weight against gravity, more energy is expended by overweight than healthy weight individuals. It has been estimated that an 80 kg man who climbs a standard 3 m flight of stairs in his own home ten times extra a day would expend approximately 28 $kcal.d^{-1}$. Over a year that adds up to more than 10,000 kcals which is equivalent to 3 lbs of fat (Olander & Eves, 2011a). Besides increased energy expenditure, stair climbing is associated with an improved cholesterol profile, cardio-respiratory fitness and weight loss in short-term experimental studies (Boreham, et al., 2005; Kennedy, Boreham, Murphy, Young, & Mutrie, 2007; Meyer, et al., 2010). Longer-term epidemiological observational studies also provide evidence of a decreased risk of cardiovascular disease and stroke associated with stair climbing (Lee & Paffenbarger, 1998; Paffenbarger, et al., 1994).

To date, 37/41 interventions have successfully increased stair climbing in public access settings, such as stations and shopping malls (see Nocon, Müller-Riemenschneider, Nitzschke, & Willich, 2010; plus Boen, Maurissen, & Opdenacker, 2010; Lewis & Eves, 2011; Nomura, Yoshimoto, Akezaki, & Sato, 2009; Puig-Ribera & Eves, 2010; Ryan, Lyon, Webb, Eves & Ryan, 2011; Webb & Cheng, 2010). Typically a poster encouraging individuals to take the stairs to benefit their health is positioned at the point-of-choice between the methods of ascent. More recently, stair climbing interventions within the workplace, a place where most adults spend half of their waking hours (Dishman, Oldenburg, O'Neal & Shephard, 1998), have also demonstrated the effectiveness of point-of-choice prompts (Eves, Webb & Mutrie, 2006; Olander & Eves, 2011a; see also Eves, 2008, 2010). At work, individuals can accumulate repeated episodes of stair climbing as they go about their daily life. Hence, meaningful increases in calorific expenditure can be achieved by increased stair climbing at work. For stair climbing interventions, however, it is helpful to distinguish between motivational and volitional components, as it is in other studies targeting health behaviour. Motivational components aim to change attitudes and intentions, e.g. information-based mass media campaigns such as Change4Life that extol the benefits of stair climbing (National Health Service, 2011). In contrast, volitional components aim to translate intentions into actions similar to interventions based on planning and implementation intentions (Gollwitzer & Sheeran, 2006; Milne, Orbell & Sheeran, 2002; Sniehotta, Scholz, Schwarzer, 2005; Sniehotta, Schwarzer, Scholz & Schu, 2005; Sutton, 2002). Point-of-choice interventions function by interrupting habitual behaviour, such as choosing the escalator/lift, at the point of its occurrence allowing substitution of a health-enhancing alternative (Kerr, Eves & Carroll, 2001a; Webb & Eves, 2007a). Importantly though, a *prior* intention to be more active is necessary for a prompt to be successful; the brief encounter with the prompt merely 'reminds' an individual of their previous goal of increased physical activity (Lewis & Eves, 2011, 2012; Puig-Ribera & Eves, 2010). Point-of-choice prompts, therefore, can be considered volitional interventions in the environment (Gollwitzer & Sheeran, 2006). They help translate intentions into behaviour and, as such, are post-decisional aids to healthy behaviour similar to volitional interventions for action initiation (Lewis & Eves, 2011, 2012; Olander & Eves, 2011a).

Olander and Eves (2011a) compared the effectiveness of two interventions for promoting stair climbing in the workplace. A motivational, information-based intervention at a health information day, called Workplace Wellbeing Day, aimed to change attitudes and intentions about stair climbing. The Workplace Wellbeing Day provided information on occupational health issues for employees, with stands promoting healthy eating, gardening, active transport such as cycling to work and offering free health checks. For the purpose of their study, Olander and Eves (2011a) added a stand encouraging stair climbing, i.e. a motivational intervention. The stand displayed a large, A2-sized poster with the message "*Stair climbing always burns calories. One flight uses about 2.8 calories, but 10 flights a day would use 28 calories. Over a year that adds up to 10,000+ calories; that's more than four days' worth of food*". In addition, leaflets, listing eight benefits of regular stair climbing, such as "*it burns more calories per minute than jogging or rowing*" and "*helps prevent osteoporosis*" were given to attendees. Stair climbing was monitored for one week following the Workplace Wellbeing Day. Next, Olander and Eves (2011a) installed a volitional intervention for comparison with the motivational one. The same poster was prominently displayed at the point-of-choice between the stairs and lift(s) and supplemented with a smaller, A4-sized poster, which read "*Stair climbing always burns calories*", and an arrow pointing to the stairs, positioned by the external lift control panels. While Olander and Eves (2011a) report effects on stair climbing only for the volitional, point-of-choice prompt, poor dissemination of the motivational intervention to the target population occurred; only 3.2% of staff from the monitored buildings attended the stand at the Workplace Wellbeing day. In contrast, the point-of-choice prompts were positioned en route to the lift and stairs in each of the buildings observed. Therefore, most employees would have been exposed to the point-of-choice prompt and it is unsurprising that it outperformed the motivational intervention encountered by only 3.2% of employees.

Given the inconclusive result of Olander and Eves (2011a), this study reports a more equitable test of effectiveness of motivational and volitional components of a stair climbing intervention in the workplace. Delivery of the motivational component was altered to increase exposure of the target population. The motivational component was a large, A2 poster, positioned <u>inside</u> the lift(s) of each intervention building. We hoped that this modification would ensure that the majority of users of the building would be exposed to this part of the intervention. One week later, the poster in the lift was supplemented with a volitional intervention consisting of point-of-choice elements as in Olander and Eves (2011a). The same large poster was prominently displayed at the point-of-choice between the methods of ascent whereas a smaller A4 poster and arrow, pointing to the stairs, was positioned next to the external lift control panels. We predicted increases in stair climbing for both the motivational and volitional phases of the study relative to baseline.

It is important to consider that choosing a method of ascent forms part of one's journey. In workplaces, the lift and stairs are simply barriers to overcome en-route to the destination (Eves, 2008, 2010; Eves & Webb, 2006). The physical environment can bias a traveller's choice, such that people are more likely to opt for the easiest and 'quickest' way to their destination. For example it has been reported that height of a building (Bungum, Meacham & Truax, 2007; Eves & Webb, 2006; Olander & Eves, 2011a) and the number of lifts (Nicoll & Zimring, 2009; Olander & Eves, 2011b) can negatively influence stair climbing behaviour. Specifically, the higher a building and the greater the number of lifts, the less likely individuals are to opt for the stairs. Furthermore, it has been reported that frequency of stair climbing can reduce as the time of day increases, i.e. more people climb the stairs earlier in the day (Olander & Eves, 2011b). These factors were, therefore, measured in each of the buildings and controlled for in the analysis. We predicted less stair climbing in buildings that were higher and had more lifts, and in the afternoon relative to the morning.

5.3 Methods

5.3.1 Procedure

In a quasi-experimental, interrupted-time-series design, we observed stair climbing within the workplace during three stages: 1) baseline; 2) a motivational component; and 3) a motivational plus volitional component. During December 2009, four discrete observers (inter-observer reliability: average kappa = 0.97, kappa range 0.95-1.00) recorded gender and stair/lift choice of ascending pedestrians, in four university buildings that offered a clear point-of-choice between the stairs and the lift(s). Observations were conducted between the periods 08:00 and 10:00 and 14:15 and 16:15 each weekday (excluding Wednesday afternoons). Nonetheless, pilot research revealed that many pedestrians entered and ascended the buildings during these times, with the exception of Wednesday afternoon that was reserved for student sport at the university. Pilot observations also revealed exceptionally high levels of stair and lift use during four, 15-minute periods, i.e. 08:45-08:59, 09:45-09:59, 14:45-14:59 and 15:45-15:59. These periods of increased pedestrian movement within the building reflected students going to lecture theatres prior to the onset of lectures. As the choice of ascent method during these times would be severely constrained by the reduced availability of the lift (Olander & Eves, 2011b), stair climbing could occur independently of any intervention. An *a priori* decision was made, therefore, not to record data within these four time periods with high levels of pedestrian traffic.

Each observer was allocated one university building for the duration of the study. Observations were recorded over 15-minute periods to allow calculation of pedestrian traffic volume, i.e. the total number of pedestrians ascending the building via the stairs and lift(s) during each 15-minute period. People unable to climb the stairs easily because they were carrying bags (larger than a brief case) or who had a physical incapacity were not counted. Our sample therefore represented all individuals in the buildings, during the recorded observation periods, who could ascend the stairs and were not encumbered. Building characteristics, namely, the height of the building and the numbers of lifts per building were also recorded.

Ethical approval was obtained from the Ethics Subcommittee of the School of Sport and Exercise Sciences, University of Birmingham, UK.

5.3.2 Intervention

Baseline observations (stage 1; 5-days) preceded a motivational intervention that was positioned in each of the four buildings (stage 2; 5-days); a yellow, A2 poster (420 x 594 mm) was positioned inside each lift above head-height near the control panel. The poster read, *"Stair climbing always burns calories. One flight uses about 2.8 calories, but 10 flights a day* *uses 28 calories. Over a year that adds up to 10,000+ calories; that's more than 3lb of fat"*. The intervention message was a slightly modified version of the extended message about calorific expenditure previously employed (Olander & Eves, 2011a; Eves, Webb, Griffin & Chambers, submitted); the final clause of the previous message, *"that's more than four days worth of food"* was changed to *"that's more than 3lb of fat"*. The message was accompanied by a large cartoon manikin climbing the stairs and endorsements by credible public health and education sources, which is a design used previously (Olander & Eves, 2011a). Next, a volitional intervention consisting of two components, supplemented the motivational one (stage 3; 8-days). The same A2 poster as used in stage 2 was positioned prominently at the point-of-choice between the stairs and the lift(s), on the ground floor, in each building such that it was visible when approaching the choice point. In addition, a green, A4 poster prompt (210 x 297 mm), which read, "*Stair climbing always burns calories*", and a yellow arrow pointing to the stairs were positioned by the external lift control panel (see Appendix 7.4).

5.3.3 Data Reduction and Statistics

Preliminary analyses of the traffic data for each 15-minute period of monitoring revealed main effects of stage of intervention ($F(2,695)=3.64$, $p=.03$) and building ($F(3,695)=80.719$, $p<.001$). Follow-up analyses revealed higher levels of traffic volume in stage 1 (mean = 21.9 SD = 18.9) than stage 2 (mean = 18.4 SD = 18.9, $p=.04$) and a difference between stage 1 and 3 that approached significance (stage 3 mean = 19.1 SD = 17.3, $p=.08$). There was no evidence of differences in overall traffic volumes between stage 2 and 3. The average levels of traffic in the four buildings are shown in Table 1. Follow-up analyses of the effect of building revealed differences in overall traffic volumes between all buildings with the exception of 2 and 3 (all $p<.001$). If, as seemed likely, there was to be an effect of traffic on stair climbing, then differences in traffic between buildings could masquerade as differences in the effects of the building characteristics. To avoid this potential confounding, traffic was mean-centred for each building prior to analyses. Mean centring of data retains the variability in the data but removes any average differences between buildings in traffic volume (Eves, Olander, Nicoll, Puig-Ribera & Griffin, 2009; Webb, Eves & Kerr, 2011). The net outcome for this study is that effects of pedestrian traffic volume could be assessed independently of building characteristics as the traffic data for each building had the same average value, i.e. zero, when the mean of each building was subtracted from the data.

Logistic regression analyses were used with method of ascent, i.e. stair/lift, as the dichotomous dependent variable and intervention, gender and time of day (morning vs. afternoon) as dichotomous independent variables. Building height, number of lifts and pedestrian traffic volumes were all entered as continuous independent variables. Preliminary inspection revealed that the ratio of the distance to the stairs relative to the lift from the entry point (see Olander & Eves, 2011a) displayed multi-collinearity with the number of lifts in this data set and, hence, the variable was not included in analyses. Statistical analyses were performed using Systat 11.

5.4 Results

5.4.1 Building Characteristics

As detailed in Table 5.1, building heights, i.e. individual step height multiplied by the total number of steps in the building, ranged from 13.12 m to 33.32 m, i.e. four to eight floors, number of lifts per building ranged from one to three, and the average traffic volumes per building, i.e. per 15-minute period across all stages, ranged from 6.10 (sd=5.3) to 31.00 (sd=20.6).

	Building 1	Building 2	Building 3	Building 4
Building height (meters)	13.12	33.32	19.25	15.58
No. of lift(s)	2	2	3	1
Average traffic levels[a]	31.00 (sd=20.6)	20.50 (sd=11.1)	21.6 (sd=18.7)	6.1 (sd=5.3)

a: per 15-minute period across all stages

Table 5.1. Summary of characteristics for each university building.

	Motivational Intervention: Poster in the lift[a] (n=8,476) **OR (95% CI)**	**Volitional Intervention: Point-of-choice prompts**[b] (n=14,138) **OR (95% CI)**
Intervention	0.93 (0.85-1.02)	1.23 (1.14-1.32)***
Gender (M>F)	1.07 (0.98-1.17)	1.07 (0.99-1.15)
Building Height (m)	0.97 (0.96-0.97)*** [c]	0.96 (0.95-0.96)***
No. of Lifts	0.47 (0.43-0.51)***	0.44 (0.41-0.47)***
Time of Day	1.15 (1.05-1.25)**	1.15 (1.08-1.24)***
Pedestrian Traffic Levels	1.01 (1.01-1.01)***	1.01 (1.01-1.01)***

Note: OR indicates odds ratio, CI, confidence interval
a: Compared with baseline
b: Compared with baseline and the motivational intervention stage (i.e. stages 1 and 2) combined
*c: *p<0.05; ** p<0.01 ***p<0.001*

Table 5.2. Effects of a motivational and volitional intervention on stair climbing in university buildings.

5.4.2 Effects on Stair Climbing

A total of 14,138 observations were recorded (stage 1 n=4,623; stage 2 n=3,853; and stage 3 n=5,662), of which 46% were women. As Table 5.2 shows, there was no significant change in stair climbing when the motivational intervention, i.e. the poster in the lift, was positioned alone (stage 2). As a result, stages 1 and 2 were treated as equivalent and then compared to stage 3. There was a significant increase in stair climbing when the volitional component, i.e. the point-of-choice prompt, was added. Consistent with this, the addition of the volitional component significantly increased stair climbing relative to stage 2 alone, i.e. the poster positioned in the lift(s) (Odds Ratio [OR] = 1.30, 95% Confidence Interval [CI] = 1.20-1.42, $p<0.001$).

Additionally, for both intervention stages, building height, the number of lifts, time of day and pedestrian traffic volume were all significantly associated with stair climbing (see Table 5.2). Specifically, individuals were less likely to climb the stairs in higher buildings and those with more lifts. In contrast, people were more likely to climb the stairs in the afternoon (14:15-16:15) than the morning (08:00-10:00) and at greater pedestrian traffic volumes. While there were no significant effects of gender throughout, the direction of any differences would be consistent with stair climbing for public access staircases such that men chose the stairs more than women.

The overall, percentage stair climbing during the baseline, motivational and volitional stages was 59.4%, 55.1% and 60.1% respectively. While these raw data suggest a drop in stair climbing between baseline and the motivational component, this impression is misleading. The raw data do not partial out effects of height of building, number of lifts, pedestrian traffic volume and time of day, all of which influenced stair climbing. Failure to include these uncontrollable factors in analyses can result in misleading conclusions (see Olander & Eves, 2011b; Lewis & Eves, 2011, 2012).

5.5 Discussion

This study compared the effectiveness of motivational and volitional components of a stair climbing intervention in the workplace. There was no significant change in stair climbing when the motivational component was positioned alone in the lift(s). In contrast, the addition of volitional components outside the lift(s) produced a significant increase in stair climbing.

5.5.1 Effects of the Intervention Components

In this study, we corrected for the low rates of exposure to the motivational component for the target population that would explain failure of a previous motivational workplace intervention for stair climbing (Olander & Eves, 2011a). A brightly coloured, A2 poster was positioned inside the lift(s) and is unlikely to have gone unnoticed by people entering and standing in the lift due to its size (see Kerr et al., 2001b). Furthermore, the motivational intervention was placed in each of the buildings being monitored, rather than in other locations around the university. Thus, it seems likely that dissemination of the message was widespread amongst users of the buildings and clearly targeted the main population group of interest, i.e. those not taking the stairs. It seems doubtful, therefore, that the ineffectiveness of the motivational component when positioned alone was due to poor information dissemination as in the previous study (Olander & Eves, 2011a). Nonetheless, there was no effect of the motivational component alone.

There are two possible explanations why the poster in the lift(s) alone was ineffective. Firstly, it is possible that the intervention message was not an effective one and hence could not change a person's behaviour. The fact that the same message was effective when positioned outside the lift makes this explanation unlikely.

The second, and more plausible explanation, of why the poster in the lift alone failed to increase stair climbing was due to its positioning. While positioning the motivational component inside the lift(s) enhanced dissemination of the message and meant that individuals could consider the calorific consequences of stair climbing as they stood in the lift, the information was provided *after* the method of ascent had been chosen. Hence, it could only affect a subsequent decision to use the stairs, which it failed to do. As noted previously in a station, visibility of a stair climbing prompt *at the time the choice is made* may be the key to its effectiveness (Olander, Eves & Puig-Ribera, 2008). In contrast, a motivational intervention in the lift does not take into account factors that may prevent intentions from being transferred into behaviour, e.g. habit (Gollwitzer, 1999). Strong habits can override one's intentions due to reduced effects of self-regulation for habitual behaviours (Gardner, de Bruijn & Lally, 2011; Verplanken, Aarts, Van Kippenberg & Moonen, 1998; Webb & Sheeran, 2006). Avoidance of stair climbing is likely to be habitual. It has been argued that habit formation is a consequence of performing a repeated behaviour to successfully achieve a goal in a stable context (Aarts & Dijksterhuis, 2000; Lally, van Jaarsveld, Potts & Wardle, 2010; Oulette & Wood, 1998; Verplanken & Aarts, 1999). Stair climbing is a mode of transport and minimisation of energy expenditure during locomotion is widespread (Eves, Scott, Hoppé & French, 2007). When faced with a choice between climbing the stairs and taking the lift, individuals frequently opt for the mechanised option, successfully minimising the energetic cost of locomotion. As a result, choice of the mechanised option can become habitual (Kerr et al, 2001a; Webb & Eves, 2007a). As a result, each time an individual enters the building, limited deliberation, if any, is required to choose the option that mimimises the energetic cost of ascent. To disrupt this habitual behaviour, the context in which the behaviour occurs needs altering to facilitate alternative responses (Holland, Aarts & Langendam, 2006; Wood & Neal, 2009). Thus, the poster inside the lift(s) failed to change the context as it would only be encountered after the choice was made. In contrast, the addition of the volitional intervention component resulted in increased stair climbing. Critically, the point-of-choice prompts were positioned at the time and place where individuals chose their method of ascent, thus changing the behavioural context. These disruptions of habitual behaviour encourage the individual to self-regulate and consciously consider which option to take.

In summary, whilst motivational interventions can be effective tools for changing behaviour (Webb & Sheeran, 2006), in a situation where the competing force of an established habit and other distractions faced en-route to a destination, are present, it is possible that a motivational component alone may be ineffective. Here, the addition of a volitional component at the time the behavioural choice was made was required to transform intentions about stair climbing into behaviour. Consistent with this, a recent study compared the effectiveness of motivational and volitional components of a stair climbing intervention in a public access setting, i.e. a tram station (Lewis & Eves, 2012). A motivational poster was positioned at the top of the stairs and escalator, so all pedestrians could see it as they exited the station. No significant change in stair climbing occurred following the positioning of this motivational component after the choice had been made. In contrast, addition of a conventional point-of-choice prompt at the base of the stairs, i.e. at the time the choice was made, increased stair climbing. The current study generalises these earlier findings of Lewis and Eves (2012) to a workplace setting.

Whilst these findings are specifically about increased stair climbing behaviour, the theory underpinning the findings applies to behaviour change research as a whole and, probably, to other health-related behaviours. The key point here is that, whilst motivational interventions may be effective in some cases, disruption of habits may require careful timing of the intervention relative to the behaviour. Optimal disruption of an 'unhealthy' habit may require changes to the context in which the behaviour occurs to promote conscious deliberation over which choice to make *at the time that choice is made*. A volitional intervention such as a point-of-choice prompt provides this timely disruption. It seems unlikely that our 8-day intervention formed new 'healthy' habits given that Lally et al., (2010) estimate 91 days (inter-quartile range 44-118) for the development of an exercise habit in the 38% of participants for which modelling was possible. Nonetheless, these environmental cues, i.e. point-of-choice prompts, are possible health 'nudges' which could assist the formation of new healthy habits. As such, point-of-choice prompts may support the development of healthy behaviour during what appears to be a protracted process of addition to an individual's repertoire (Lally et al., 2010). In addition, where the behavioural choice may be biased by the immediate consequences of that choice, for example the effects of taste on food selection (Marteau, Ogilvie, Roland, Suhrcke & Kelly, 2011), active health prompts may have a role in countering this bias at the time the choice is made.

One further point about the difference between the two stages of this study is relevant. The simultaneous positioning of both components in this study (OR= 1.23, 95% CI=1.14-1.32), did not have a greater magnitude of effect than that of Olander and Eves (2011a) where only 3.2% of the target population were exposed to the motivational component as part of Workplace Wellbeing day (OR=1.20, 95% CI=1.06-1.37). Hence, there is no evidence in this data set that the motivational poster in the lift changed intentions of the target population.

5.5.2 Other Influential Factors

Consistent with previous research, both increased building height and greater numbers of lifts in each building were negatively associated with stair climbing (Olander & Eves, 2011a, 2011b). Contrary to an earlier study, however, more people climbed the stairs in the afternoon (14:15-16:15) than the morning (08:00-10:00), whereas Olander and Eves (2011b) reported the opposite effect. Only further research could clarify the issue of time of day. Additionally, increased pedestrian traffic volume was associated with increased stair climbing consistent with research in public access settings (Webb et al., 2011). Whilst the effect of traffic reported here is similar to a previous workplace intervention that measured traffic over 30-minute periods (Kerr et al., 2001c), two recent workplace studies that used minute-by-minute measures of pedestrian traffic volume reported the opposite effect. Increased momentary traffic was associated with reduced stair climbing (Eves et al., submitted; Olander & Eves, 2011b). A likely explanation for this contrast is differences in the measures used. Measurement over a 15-minute period, similar to that used in public access settings, reflects the ‘busyness’ of the site. When a lot of people are trying to use methods of ascent simultaneously, the mechanised alternative can be unavailable and hence some individuals choose the stairs rather than wait (see Eves, Lewis & Griffin, 2008). In contrast, minute-by-minute measures of pedestrian traffic better model the effects of social interaction on stair choice, for example, if pedestrians choose to travel together (see Olander & Eves, 2011b). There is one important corollary of these effects of 'busyness' of the buildings; the apparent drop in frequency of stair climbing between the baseline and the motivational phase may simply reflect the significant differences in the overall pedestrian traffic levels between the two phases. Put another way, the buildings were less busy overall during the motivational phase and, hence, lifts would have been more available should people entering the building wish to use them (see Olander & Eves, 2011b).

Concerning demographic factors, no significant effects of gender were found during either stage of this study, consistent with a previous workplace study (Bungum et al., 2007). Studies in public access settings, however, consistently report that men choose to climb stairs more than women (see Webb et al., 2011). Whilst a few workplace studies support this (Eves et al., 2006; Kerr et al., 2001b study 2; Olander & Eves, 2011a; Russell, Dzewaltowski & Ryan, 1999), others have found the opposite (Coleman & Gonzalez, 2001 study 2; Kerr et al, 2001b study 1). These inconsistent effects of gender in the workplace, compared to public access settings, warrant further investigation.

5.5.3 Strengths and Limitations

The success of the volitional components is promising, supporting the use of point-of-choice prompts within the workplace (Eves et al., 2006; Eves et al., submitted; Olander & Eves, 2011a, 2011b). Further the success of a calorific expenditure-based intervention is encouraging and seems a positive theme for the workplace (c.f. Eves et al., submitted). As the order in which the components were installed was not reversed such that the volitional components were positioned alone, it is not possible to conclude whether the prompts alone would have been effective. Nonetheless, Olander and Eves (2011a) reported increased stair climbing when point-of-choice prompts were installed and exposure to a prior motivational intervention was poor. Thus, it seems likely that the point-of-choice prompts alone would have increased stair climbing.

While we were able to code gender, the high levels of pedestrian traffic and the availability of only one observer per building, precluded coding of other demographic variables. Weight status, age, ethnicity, the presence of large bags and building occupancy can influence choice of ascent method (Lewis & Eves, 2011; Webb et al., 2011). Thus, the precision of our estimate of the magnitude of effects could be affected. Further, we did not include nor record the number of people unable to climb the stairs easily because they were carrying large bags or who had a physical incapacity. Consequently, pedestrian traffic volume would have been underestimated. The inclusion of pedestrian traffic in modeling, however, was a strength of this study as it is often overlooked despite its almost ubiquitous effects on stair climbing (see Webb et al., 2011). Similarly, observations were made from the ground floor only. Therefore, the actual number of flights of stairs climbed is unknown. Greater resources would help overcome these issues in future research.

5.5.4 Conclusion

This study compared the effectiveness of motivational and volitional components of a stair climbing intervention in the workplace. Critically, a motivational component positioned alone, inside the lift(s) did not increase stair climbing. When a volitional component was added, i.e. a point-of-choice prompt positioned at the time and place where individuals choose their method of ascent, stair climbing increased significantly. Furthermore, environmental factors such as building height, the number of lifts, time of day and pedestrian traffic levels, significantly influenced stair climbing behaviour.

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CHAPTER SIX

DISCUSSION AND CONCLUSION

6.0 Discussion and Conclusion

This thesis aimed to assess the success of point-of-choice prompts as a tool for changing stair climbing behaviour and tested the theoretical underpinnings behind their previously consistent success in public access settings. Specifically, key findings are: after controlling for the effects of traffic, similar effects on stair climbing were evident for a more specific and a simpler message (chapter two); the simultaneous positioning of motivational and volitional components was required to increase stair climbing in a setting where choosing the stairs resulted in a time delay for pedestrians due to the site layout (chapter three); a multi-component intervention targeting weight control increased stair climbing in individuals coded as overweight, with no effects in individuals of normal weight (chapter four); and, a motivational intervention alone did not change stair climbing behaviour in the workplace. When supplemented with a volitional, point-of-choice prompt at the time the choice of ascent method is made, a significant increase in stair climbing was seen (chapter five). This section aims to discuss the integration of these findings with previous research.

6.1 Message Content

6.1.1 Comparison of Message Content

The first study (chapter two) compared the effects of two messages differing in specificity in a train station. After adjusting for effects of pedestrian traffic, that is the total number of pedestrians leaving each train, similar effects on stair climbing were seen for a specific, more complex and general, simpler message. In this study effects of pedestrian traffic were large; an interaction between traffic volume and intervention showed that pedestrian traffic influenced intervention success for the more specific message (OR=0.36, CI=0.20-0.66, p=.001), such that intervention success was diluted during higher traffic volumes, i.e. busier times. There was no interaction between pedestrian traffic and the more general message (OR=1.48, CI=0.72-3.02, p=0.28). Thus, the simpler message appears immune to the effects of traffic volume.

Results presented in chapter two do not support self-reported findings of an interview study (n=1,200; Webb & Eves, 2007a). Webb and Eves (2007a) suggested that messages outlining specific health outcomes might be more motivating than more general statements. In line with the Theory of Planned Behaviour (TPB) (Ajzen, 1991), a person's attitude towards behaviour derives from their positive or negative evaluation of performing it; a positive evaluation results in higher motivation (intentions) to perform the behaviour (Orbell & Sheeran, 2002). Intentions are the prime determinant of future physical activity behaviour (Hagger, Chatzisarantis & Biddle, 2002; Waumsley & Mutrie, 2011). Two previous studies conducted in train stations, however, also found that intervention success was reduced at higher traffic volumes (Olander, Eves & Puig-Ribera, 2008; Puig-Ribera & Eves, 2010), supporting the findings of chapter two. On the contrary, no interaction between pedestrian traffic and intervention was seen in a station using a shorter, simpler message (Ryan, Lyon, Webb, Eves & Ryan, 2011). Hence, more general, simpler messages may be more suitable for busy public access sites. A specific, complex message may be more motivating than a general, simpler message in settings where processing of the message is unlikely to be impeded by pedestrian traffic or time pressure.

Previous comparisons of messages also indicated that certain messages may be more motivating than others in different settings. As summarised beforehand (section 1.11.3.1), Kerr, Eves and Carroll (2001a [study 2]) and Andersen et al. (2006) reported that in a train and subway station during commuter periods, messages containing the phrase ‘save time’ were associated with significantly greater increases in stair climbing than generic health-based messages. Kerr et al. (2001a [study 1]) positioned the same messages in a shopping centre, where people are unlikely to be pressured by time, and reported equivalent effects for both. Whilst these studies did not compare the issue of message specificity, findings imply that messages may have differential success in different settings. Thus, future research should explore whether specific messages are more motivating than more general messages in alternative settings. Further studies should also attempt to distinguish between the issue of message specificity, complexity and length.

6.1.2 Weight Control Messages

Findings from chapters three to five demonstrate that specific weight control messages, about calorific expenditure especially, are associated with significant increases in stair climbing in public access and workplace settings. Only two studies in public access settings, that is a train station and shopping centre, (Olander et al., 2008; Webb & Cheung, 2010, respectively) and three studies within the workplace (Eves, Webb & Mutrie, 2006; Eves, Webb, Griffin & Chambers, submitted; Olander & Eves, 2011a) have used a calorific expenditure message; each reported increased stair climbing following installation of the message. The results of chapters three to five support these previous findings, suggesting it is rewarding theme for stair climbing interventions.

The weight control messages may have been successful for two reasons. Firstly, they specified the amount of stair climbing needed to achieve the outcome and emphasised an outcome that was attainable from climbing one flight of stairs, as well as climbing the stairs regularly. This emphasised an achievable task, i.e. one flight of stairs, as well as maximising the gain when climbing them regularly. In line with the TPB, positive outcomes of an achievable behaviour result in greater intentions to perform it (Azjen, 1991). Secondly, given the current obesity epidemic and increased health promotion surrounding it (e.g. the Change4Life Campaign), individuals may have been seeking achievable ways to manage their weight. These message prompts informed individuals of an immediate way to increase their activity levels and expend energy, whilst overcoming barriers to engage in activity such as limited time and dislike of sport/exercise (Health Survey for England [HSE], 2008).

The findings of chapter four also demonstrate that a message, highlighting the specific calorific consequences of stair climbing, can encourage stair climbing amongst individuals coded as overweight; a population group who are likely to benefit from increased lifestyle activity. Pre-intervention, normal weight individuals climbed the stairs more than overweight individuals (OR=1.94, 95% CI=1.47-2.55, p<.001). In the final intervention stage this trend was reversed, such that more overweight than normal weight individuals climbed the stairs (OR=0.79, 95% CI=0.68-0.92, p<.01). Similar success amongst overweight individuals is reported by Webb and Cheung (2010) and Eves et al. (2006). Webb and Cheung (2010) installed stair riser banners in a shopping centre that each displayed the same message outlining a specific weight control outcome of stair climbing (n=20,807). Post intervention, overweight individuals had larger increases in stair climbing than normal weight individuals (+1.7%; OR=1.95, CI=1.34-2.83 and +1.2%; OR=1.29, CI=1.09-1.53, respectively). Further, after installing messages about the specific heart-health and weight control outcomes achievable from stair climbing, in a workplace, Eves et al. (2006) reported larger intervention effects in overweight individuals (+5.4%; OR=1.33, 95% CI=1.16 1.52, $p<.001$) than in the normal weight (+2.5%; OR=1.12, 95% CI=1.02-1.23, $p=.02$). Together, these findings suggest that stair climbing is an appealing lifestyle physical activity that overweight individuals are willing and able to engage in. Hence is should be encouraged as part of daily living. Further, prompts containing specific health outcomes are an effective tool for changing behaviour.

6.2 Understanding the Tools of Effective Behaviour Change; Multi-Component Interventions

Chapters three to five sought to understand the theoretical mechanisms underpinning point-of-choice prompts and assess the success of utilising a multi-component intervention in public access (chapters three and four) and workplace (chapter five) settings. Two intervention approaches to behaviour change exist. Motivational interventions aim to change attitudes and hence motivation towards being more active, such as mass-media campaigns (e.g. the Change4Life Campaign). Volitional interventions, based on planning and implementation intentions, aim to translate intentions into behaviour (Gollwitzer & Sheeran, 2006; Milne, Orbell & Sheeran, 2002). Point-of-choice prompts are akin to volitional interventions; appropriately worded and positioned prompts are likely to remind individuals of their prior intention to be active and present an immediate means of fulfilling it. As exposure to a prompt is brief and most likely an incidental part of one's journey, they may be insufficient to change intentions to be active, thus alternative strategies may be required to do so. Furthermore, the combination of both behavioural change approaches may have greater results upon stair climbing than using point-of-choice prompts alone.

The studies reported in chapters three to five used a multi-component intervention rather than a conventional point-of-choice prompt alone. Recent interventions within the workplace successfully used this approach (Eves et al., 2006; Eves et al., submitted; Olander & Eves, 2011a), however it has not been tested in public access settings. The multi-component intervention used in the studies presented in this thesis contained two main components; a conventional point-of-choice prompt (volitional component), which aimed to translate prior intentions into actual behaviour and an extended message designed to target attitudes (motivational component). The motivational component was positioned after the choice of ascent method was made, providing individuals with a 'take-away' message about the specific benefits that could have been achieved by choosing the stairs.

The findings reported in chapters three and four are part of the same study (see section 3.8). Overall, this study investigated the single and combined effects of a volitional and motivational component of a stair climbing intervention in a tram station. Following baseline, a volitional component was positioned alone and then supplemented with a motivational component. There was no change in stair climbing following the volitional component alone. Only the later addition of the motivational component was associated with an increase in stair climbing (chapters three and four). As reported in chapter three, following removal of all intervention components, the single and combined effects of each component were further investigated in a cross-over design; the motivational component was positioned alone and then supplemented with the volitional component. Reversing the order in which the components were installed tested whether a motivational component alone was able to increase stair climbing or whether the volitional component at the bottom of the climb was needed. Data revealed that, in a setting where choosing the stairs resulted in a time delay for pedestrians due to the site layout, there was no change in stair climbing when either component was positioned alone. Stair climbing only increased when both components were used together.

Whilst the previous multi-component interventions conducted in the workplace did not investigate the single and combined effects of these components (Eves et al., 2006; Eves, et al., submitted; Olander & Eves, 2011a) findings of the study presented in chapters three and four suggest that a multi-component intervention may be more successful than using point-of-choice prompts alone. Considering the roles of each component, it is possible, through targeting attitudes, that the motivational components may have increased intentions to be active, which were subsequently converted into behaviour when the point-of-choice prompt was next encountered. This multi-component approach could provide new insight into stair climbing interventions and should be tested further, and in alternative settings.

The study presented in chapter five was based upon the inconclusive findings of Olander and Eves (2011a), who attempted to compare the success of motivational and volitional components of a stair climbing intervention within the workplace. The motivational intervention component was displayed for one-day at a stand encouraging stair climbing which formed part of a health information day (Workplace Wellbeing Day) on a university campus. Seven days after the Workplace Wellbeing Day, the volitional intervention component was positioned at the point-of-choice between the stairs and the lift(s) in four university buildings, where the behaviour was observed. No significant change in stage climbing following the motivational component was reported, however the addition of the volitional component was associated with increased stair climbing. Poor dissemination of the motivational component, however, led to an inconclusive result; only 3.2% of employees in the buildings being observed attended the location of the intervention, thus it failed to reach the target audience. Hence, in the study of this thesis (chapter five), the motivational intervention component was positioned inside the lift(s) of the buildings being observed to ensure it reached the target audience; the motivational component was positioned alone (5-days) and then supplemented with the volitional component (further 8-days). The motivational component, positioned alone after the choice of ascent method had been chosen, did not increase stair climbing. When a volitional component was added, that is point-of-choice prompts were placed at the time and place where individuals chose their method of ascent, stair climbing increased significantly. This finding suggests that visibility of a prompt at the time the choice of ascent method seems necessary to change actual behaviour.

It is possible that the motivational component alone failed to change stair climbing behaviour as the actual context where a person decided which method of ascent to take remained the same. Thus automatic habitual behaviour of choosing the lift rather the stairs remains uninterrupted. As defined by Verplanken and Aarts (1999), habits are *"…learned sequences of acts that have become automatic response to specific cues…"* (p.104). Thus, a more appropriate way to alter actual behaviour is to change the context/situation in which the behaviour occurs (Kerr et al., 2001b; Holland, Aarts & Langendam, 2006; Jager, 2003; Wood & Neal, 2009). Unlike the motivational components used, similar to implementation-intentions, point-of-choice prompts change the context where the behaviour occurs, provoking individuals to consciously consider their method of ascent and present an immediate opportunity for individuals to act upon their intentions.

In summary, whilst a motivational intervention targeting attitudes may increase a person's intentions to be more active, it may be unable to change actual behaviour when positioned alone due to an established habit of taking the mechanised option rather than the stairs. Rather a point-of-choice prompt may be required to change the context where the behavioural choice is made to potentially translate prior intentions into behaviour.

6.3 Influence of Contextual Variables

6.3.1 Pedestrian Traffic

Findings of each study (chapters two to five) suggest that choice of the stairs is influenced by pedestrian traffic such that the higher the traffic flow, the greater the proportion of people that took the stairs. This moderating effect of pedestrian traffic upon pedestrian behaviour is consistent with previous work in public access settings; pedestrians appear to respond differently to interventions during differing levels of traffic flow (Eves, Lewis & Griffin, 2008; Webb, Eves & Kerr, 2011). Findings of chapter two do not support the proposal that messages presenting specific outcomes will be more motivating than those presenting general outcomes (see Webb & Eves, 2007a). As highlighted in section 6.1.1, pedestrian traffic interacted with the intervention, thus it appears that the efficacy of a more specific, complex message was reduced at higher traffic volumes. In chapters two and three, it is reported that the impact of traffic had a larger magnitude of effect than the intervention. In each of these studies, pedestrian traffic represents a potential source of variation in stair climbing. Thus, in studies of this design, inclusion of traffic (as well as the other contextual variables to be discussed) in analyses sets to avoid effects of contextual variables that might change independently of the intervention. Further, it suggests that the context in which the intervention is conducted should be considered during intervention design.

6.3.2 Time Pressure

A possible explanation for the effects of pedestrian traffic is time pressure; when the escalator and lift is full or unavailable, some passengers avoid delay by opting for the stairs. In the study presented in chapters three and four, people were more likely to climb the stairs earlier in the morning (08:00-08:59) than later (09:00-09:59). In chapter five, more people in the workplace climbed the stairs in the afternoon (14:15-16:15) than the morning (08:15-10:15). The mean centring of data in chapters three and four enabled consequences of time of day to be assessed unconfounded by differences in overall traffic volume. These findings suggest that people respond differently to an intervention at different time points, consistent with previous research (Eves & Masters, 2006; Eves, Masters et al., 2008; Eves, Olander, Nicoll, Puig-Ribera & Griffin, 2009; Olander & Eves, 2011b). As time of day represents a potential source of variation in stair climbing, different message content may be required during different stages of the day to encourage regular stair climbing. For example, when people are less pressured by time and do not seek the quickest option of ascent, message content may need to be more persuasive to encourage stair climbing. In line with the TPB (Ajzen, 1991), the positive consequences of performing the behaviour need to outweigh the negative consequences if a change in behaviour is likely to occur.

6.3.3 Site Layout

The findings presented in chapter three demonstrate how site layout might negatively influence a person's choice of the stairs. At this site, the stairs were positioned 16.5 metres behind the foot of the escalator and were also wrapped around a lift block. Follow-up observations identified that the time from leaving the tram to reaching the top of ascent via the stairs (mean 50.3 seconds, 95% CI=47.8-52.8) was much slower than that of a nearby station of the same height where stairs and the escalator were adjacent and straight up (mean 21.3 seconds, 95% 20.0-22.5). Hence choosing the stairs in this setting resulted in a time delay for the traveller. Consistent with previous work (Eves et al., 2009; Kerr et al., 2003; Webb & Eves, 2007b), additional time and distance to reach the stairs, compared with the mechanised option, may act as a barrier to stair choice. Unlike previous interventions within public access settings (see Nocon, Müller-Riemenschneider, Nitzschke & Willich, 2010), a point-of-choice of prompt alone was not associated with increased stair climbing. It was only when both the motivational and volitional components were positioned together that stair climbing increased; the extended message that aimed to target attitudes, informed pedestrians of the potential gain from climbing just one flight of stairs, that is it maximised the gain whilst minimised the cost. Future research should seek alternative settings where methods of ascent are adjacent to assess the magnitude of the effects of each component alone. As discussed in detail below (section 6.4.2), none of the sites that assessed the impact of multi-component interventions within the studies of this thesis (chapters three to five) had adjacent methods of ascent.

Findings of chapter five suggest that building characteristics were also influential upon stair choice in the workplace as anticipated; the higher the building and the greater number of lifts, the less likely people were to take the stairs. Recent research has reported similar associations (Olander & Eves, 2011a, b). Thus, it is important to consider the impact of site design when designing interventions to increase stair climbing; messages may need to be specific to counteract contextual barriers that cannot be modified.

6.4 Strengths and Limitations

Each chapter presents its own strengths and limitations. This section highlights the core issues, alongside additional suggestions for future research.

6.4.1 Research Design

The studies presented in this thesis (chapters two to five) were uncontrolled quasi-experimental, interrupted time-series designed studies; the method of ascent chosen by individuals was observed before and after the intervention(s) was installed. The absence of randomly allocated control sites make it difficult to assess whether the observed changes in stair climbing behaviour were due to the intervention or whether they occurred due to other spontaneous sources and bias. Only associations between the intervention and the change in behaviour, and their potential impact, can be reported by the studies presented in this thesis. To assess the true effectiveness of point-of-choice prompts as a tool to change stair climbing behaviour to help influence health-care practices and policy, a randomised controlled trial (RCT) should be considered; as sites are randomised to intervention or control status, this would reduce the likelihood of bias. No RCTs assessing the effectiveness of point-of-choice prompts for stair climbing have been conducted. This should be a key aim of future stair climbing research.

Stair climbing RCTs should be conducted in both public access and workplace settings due to the different setting-dependent factors, such as whether the choice of ascent is between an escalator or a lift (Eves, 2008; 2010; Nocon et al., 2010; Soler et al., 2010). Changes in the proportion of people climbing the stairs post-intervention would be the primary outcome, with changes at follow-up time-points as secondary outcomes to assess the maintenance effects. Important considerations, however, would need to be made. The impact of stair climbing interventions appears to vary according to the message used, that is whether a general or specific outcome of the behaviour is presented (Webb & Eves, 2007a; also as summarised in the Introduction, section 1.11). The optimum period that an intervention should be displayed has not yet been investigated. Finally, as indicated in chapter four, different population groups may respond differently to different interventions. A known disadvantage of RCTs is their external validity.

Whilst the absence of a control site was a limitation of this work, there is reduced likelihood that the changes in stair climbing behaviour reported were due to spontaneous sources and bias. In study one for example (chapter two), the site layout meant that different messages could be simultaneously compared, that is one message was positioned on one platform and the other on a separate platform. Thus, a potential confound of prior intervention history was avoided. Further as trains at this station arrived from the same locations daily, it was unlikely that passengers were exposed to both messages; intervention contamination was reduced. In chapter three, a change in stair climbing was reported when both intervention components were installed but not when only one was installed, which occurred twice in the cross-over design. Further, in study three (chapter four), an increase in stair climbing was only observed in individuals coded as overweight. If factors other than the intervention were responsible for the change in behaviour then one would have expected to see increases in both groups.

In addition, one strength of this work was that, unlike much of the early stair climbing research (e.g. research conducted prior to Kerr et al., 2001a – see Nocon et al., 2010 for details), regression analyses adjusted for potential moderators of behaviour such as pedestrian traffic, gender, time of day and building characteristics, e.g. height and number of lifts. Similarly, excellent inter-observer reliability scores in the studies (average kappa >0.94) when recording demographic data such as gender and weight status reduce the likelihood of classification bias.

6.4.2 Generalisation of Findings

Another potential limitation of this research is whether results are generalisable to alternative settings; the studies in chapters two to four were only each conducted in one site. Results of chapter two suggest that messages with general, simple content may be more appropriate for busy sites or at least where pedestrian traffic is pulsatile in nature, that is large amounts of people are exiting the 'station' at the same time-point as they depart each train. It is unclear, however, whether similar effects would be seen in a less-busy site, or at sites whereby traffic is less pulsatile, e.g. a shopping centre or workplace; a more specific, complex message may have heightened efficacy in a setting where people have the time and ability to adequately read and process the message. As no other study has simultaneously compared the effects of two messages differing in specificity, it is not possible to compare findings.

Further, in the study of chapter three and four, the stairs at this public access site were positioned behind the escalator, which resulted in a time delay for pedestrians who chose the stairs. These findings may not apply in settings where the choice of ascent methods is adjacent; the impact of both the single and combined components upon stair climbing may vary. None of the sites used to assess the impact of multi-component interventions within this thesis (chapters three to five) had adjacent methods of ascent. Therefore, findings of chapter five support those of chapter three, and a previous study (Olander & Eves, 2011a) in that a motivational component alone was unable to change stair climbing behaviour. Thus similar results have been seen in the workplace and public access settings.

In addition, the intervention message used for the study presented in chapters three and four was site specific as it detailed the possible calorific consequences of climbing that particular set of stairs, which was based on the distance walked to the stairs and the height of the climb. Thus, the success of this message may not generalise to settings where the height of the stairs is lower; the calorific consequences of climbing the stairs would be less and so may be less motivating. In contrast, where a flight of stairs is higher and therefore expends more energy, the message may be more motivating. Thus, the impact of this message where stair height differs would be insightful; to change attitudes and intentions to be active, individuals need to believe that the outcomes of performing the behaviour are positive (Ajzen, 1991).

Finally, observations for chapters two to four were conducted between 08:00 and 10:00 on weekdays, thus effects during other time-points and at weekends within these travel/commuter settings, is unknown and may vary. Point-of-choice interventions have been shown to increase stair climbing during an evening commute (16:00-18:30; Ryan et al., 2011), however non-commuter times have not been investigated. A previous study reported that more people walked up a travelator during the week, when they were most likely required at work, than at the weekend, when they were most likely travelling at their own leisure (Eves & Masters, 2006); further research should investigate the issue of time of day and weekday versus weekend. Different interventions may be required accordingly.

6.4.3 Maintenance of Behaviour Change

Another possible limitation of this work was the lack of follow-up measures. It is not known, therefore, whether the increased levels of stair climbing reported in each chapter, were maintained and if so, for how long. As noted in chapter four, investigating the long-term impact of interventions was not the aim of these studies. That being said, in chapter three all intervention components were removed for a four-week period prior to reinstalling them; compared with the original baseline, stair climbing levels remained significantly elevated, which suggests that successful interventions can result in maintained behaviour change, albeit only for four weeks. Where follow-up measures have been included at sites where the choice of ascent is between stairs and an escalator, that is public access settings, higher rates of stair climbing relative to baseline have been seen between 1-and 12-weeks after the end of an intervention (Andersen et al., 2006; Blamey, Mutrie & Aitchison, 1995; Brownell, Stunkard & Albaum, 1980; Coleman & Gonzalez, 2001 [airport & bank sites]; Iversen, Handel, Jensen, Frederiksen & Heitmann, 2007; Kerr et al., 2001b; Puig-Ribera & Eves, 2010; Ryan et al., 2011; Webb & Eves, 2007c), but not at two-years (Iversen et al., 2007). The only known study to conduct follow-up measures where the choice of ascent is between the stairs and a lift(s), that is a workplace, reported increased levels of stair climbing relative to baseline only for women, 4-weeks post intervention (Coleman & Gonzalez, 2001 [office site]). Studies in both public access and workplace settings should, therefore, investigate whether the effects of a short-term stair climbing intervention can be maintained and for how long and whether they indeed result in the formation of new habits. Following from this, it would be important to investigate the ideal duration that interventions are displayed for and whether they cease to change behaviour after a prolonged display period. Do messages perhaps need to be changed to regularly encourage people to use the stairs?

Webb and Eves (2007b, c) investigated whether exposure to a prompt at one set of stairs in a shopping centre, influenced stair use at another set of stairs where there was no prompt, within the same public access building. In both studies, an increase in stair climbing was reported at a subsequent set of stairs. So, whilst there is limited research surrounding the long-term impact of stair climbing interventions, it does appear that prompts may encourage a change in habitual behaviour. This generalisation effect has not been tested within the workplace where people may be journeying from floor to floor, which could easily be investigated by monitoring stair use on another staircase where no prompt is placed. Further no studies have investigated whether prompts in one location/building will have effects in another location/building.

6.4.4 Demographics

A key strength of study three (chapter four) was the recording of pedestrian weight status via standardised measures. This identified that prior to intervention, individuals coded as normal weight chose the stairs more than overweight, as previously identified (Andersen, Franckowiak, Synder, Bartlett & Fontaine, 1998; Brownell et al., 1980; Eves et al., 2006; Webb & Cheung, 2010). This supports the notion that interventions to increase activity should target overweight/obese individuals. More importantly, the interaction between intervention and weight status showed that overweight individuals responded differently to the intervention than normal weight individuals, similar to previous research (Andersen et al., 1998; Eves et al., 2006; Webb & Cheung, 2010). Research also indicates that the old, ethnic minority groups and people with large bags and/or children climb the stairs less than their counterparts (Nocon et al., 2010; Soler et al., 2010; Webb et al., 2011). So these population groups may also respond differently to interventions. Due to limited observer resources, however, demographic details such as ethnicity, age, the presence of large luggage and children were not recorded in any of the studies. Whilst a recent systematic review of stair climbing interventions found no differential response to intervention between racial groups (Soler et al., 2010), responses between the other groups remains unclear and future research should assess this.

6.4.5 Number of Observations Recoded

Finally, a key strength of this work is the large number of observations. Using data from a recent systematic review of stair climbing interventions (see Nocon et al., 2010), the calculated median number of observations from studies whereby the choice of ascent was between stairs and an escalator was 32,340 (n=18; range 1,779 to 94,967). The median number of observations presented in chapters two to four, which are public access interventions, was 38,187 (range 23,121 to 48,697). Further, the calculated median number of observations when the choice was between a lift and the stairs, was 13,138 (n=11; range 2,050 to 62,732 [see Nocon et al., 2010; plus Eves et al., submitted; Olander & Eves, 2011a) the median number of observations for the workplace study in chapter five was 14,138. Of note, the calculation for choice between lift and stairs excluded one large workplace study (Marshall, Bauman, Patch, Wilson & Chen, 2002; n=158,350) as automated counters, rather than persons, were used to record observations 24-hours a day, seven days per week for the total duration, thus is not comparable to the other studies whereby selected time periods and days were observed.

6.5 Implications of this research

The data presented in chapters two to five show that point-of-choice prompts are associated with increased stair climbing in public access and workplace settings. Intervention success within the workplace is particularly promising given the previous failings of interventions within this setting. As individuals spend around half of their waking day at their place of work (Dishman, Oldenburg, O'Neal, & Shephard, 1998) and most buildings have staircases, the workplace is a worthy setting to encourage stair climbing. Similarly, public access settings such as commuter contexts where people regularly visit, offer great potential; based on an average five-day working week and allowing six weeks per year for annual leave, it is possible that commuters could travel through the same station 230 days each year (Eves et al., 2009). Thus, both these settings have large reach, which is promising for public health gains.

Increased physical activity and weight control are two major public health goals. Regular stair climbing has important health implications. Experimental findings show that accumulated bouts of stair climbing have been linked with significant cardiorespiratory fitness and cholesterol profile (Boreham, Wallace & Nevill, 2000; Boreham et al., 2005). Yu and colleagues (2003) also reported that the equivalent of seven minutes per day of stair climbing could reduce the incidence of coronary heart disease amongst men by 63% (Yu, Yarnell, Sweetnam & Murray, 2003). Further, an 80 kilogram man climbing a standard three metre flight of stairs an additional ten times a day would expend around 28 kilocalories per day, that is equivalent to three pounds of fat or four days worth of food (Olander & Eves, 2011a).

As stair climbing is a lifestyle activity it overcomes key barriers to engaging in activity, such as limited time, unlike other forms of exercise. Thus, interventions that can encourage regular use of this stairs in settings where people spend large amounts of time are a valuable public health tool. A recent systematic review identified that 31/40 interventions using point-of-choice prompts reported significant increases in the prevalence of stair climbing (Nocon et al., 2010). Research has also shown that point-of-choice prompts in public access settings can increase stair use at a subsequent choice point within the same building where signs are not present (Webb & Eves, 2007b, c). Thus, the population levels of increased physical activity could be greater than these studies have revealed.

An important implication for health promotion is that these interventions are inexpensive to produce and install. Olander and Eves (2011a) compared the success and cost of two stair climbing interventions at a UK university: a stand providing health information about stair climbing as part of a Workplace Health Wellbeing Day and point-of-choice prompts positioned in four buildings. No significant change in stair climbing was reported following the Workplace Wellbeing Day, whereas the point-of-choice prompts were associated with a significant increase in stair climbing. The point-of-choice prompts were 25-times cheaper than the Workplace Wellbeing Day; at a cost of $0.05 per employee working in the four buildings (n=693), they appear a cost-effective and practical way to encourage stair climbing (Olander & Eves, 2011a).

6.6 Conclusion

This thesis aimed to assess the success of point-of-choice prompts as a tool for changing stair climbing behaviour and tested the theoretical underpinnings behind their success. The data presented in chapters two to five show that point-of-choice prompts are associated with increased stair climbing in public access and workplace settings. Specifically, findings indicate that message content influences intervention success. Where feasible, messages should specify the outcome of an achievable behaviour to encourage regular stair climbing. In particular, calorific-expenditure messages appear a rewarding theme and were associated with increased stair climbing in overweight individuals, which is encouraging given the current obesity and physical inactivity crisis.

Furthermore, findings suggest that extended messages targeting attitudes (motivational components) can enhance the impact of conventional point-of-choice prompts (volitional components). The ability of a motivational component alone to change actual behaviour, however, does not appear promising. Thus, when competing forces of established habits and other distractions faced en-route to a destination exist, point-of-choice prompts may be required to change actual behaviour. Finally, in non-RCT studies, during analysis, investigators should adjust for potential moderating effects of pedestrian traffic, time of day, demographics and building characteristics; a failure to do so may mask the true impact of the intervention.

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CHAPTER SEVEN

APPENDICES

7.0 Appendices

Appendix 7.1 Positioning of a point-of-choice prompt and example of intervention posters (link chapter 2)

Figure 7.1: A point-of-choice prompt in position.

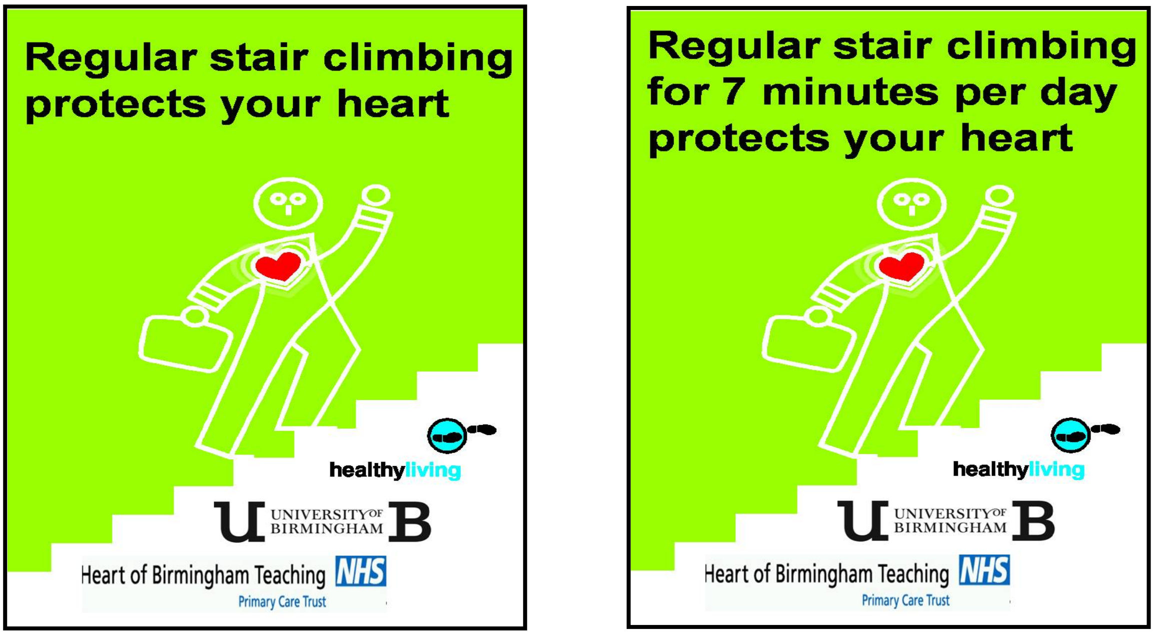

Figure 7.2: Example of the simple (left) and complex (right) intervention poster.

Appendix 7.2 Positioning and example of volitional and motivational intervention components (link chapter 3).

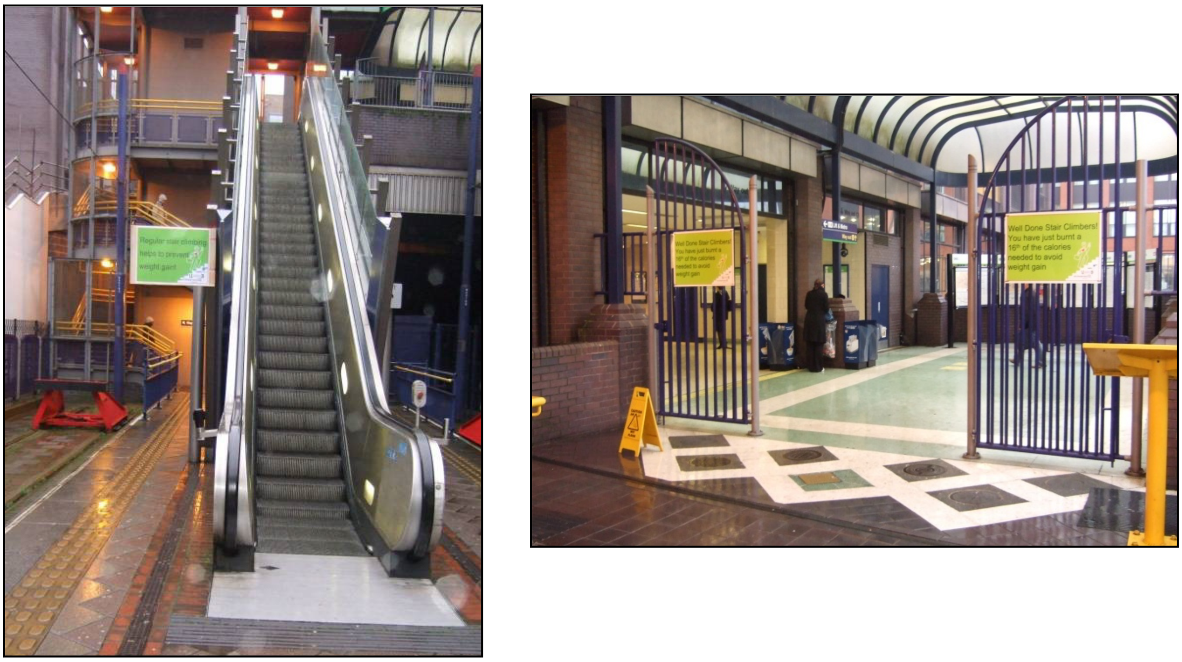

Figure 7.3: The volitional (left) and motivational (right) intervention components in position.

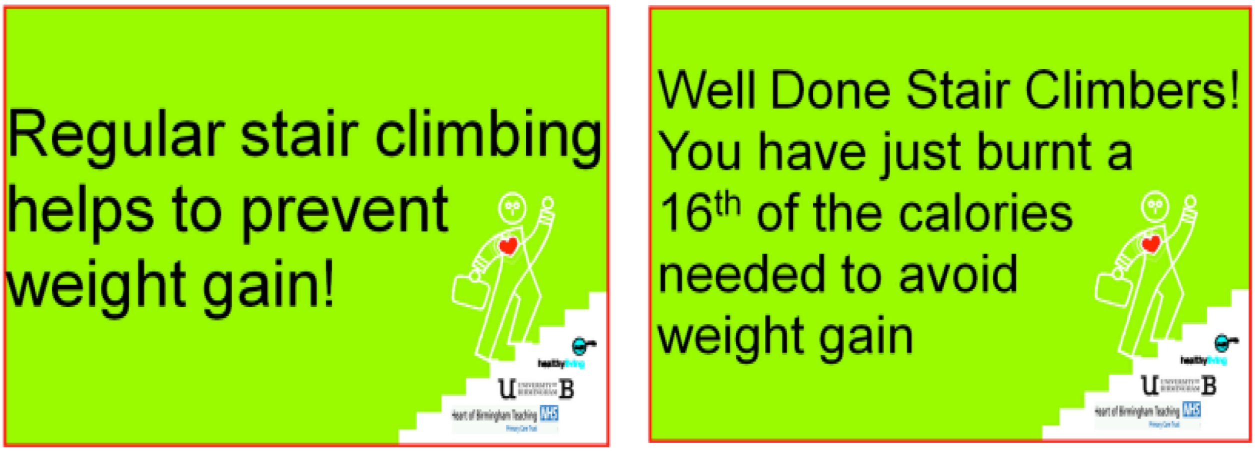

Figure 7.4: Example of the volitional (left) and motivational (right) intervention poster.

Appendix 7.3: Silhouettes for coding of weight status (link chapter 4).

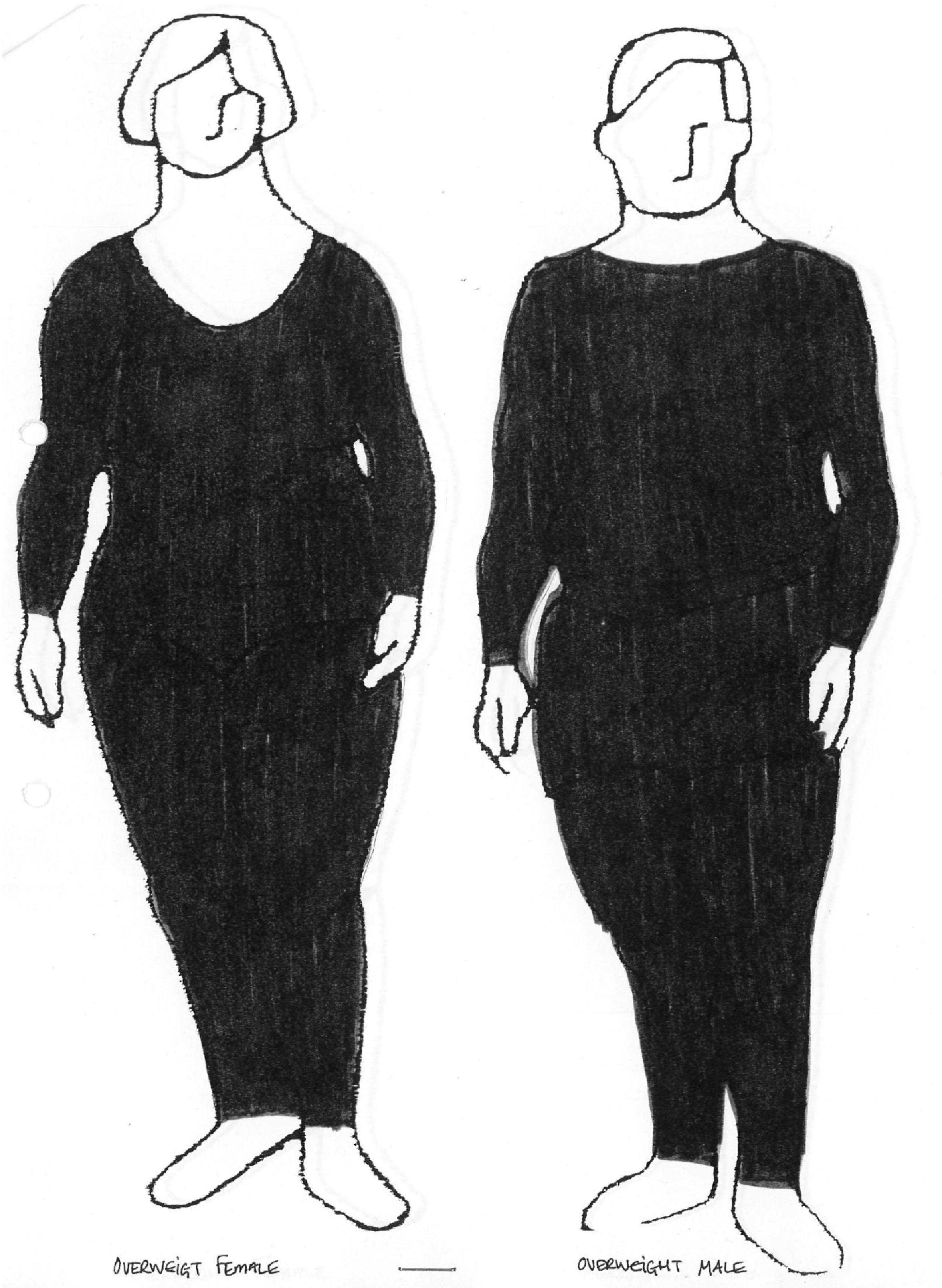

Figure 7.5: Example of the silhouettes used for coding overweight individuals.

Appendix 7.4: Positioning and illustrations of motivational and volitional intervention components (link chapter 5).

Figure 7.6: Illustration of the motivational intervention positioned inside the elevator (i.e. stage 2).

Figure 7.7: Illustration of the volitional intervention (i.e. stage 3, a point-of-choice prompt and additional signs by the external elevator control panel).