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Shaping pedestrian movement through playful interventions in security planning: what do field surveys suggest?

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ABSTRACT

The control and shaping of pedestrian movement recurs as an aspect of security planning for crowded spaces. Using the concepts of *triangulation*, *performance* and *flow*, this paper presents a series of experiments designed to shape pedestrian movement patterns in public spaces in different spatial and operation contexts, by eliciting noticeable behaviours and disrupting routine use of space. The hypothesis investigated is that playful, non-obstructive interventions foster a positive social experience yet can be used to shape pedestrian movement. The interventions examined were around the themes of floor marking and mirrors. Analysis demonstrated that the interventions were able to create zones of attraction and exclusion, engage people's curiosity and elicit playful actions. Habituation, goal-directed behaviour and the influence of increased cognitive load at personal level were all important factors responsible for reducing the level of engagement with an intervention. The results suggest that increased understanding between environmental and interpersonal stimuli and behavioural responses can provide guidance in using socially acceptable design interventions to influence use of space in different operational contexts, contributing to sustainable security.

Introduction

Design can play a strategic role in altering the flow and shaping pedestrian movement in a space across different scales. Such strategies are considered desirable for a range of purposes from commerce and entertainment to security. The fields of art, architecture and human-computer interaction can provide a broad palette of potential interventions for this aim. This paper presents a series of experiments designed to shape people flow and pedestrian movement in various types of public spaces, in a positive social context for security planning in counter-terrorism. It investigated the hypothesis that playful, non-obstructive interventions foster a positive social experience yet can be used to alter pedestrian movement.

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Security design for public space includes consideration of a wide range of potential elements from landscaping, gateways and buildings, to barriers, crowd control, sculpture, furniture and materials, to signage, smart architecture, games and advertising, to police tactics, performance and social stakeholder norms. These can be further divided into either permanent or temporary interventions.

There is a growing emphasis on the role of design in counter-terrorism policy and research for public spaces. The UK planning process now requires evidence of counter-terrorism security design for new projects (RIBA 2010). At the same time, there has been an increasing recognition that reduction of fear, and in particular community acceptance and comfort, must play a primary role in counter-terrorism policy, and design practice in particular, if it is to be effective and sustainable (Braithwaite 2013). Permanent interventions have progressed significantly in this respect, with a shift from often alarmist and ad hoc 'strong-arm tactics' to architecturally sympathetic and socially acceptable design interventions.

Unfortunately, too frequently counter-terrorism design interventions have resulted in hastily retrofitted target-hardening or ad hoc solutions focusing on extensive attempts to disrupt covert terrorist activities, with little consideration for the resulting public realm, openness of the space and social interaction. Target hardening is visible in the construction of the 'ring of steel' fortifications, around the City of London following the Bishopsgate bombing in 1993 (Coaffee, O'Hare, and Hawkesworth 2009) and in the sunken paths encircling the Washington Monument, Washington DC (Benton-Short 2007). Such authority-focused responses can be disorientating and threatening for the general public, diminishing the quality of experience of a space (Benton-Short 2007). Furthermore, the proliferation of security bollards and barriers has caused detrimental impact to the quality of the space in many urban environments (FEMA 430 2007), leading to what the National Capital Urban Design and Security Plan for Washington referred to in 2002 as the "present intolerable environment" (NCPC 2002, 5).

Petroski's exasperation with the above situation is reflected in a paradigm shift with evidence that:

> … architects and engineers have been rising to the occasion and recapturing public spaces from ugly Jersey barriers, unattractive metal detectors, and other oppressive obstructions of virtually no design value. (Petroski 2004, 166)

Indeed, recent strategies for securing public space have shifted from such overt security measures to less conspicuous responses such as the manipulation of form, materials and configuration to create spaces, spatial features and street furniture that intend to influence people's movement and emotional state (Adey 2008; Coaffee, O'Hare, and Hawkesworth 2009).

In comparison to permanent architecture and built environment policy, temporary interventions have lagged behind. Analysis of existing counter-terrorism strategies for temporary interventions in public space highlights an overemphasis on a small palette of authority-focused approaches. However, a wider palette of socially acceptable interventions is required for long-term sustainable effectiveness (Martin, Dalton, and Nikolopoulou 2013). Here, this paper focuses specifically on testing temporary interventions for shaping pedestrian flow.

The emphasis on design is highlighted in a recent Home Office report (2012) which provides advice on how to integrate such measures at different stages, from conception to development so that "… vulnerability of crowded places to terrorist attack can be tackled

in an imaginative and considered way" (Home Office 2012, 3). This last point is critical if we are to develop and manage public spaces in way that will not have a detrimental effect on the quality of the public realm, but will be socially responsive, enhancing a sense of vitality and well-being.

This paper focuses on the above dilemma, investigating whether it is possible to shape pedestrian movement in public spaces, in what the Home Office aspire to be an *imaginative* and *considered* way, applying effective uses of disruption while being socially responsive, fostering corresponding routine and comfort. This is done employing the concepts of 'triangulation', 'performance' and 'flow', as suggested by Martin, Dalton, and Nikolopoulou (2013), to describe the desired effects of disruption in the current publicly visible counter-terrorism measures. The first section of this paper provides an overview of the literature on aspects of pedestrian movement flow that are currently employed in counter-terrorism strategies. This informed the approach here. The interventions are described in the second section, with the analysis and findings described in the third section. The final section highlights the conclusions drawn from this work.

Effects of disruption in publicly visible counter terrorism

The manipulation of the built environment for social change has been extensively explored at different scales extending the concepts of 'natural surveillance' from Jacobs (1961) and Newman (1972) to the context of counter-terrorism (Secured by Design 2011). Such 'natural policing' (Hillier 2004) is at the core of crime prevention through environmental design (CPTED), which has been employed globally (Cozens, Saville, and Hillier 2005) with the goal of reducing both fear and incidence of crime. Natural surveillance can be linked with social resilience, as increasing social cohesion and connections is identified as a means of augmenting social resilience (Durodié 2004). Indeed, researchers have highlighted the synergies between CPTED and urban sustainability (Du Plessis 1999; Cozens 2002), however, understanding how to achieve this social resilience is challenging.

Triangulation (Whyte 1988), the process that provides a linkage between people and the stimulus for strangers to talk to each other, can be understood as a temporary disruption of a state of 'civil inattention'. In counter-terrorism strategy, reducing civil-inattention acts to heighten opportunity for identifying and reporting of unusual activity of a potential hostile actor, or an unexpected item in a public space. This concept provides a framework to understand existing counter terrorism signage, announcements and security, and begins to suggest the ways in which alternative design approaches could support heightened awareness and reporting.

Numerous examples from art and advertising illustrate how temporary, playful interventions can increase social connections, encourage social interaction and raise engagement with public space (Lozano-Hemmer 2001; thefuntheory.com, 2009; Martin, Dalton, and Nikolopoulou 2013). This provided the informed background for a series of interventions to be employed that can influence movement patterns.

Publicly visible counter-terrorism interventions are often intended to evoke *performances* from people in a space (Edwards 2010) in an attempt to raise levels of discomfort. The goal of this type of intervention is to elicit behavioural cues that help security staff identify people who have something to hide. A visible security regime to 'deter, detect and delay' can play an important role in deterring suspicious terrorist activity, including hostile reconnaissance

(Home Office 2012). Initiatives such as BASS (Behaviour Analysis Screening System) in the UK and SPOT (Securing Passengers by Observation Techniques) in the US train security staff to try to identify suspicious behaviour and body language in response to temporary, high-visibility disruption of spaces such as temporary cordons and high visibility patrols (Coaffee et al. 2008). The queue and search routines of the archway metal detector are some of the various security interventions that require pedestrians to *perform* in public view. For someone conducting hostile reconnaissance, the deterrence seems to lie in the performance of normality that these interventions require of them.

In the context of deterring hostile reconnaissance, design and art can create physical examples of unexpected playful disruption or a heightened sense of being on view. Such design concepts are not only useful for stimulating triangulation but can also be effective at encouraging performance from audiences.

Shaping the *flow* of pedestrian movement is an integral aspect of security planning for crowded spaces. Examples vary from physical barriers to shape crowd flow, particularly in airports, stations and sports events, to overt displays of security as a means of 'heating up' key locations (Stratfor 2010) to move potential hostile reconnaissance away from one area and into other areas where covert surveillance may be.

Physical and social characteristics of a space are inter-dependent, and changes to one element will elicit change in the other (Hillier and Sahbaz 2009). As an example, airport designers manipulate form, materials and configuration to elicit specific emotions and to direct passengers' movement around airport departure areas (Adey 2008).

Literature from criminology discusses how people carrying out crime develop a 'crime template' or idealized site for their criminal act and then try to match this location with places they already know or those that they come into contact with (Brantingham and Brantingham 1993). As a result, the ideal crime location is one where criminals are comfortable and feel that they fit in. By intervening at the point where situational aspects of covert activity converge, that is the times and places where the actors, location and opportunity for criminal endeavours overlap, the intended action can be interrupted (Cornish 1994).

In the context of security planning in public places, this suggests a particularly strong effect on flow for disruptions that heighten crowd pleasure for many, while reducing feelings of control over 'crime templates' for a few. Playfulness can be particularly effective in encouraging pedestrians to engage, whilst reducing feelings of personal control through disruption of routine for those with malicious intent.

In this framework using the concepts of *triangulation*, *performance* and *flow*, the aim of the study here was to design, install and evaluate a series of temporary interventions in public spaces of different types that can shape pedestrian movement pattern by eliciting noticeable behaviours and disrupting routine. This can be employed as a strategy to augment existing policing techniques for identifying people engaged in suspicious activities. In all cases, the interventions had to be able to win public support, which can be considered as vital for counter-terrorism in order to reduce public anxiety and increase social resilience and cohesion.

Design of interventions

The design of the interventions has built on existing work in the area of deception studies and counter-terrorism, borrowing vocabulary from the arts. Martin, Dalton, and Nikolopoulou

(2013) argued how a palette of art, advertising, architecture and entertainment projects offered examples of unexpected interventions that can heighten attention, disrupt planned routine and elicit noticeable behaviours. The Safer Spaces Design Guidelines (Triggs et al. 2012) advocate taking a design-led approach, drawing on designers' perspectives, processes and methods to develop site-specific, participatory processes that build on current research in counter-terrorism to create responses that are effective yet publically acceptable.

In choosing playful interventions to test, emphasis was placed on techniques that might dissuade or reveal signs of malicious activity in addition to shaping general pedestrian flow. Findings and methods from deception studies were adapted for the experiments. The potential for unanticipated questions to elicit noticeable responses in interviews has been discussed in literature (Vrij et al. 2009). This method was appropriated and the studies were designed to initiate unanticipated interactions and moments of public performance. The literature suggests that asking temporal questions when suspecting a scripted answer can help reveal deceptive responses. The analogy in physical space is shaping of crowd flow to expose temporary areas of high or low occupancy that in turn may highlight individual movement routines. The strategic use of evidence gathered from observations of typical movement patterns was used to decide the location of the interventions with the goal of zones of attraction. These zones aimed to encourage people to linger in areas where movement is normally flowing without pause.

Types of intervention

The hypothesis here is that playful, non-obstructive interventions foster a positive social experience yet can be used to shape pedestrian movement. With this hypothesis in mind, the aims of the interventions were to (a) alter the flow of pedestrian movement through a space, (b) create zones of attraction and exclusion within the space, and (c) engage people's curiosity and elicit playful actions. The first two of these aims intend to address the ability of interventions to shape pedestrian movement. The third aim addresses the ability of interventions to foster heightened awareness within a positive social experience. The design interventions were intended to be lightweight, low-cost and temporary, which could be installed for short periods of time as required.

Two categories of non-obstructive interventions were investigated, around the themes of floor markings and mirrors, in a range of spatial and situational contexts. Floor markings intervene in a space by changing the appearance of the ground. They were chosen as a suitable form of intervention as they can guide movement through a space or establish points of interest, yet do not physically impede pedestrian flow. Floor marks are regularly used in public spaces to assist direction to services (e.g. train platforms, lifts, taxis, etc.) or advertising. As it is not necessary for pedestrians to alter their movement path in order to pass through the space investigated, changes in behaviour in response to the intervention can be attributed to engagement with the intervention.

Mirrors were considered as a form of intervention that suggests the potential to catch and hold attention, and may also foster heightened self-awareness. Merleau-Ponty (1958) suggests that seeing reflections of oneself in the mirror is engaging yet alienating. Becoming a spectator of oneself is an illusory perception, which while often playful can be confusing at the level of emotions, universally unsettling and even a source of anxiety and fear in the context of heightened self-awareness (Rochat and Zahavi 2011). This unsettling experience has been explored in various experimental studies investigating deceit. Mirrors have also

been demonstrated to be a potential means to distinguish liars from truth-tellers in contained environments (Lawson et al. 2011, 2013).

Building on these findings, it was speculated that people trying to hide or disguise their activities would feel uncomfortable seeing their reflection in addition to the mirror surface acting to increase the likelihood of an intervention attracting the attention of passers-by, visually exaggerating change and movement in the space. Finally, mirrors offer the potential for altering movement flow through using the reflective surface to create playful and unexpected effects, evoking the spectacle of a hall-of-mirrors. By strategically placing mirrors in unanticipated locations people may slow down, or stop, to investigate. It was speculated that the sense of movement and change produced by this type of intervention would contribute to eliciting curiosity from passers-by.

Two floor-marking and one mirror experiments were integrated with deception studies to explore the effects of disruption, self-awareness and increased cognitive load on the behaviour elicited by the interventions. In the experimental studies, the general public were considered to be non-primed participants representing the behaviour of individuals with benign intentions. This revealed how the interventions fit into patterns of everyday behaviour and the types of response they elicit. The participants in the deception studies acted as primed participants and they were not aware of the link between the deception study and the interventions.

The hypothesis was that primed participants are involved with their task to such an extent that they are less aware of their environment or less willing to deviate from prepared scripts of activity, and therefore exhibit less playful behaviour than non-primed participants. This could then elicit noticeable differences in behaviour between those engaged in benign and suspicious activities.

Methodology

A number of studies were developed for each type of intervention between May 2011 and May 2012. Pilot studies were run for both types of intervention to assess their viability before installing them in more challenging public environments. It was essential for all the selected spaces to have a high footfall of transitory routes passing through the space while also containing a cross-section of pedestrian uses with longer dwell times.

In addition, all spaces were publicly accessible, whether privately or publicly owned.

Action research techniques enabled designing, implementing and analyzing interventions in an iterative cycle. Lessons learned and findings uncovered in one study informed subsequent experiments. Grounded theory analysis was used to reveal and construct hypotheses of how people respond to interventions in public space (Strauss and Corbin 1998).

Different methods of data analysis were employed. The researchers observing the spaces were taking structured notes, while they also used maps to record movement patterns and novel behaviours. Further analysis included video transcribing, along with automated video recording in order to sample over longer time periods. For the selection of the public spaces for the experiments, an essential criterion was that cameras could be positioned to capture top-down views of pedestrian movement. Researchers watched the video output and noted pre-selected behaviours, for example, direction of movement or pausing by the intervention. Spatial analysis of the movement and behaviour of passers-by enabled patterns of

movement to be visualized and indicated how passers-by chose to position themselves in relation to the intervention, which was supplemented by MATLAB image analysis. Heat-maps of space usage were derived from hand-mapped observations. This technique was extended through the use of computer vision tracking of pedestrian movement using the openCV library implementation of blobtracking. Averaging collections of movement trails and normalizing for the busiest section of the map generated heat-maps. Visualizing patterns in this way allows for analysis of space usage.

Questionnaires and surveys offered an additional method of data collection for three of the interventions. This provided further insights into the attitudes of passers-by to the space and respective interventions. The responses enabled highlighting the relationship between the properties of the space, the intervention and behaviour.

Experimental studies

Seven different experiments are presented with different types of floor markings and mirrors presenting the main interventions.

Floor-marking studies

Four different floor-marking interventions were designed, installed and studied in different operational contexts of increasing complexity.

Tapelines

A pilot study was carried out with a pattern created using tape on the floor on the campus at the University of Kent. The pattern was based on one of Paul Klee's drawings and covered an area approximately 8 m long. The design was composed of a tapeline in two contrasting colours, fluorescent pink and fluorescent yellow. This was to ensure visibility while minimizing the possibility for any confusion with tape used to indicate safety issues.

The tapeline was positioned to reflect the direction of pedestrian flow through the space. A path joins the area about halfway along the length of the line. The path is perpendicular to the line. The hypothesis was that people might change their existing path of movement and begin following the line. This response would be considered playful behaviour.

Tape maze

The next stage of floor intervention consisted of a maze design covering half the width of the corridor in Warwick Business School (WBS).[1] It was created out of black tape with pink tape feet at each entrance to the maze to indicate that people should walk through it, covering an area of 5 m x 2.5 m.

The intervention was presented to students as an artwork. In addition, WBS ran a deception study, where participants had to lie about the contents of a bag they were given to carry along the corridor. They were not told of any connection between the deception study and the maze intervention. The video rerecording was for four days.

Floor text: Portsmouth

The intervention consisted of a paragraph of text printed onto vinyl appropriate for attaching to outdoor floor surfaces. It was a simple design of black text on a white background,

4 m x 3 m, placed in the centre of Guildhall Square, Portsmouth, for eight days. The space consisted of low-density population at any one time, with a number of well-used pedestrian commuter routes through the square along with a cafe, lunch spots and proximity to public amenities, including a library.

The text was a paragraph from *Nicholas Nickleby* by Charles Dickens (1839), from a section of the novel set in Portsmouth. No accreditation for the text was given on the vinyl, as the authors speculated this anonymity would provoke curiosity and increase the chance of the text being read in its entirety. Portsmouth strongly associates with Charles Dickens who was born in the town. During the time the floor vinyl was in place, the city celebrated the bicentenary of his birth.

Floor text: Glasgow Queen Street station

A similar intervention to the floor vinyl used in Portsmouth was applied to the Queen Street railway station in Glasgow. The space consisted of high-density population, particularly at rush hour, with a mix of focused train activities, travelling directly to a platform or waiting for information, along with shopping and cafes. The researchers speculated that people on the station concourse would look around the environment while they waited. The proposal was that the large floor vinyl would arouse their curiosity and draw them over to investigate further.

The 3 m x 3 m floor vinyl was installed on the station concourse. It contained text from the 1865 edition of *Bradshaw's Tourist Guide to the United Kingdom* describing Glasgow city and the railway journeys it was possible to take from Glasgow at this time. It was oriented towards the passenger information boards at the far end of the concourse. Researchers experimented with colouring the background and text, however, using colour created the impression that the floor vinyl was a piece of advertising. The simple design with text in black on a white background minimized this effect.

Beyond the video recording and analysis, surveys were also used, aiming to understand if the floor vinyl contributed to a positive environment for occupants of the space. A small number of the individuals on the station concourse, who had shown an interest in the intervention, were invited to take part. The questions focused on people's perception of the intervention (see Appendix A).

Mirror studies

Three studies with mirrors were designed and carried out in different settings, employing both physical and digital mirrors (Figure 1).

Library mirrors

A series of three mirrors were set up outside the entrance to the library at the University of Kent, a busy area with students entering the library or waiting to meet friends. The mirrors were set up to create a feedback effect as one passed between them.

Digital mirror: BBC Big Screen

This intervention was installed in Guildhall Square, Portsmouth. The BBC Big Screen is a permanent fixture in the square. This study used the application *Hand from Above* by Chris O'Shea (2009) to create a digital mirror (Figure 1). *Hand from Above* was designed for a BBC

Figure 1. Mirrors (left) on the station concourse, Glasgow; (right) digital mirror with *Hand from Above* on the BBC Big Screen, Portsmouth.

Big Screen and shows a live image of the space on the BBC Big Screen, effectively acting as a digital mirror. At irregular intervals a large hand entered the screen to tickle or pick up one of the people seen on the video image.

The authors believed that the *Hand from Above* artwork would create a fun experience for visitors to the square. This assumption was based on documentation of previous showings of *Hand from Above* (O'Shea 2009). The study ran for a period of a month, where for 12 days a parallel study on deception with primed participants was also taking place, run by the University of Portsmouth.[2]

The deception study required primed participants to visit the square for a photography task. Half of the participants were instructed to take photographs for a tourist brochure and the others for use in hostile reconnaissance. The participants who took photographs for use in hostile reconnaissance were asked to lie about the purpose of their photographs during a subsequent interview with researchers. Participants were not told of any connection between the deception study and the *Hand from Above* artwork. There were 83 participants in the deception study, 64 of whom were captured on video.

A short questionnaire to elicit participants' feelings about their experience in Guildhall Square was also completed at the end of the subsequent interview (see Appendix B).

Analysis focused on the participants in the deception study and their movement paths were mapped onto a plan of the square. The time of their entry and exit into the space was documented as well as times at which they exhibited notable behaviours.

Mirrors: Glasgow Queen Street station

Sheets of silver mirror HIPS were installed into three freestanding poster frames at Queen Street station (Figure 1). Organizational safety concerns prevented the mirrors being placed in a location that the researchers felt had the potential to influence pedestrian flow and behaviour, so the frames were placed adjacent to each other between two sets of gates leading to the station platforms (Figure 1).

In addition to the video data collection, researchers approached people standing on the station concourse in the vicinity of the intervention to enquire if they had noticed the mirrors, and if so what they thought the purpose of the mirrors might be. Due to the restrictions on the location little awareness of the intervention was demonstrated by passers-by. This was

Figure 2. Playful behaviour engaging with the intervention (left) tapeline at Kent; (right) maze at Warwick.

Table 1. Movement path of passers-by in relation to the maze intervention.

	Across (disregard intervention)	Around (indirect engagement)	Follow (direct engagement)	Around & Follow (percentage of direct & indirect engagement)
Monday	664	810	61	57%
Tuesday	1079	773	40	43%
Wednesday	1183	609	25	35%
Thursday	1034	742	28	43%

highlighted by the survey findings (n = 35) that found very few people noticed anything unusual about the station or noticed the mirrors in particular. As a result, this intervention was discounted from further analysis.

Findings

This section is organized around the three aims: (a) alter the flow of pedestrian movement through a space, (b) create zones of attraction and exclusion within the space, and (c) engage people's curiosity and elicit playful actions. In addition, the effect of cognitive load and task-oriented activity became increasingly noticeable during the implementation of the interventions and this is considered as an additional point.

Alter flow

The studies showed that pedestrians altered their movement paths in response to the interventions. This was observed for both floor marking (Figure 2) and mirror interventions. There were two aspects to this. First, people deviated from their current movement path to avoid and go around the intervention. Second, interventions were seen to elicit a temporal deviation where people would stop for longer in the space than their current movement suggested they were planning to.

It became apparent that the tapeline intervention acted as an anchor point for people engaged in other activities, e.g. talking on the phone; stopping on the line without paying close attention to the intervention. This effect was also seen with the library mirror study.

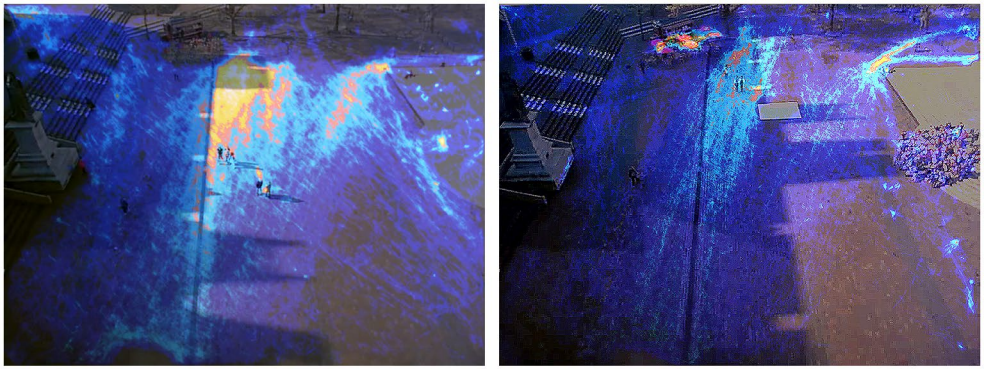

Figure 3. Visual analysis indicating movement paths: (left) without floor vinyl, 9–11 am Tuesday 3 April; (right) with floor vinyl in place, 9–11am Friday 20 April.

Table 2. Level of engagement with the floor vinyl in Portsmouth.

	Walk across	Stop to read
Saturday	25	82
Sunday	30	65
Monday	28	109
Tuesday	22	40
Wednesday	18	53
Thursday	37	38
Friday	48	57
TOTAL	208	444

Analysis demonstrated different levels of interaction with the interventions. Deviating from the current path to follow the WBS maze or the tapeline was considered to be direct engagement with the intervention. People alone and in groups engaged directly with the maze in this way. This behaviour was only observed in a small number who passed-by.

Altering the movement path to walk around the floor markings was considered to indicate an indirect acknowledgement of the intervention. This behaviour only occurs if there is an awareness of its presence. Taking into account the number of people who acknowledge the presence of the maze by walking around it shows a significantly higher level of engagement (Table 1). On average, the movement of 45% of the passers-by was affected by the intervention.

The text intervention in Portsmouth supported the findings that interventions can elicit deviation from routine movement paths. The analysis of a two-hour period in the morning rush-hour on a weekday shows the extensive use of the square. However, with the intervention in place, there is a more limited use of the section of ground covered by the intervention, creating an exclusion zone, with movement paths deviating at the edges of the floor vinyl with very few people walking across (Figure 3).

As with the WBS maze, there were different levels of engagement with the floor text intervention. Stopping to read the text was considered to be direct engagement with the intervention. Those who showed a peripheral acknowledgement of the intervention deviated from their current movement path so as to avoid walking on the text. Table 2 demonstrates that the number of people stopping to read the text was consistently higher than the number of people walking across the intervention.

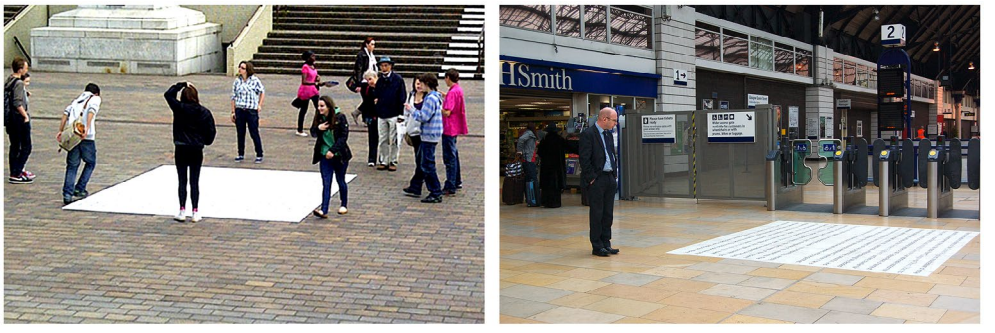

Figure 4. Examples of noticeable behaviour, people stopping to read the text (left) in Portsmouth; (right) at the concourse of Glasgow Queen Street train station.

Another important point when considering the ability of interventions to alter movement flow is the effect of habituation, i.e. the decrease in response to a stimulus after repeated exposure to it. In the WBS maze study, the number of people engaging with the maze consistently decreased across the four days the intervention was installed (Table 1). The effect of habituation was also noted at the Portsmouth text intervention. The number of pedestrians walking across the floor markings was always greater than number stopping to read, but a decreased engagement with the intervention over the time it was installed can be seen (Table 2).

Zones of attraction and exclusion

The tape maze intervention illustrated how a floor-marking intervention can act as an attractor for people. The library mirrors intervention indicated that mirrors can elicit a similar response. The text interventions in Portsmouth and Glasgow also attracted passers-by. People who engaged with the intervention by reading the text were observed to stand still as they did so (Figure 4). They usually stood at the base of the text in order to read it easily.

The text interventions also seemed to provide a zone of exclusion as people rarely stood on the floor vinyl unless preoccupied by another activity. Even at busy times the floor vinyl would remain clear (Figure 5). For the high density, task focused context of the station, it was a different situation, and analysis of the video time-sections indicated no easily discernible effect. As the vinyl was located in front of the gates leading to the train platforms, people crossed the floor vinyl regularly, especially going to or from the platform gates.

Elicit playful behaviour

The analysis revealed that the digital mirror intervention was successful in eliciting playful and noticeable, performative behaviour from the general public (Figure 6), e.g. waving to the camera. This type of response was also observed in response to the library mirror intervention.

Following the floor markings of the tapelines and maze was considered playful and noticeable behaviour. Both interventions were successful at eliciting this behaviour, although the number of people who engaged was low. The maze intervention also revealed a different

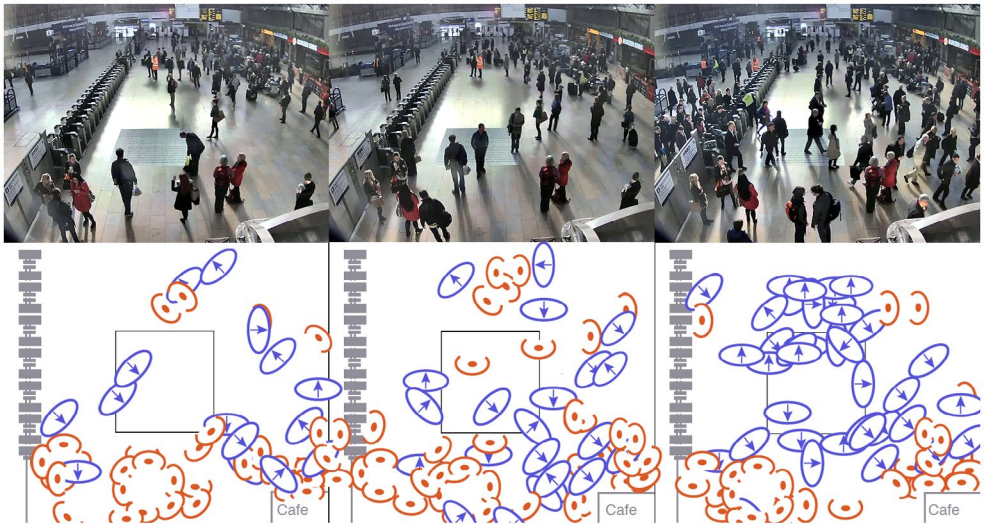

Figure 5. Example of the mapping of movement around the intervention. Dots denote people standing, whereas arrows denote people walking towards the direction of the arrow. Vinyl provided zone of exclusion for stationary people.

Figure 6. Mirrors eliciting noticeable behaviour (left) in Portsmouth, (right) in Kent.

form of noticeable behaviour as people deviated from their movement path to walk around the maze. Analysis of the text interventions at Portsmouth and Glasgow clearly demonstrated their ability to attract attention and elicit curiosity as people were observed stopping to read the floor vinyl (Figure 4).

Effect of cognitive load and goal-directed activity

The hypothesis was that participants in the deception study connected to the WBS maze intervention would be less likely to engage in playful activity due to their heightened cognitive load caused by participating in the study. In total, participants passed the maze 236 times during the deception study. Participants followed the maze on only two occasions, corresponding to 0.8%. For other users of the corridor direct engagement was significantly higher (over 4% on the first day, dropping to 1.4% on day four).

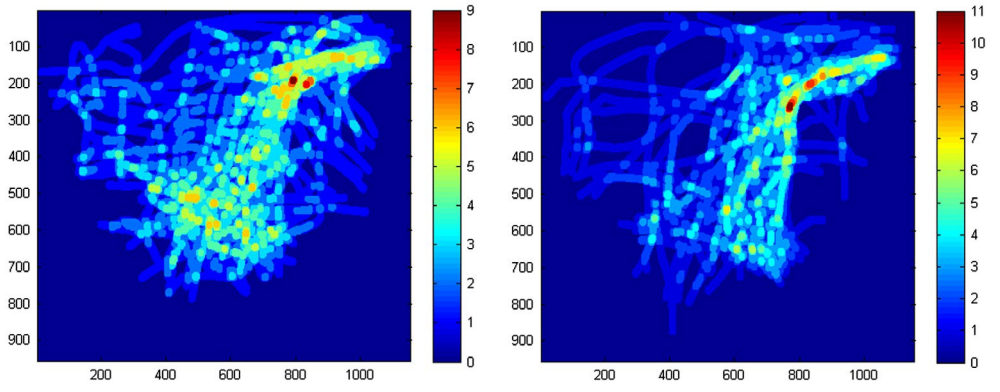

Figure 7. Visual analysis indicating movement paths of (left) truth tellers, taking pictures for a tourist brochure and (right) liars, taking photos for reconnaissance.

The analysis also highlighted the effect of goal-directed behaviour on non-primed passers-by, as people engaged with other tasks, such as delivery of goods, more often walked across the intervention than around it. For the text intervention in Glasgow, as with the tape maze, there is influence of goal-directed behaviour, reducing the level of engagement with the intervention. People crossing, or standing on, the floor vinyl were often preoccupied with another activity looking for tickets or friends, running for trains, managing luggage, watching the departure boards, etc. It is speculated that this may help to explain the differences in the findings of the text intervention in Portsmouth where a clear zone of exclusion was created, and the text intervention in Glasgow where passers-by were more inclined to cross the intervention.

The deception study associated with the digital mirror intervention in Portsmouth offered the opportunity to examine potential differences in behaviours arising from the task-oriented activity of truth tellers and liars. The assumption was that all participants in the deception study would be involved with their task to such an extent that they would exhibit less playful behaviour in front of the digital mirror than members of the general public. In addition, the authors speculated that liars engaged in taking photographs for hostile reconnaissance purposes might not wish to draw attention to themselves by having their image appear on the screen and so would stand on the edge of the area detected by the camera. None of the participants were observed interacting with or acknowledging the intervention irrespective of whether they were asked to carry out benign or suspicious activities. This effect of increased cognitive load and goal-directed behaviour is consistent with the results from the previous studies.

Analysis of movement using image processing of the participants' individual paths on MATLAB revealed differences in patterns of spatial movement between those engaged in benign and suspicious activities, or else truth-tellers and liars. This is best understood when evaluated against the geometry of the space. The square is contained between buildings on three sides, with steps on the east and west leading to the Guildhall and the council offices.

Overlaying the floor plan with heat maps of pedestrian movement through the space, it is noticeable that truth-tellers appear to use more of the available floor area, including the stairs (Figure 7). Conversely, the liars have a tendency to concentrate their movement nearer the steps by the Guildhall. This may be seen as offering better protection and avoiding unnecessary exposure.

This feeling of exposure was confirmed by the post-survey interviews. A total of 23% of the participants mentioned the space configuration influencing feelings of exposure, with a focus on the openness of the space and their location in the space. There was a moderate correlation between their feelings of exposure and being watched ($r = 0.579$, $p = 0.000$), which then influenced their confidence to get the required photos ($r = -0.176$, $p = 0.003$). Overall, there were no statistically significant differences between liars and truth-tellers, or males and females in the survey responses. Another differentiation between truth-tellers and liars was dwell time, as the latter on average spent less time in the space.

Reflections

Using the concepts of *triangulation*, *performance* and *flow*, the work described in this paper presented the findings from seven experimental studies designed to disrupt routine use of space stimulating *triangulation*, while eliciting noticeable behaviours encouraging *performances* from audiences, as well as influencing pedestrian movement and altering *flow* in public spaces. This was done through the design and installation of interventions in different spatial and operational contexts – university campuses, a civic square and a railway station. These temporary and low-cost interventions were around the themes of floor markings and mirrors.

The four floor-marking installations and the library mirrors were all successful in disrupting routine behaviour in the space by altering flow. This occurred as people deviated from their existing movement path as a result of being attracted to the intervention. In that respect floor markings had a greater effect on movement flow than mirror interventions. The text interventions also elicited a temporal deviation as people were encouraged to linger in the space for longer, increasing their dwell time.

The disruption of routine movement paths illustrated how interventions can draw people to a specific area or establish a zone of exclusion. Zones of attraction and exclusion are not mutually exclusive effects. Interventions were observed to provide anchor points for passers-by that simultaneously attracted people towards the area of space where the intervention was located, while also encouraging them to keep certain areas of the space clear. The orientation of the text-based interventions offers further opportunities to influence people's position while they engage with the intervention.

All the interventions, with the exception of the mirrors in Queen Street station, were successful in stimulating triangulation and performances from the public, eliciting noticeable behaviours, mainly in terms of playfulness and curiosity. Playfulness can be defined as behaviour that appears out of place, unnecessary for the norms of the space and is intended to entertain or amuse. Behaviour such as following the maze (WBS) or waving (Big Screen; Library mirrors) was considered to be playful behaviour. Curiosity can be defined as behaviour that indicates a desire to know more about the intervention. Stopping to read the text (Portsmouth; Glasgow) or walking over to look at the reflections in the mirror (Library mirrors) were considered to be examples of curiosity.

Such behaviours have been explored extensively in arts projects to engage with audiences in public spaces (Martin, Dalton, and Nikolopoulou 2013). Luke Jerram's (2008) 'Play Me, I'm Yours' placed upright pianos into a number of empty locations with the invitation to play as people chose, while the 'Piano Stairs' transformed the entrance to a Stockholm subway station into a keyboard where each step produced a different note, next to the escalator

(DDB Stockholm 2009). Both were familiar objects, placed in atypical locations drawing people in, and inviting unprompted, unexpected behaviour, encouraging triangulation and performances from members of the public. Furthermore, the 'Piano Stairs' demonstrates how alterations to a physical space can lead to dramatic changes in flow behaviour, as the following day passengers altered their routine path to exit the station, with 66% more people than usual choosing to take the stairs instead of the escalator.

In analyzing the interventions two levels of noticeable behaviour were identified – direct engagement and acknowledgement. The former can be defined as a deliberate response to an intervention, while the latter as behaviour indicating the person is aware of it. Direct engagement refers to, for example, following the maze, waving into the mirror or reading the text, while an example of acknowledging an intervention is altering their path to avoid the floor marking, without appearing to pay any attention to the intervention.

Direct engagement was a noticeable trend in all studies that elicited noticeable behaviour, but only from a small percentage of passers-by. Acknowledgement, on the other hand, was elicited from a high percentage of users of the space. When the two are considered together then approximately half of the passers-by elicited a form of noticeable behaviour.

In all cases, the greatest effect occurs when the interventions are unexpected, which can be regarded as a pre-requisite to attract curiosity and playfulness. They may have a form that contrasts with its surrounding environment (maze; floor vinyls; library mirrors), or present a different experience of the space from usual (digital mirror Big Screen). Interventions that blend in with their surroundings in terms of form and experience (Glasgow mirrors) are less likely to elicit noticeable behaviours from passers-by.

The ability of interventions to alter flow and elicit noticeable behaviours is also affected by personal factors, such as increased cognitive load and goal-directed behaviour. As the maze intervention at WBS and the text intervention in Glasgow demonstrated with increasing goal-directed behaviour (whether it was carrying goods, running for the train or checking departure boards), people were less likely to respond to the interventions by disrupting routine behaviour or displaying signs of curiosity or playful engagement. This was particularly noticeable with the increased cognitive load imposed on the participants in the deception studies (maze; digital mirror), where they were least likely to alter their path or engage with the interventions directly or indirectly.

The interventions had a more noticeable effect in spaces that were not very crowded. The text interventions in Portsmouth and Glasgow provided an opportunity to compare near-identical interventions in locations with different spatial and social characteristics. The analysis showed that the text intervention in Portsmouth produced more noticeable disruption to movement paths and routine behaviour. Outside peak periods of use in Glasgow there was a tendency for bystanders to engage with the text; however, this diminished rapidly as the station became densely populated and the intervention less visible.

Another very important factor is the effect of habituation, which became noticeable in all studies. The studies indicated that the potential for interventions to disrupt routine behaviour, create zones of attraction and exclusion decreases with repeated encounter. Findings from the floor-marking studies suggest that the number of people passing by who are influenced by an intervention drops after the first two or three days. The same effect was noted for the ability of interventions to elicit noticeable behaviour.

Towards design guidelines

Analysis of the data can also support the provision of basic guidelines for designing interventions to disrupt pedestrian flow and elicit noticeable behaviours to be used in security planning alongside more authority-focused interventions.

The form and purpose of an intervention should be led by the characteristics of the space in which it will be located. Understanding the ongoing activities is essential to suggest appropriate types of interventions that may disrupt existing activities without causing unnecessary inconvenience.

Spatial and morphological characteristics of the space affecting existing movement patterns, along with the temporal rhythm of activities, should be considered. The level of exposure experienced in the space, the arrangement of the buildings and the access points influence movement in and through a space. The crowdedness of the space should also be considered, as a successful intervention may become less effective in crowded conditions. Interventions in crowded situations may need to be bolder in order to attract attention.

To have the greatest chance of altering movement flow and eliciting noticeable behaviour, it is vital that the position of the intervention in the space is considered carefully and sited in a location with the potential to disrupt existing flow. If the intervention is away from the area of routine movement or activity, the opportunity for meaningful engagement is minimized. Heat mapping typical movement patterns can assist in understanding flow norms.

To maximize the potential for disrupting movement and eliciting noticeable behaviours the interventions should allow for multiple levels of engagement and interaction – direct and indirect. Direct engagement with the interventions was the least frequent; however, combined with acknowledgement and indirect interaction (such as altering one's movement path) the number of interactions provided a noticeable effect in the space through the creation of attraction and exclusion zones.

For best results the intervention should be unexpected and avoid the vocabulary of advertising, which is ubiquitous in public spaces, hence reducing the opportunities for engagement minimizing its effect.

Finally, even with the most successful design intervention, habituation will occur. As a result, within a few days the level of engagement will begin to decrease and eventually they will be part of the wallpaper, as was also highlighted at the 'Safer Spaces' project emphasizing the need for periodic change (Triggs et al. 2012). Such findings are consistent with more traditional strategies, such as CCTV where initial deterrence fades with time (Scottish Government 2009).

This suggests that interventions should be quick and easy to install and remove, allowing for a rapid turnaround to ensure continuing engagement. As designing and producing an intervention can be time-consuming, it may be useful to create interventions that can easily be implemented in a number of locations in different contexts.

Conclusions

Using the concepts of *triangulation*, *performance* and *flow,* the paper has extensively discussed different ways to disrupt routine use of space, by influencing pedestrian movement and altering flow in public spaces, as well as eliciting noticeable behaviours. The control and shaping of pedestrian movement recurs as an aspect of security planning for crowded spaces. Triangulation can be viewed as an effective way to disrupt a state of civil inattention. It is argued that using

art-inspired interventions as an alternative to an overt security approach invites people to perform in a public space, disrupting routine use of space to act as a form of deterrence, and shaping the flow of pedestrian movement which is an integral aspect of security planning.

In the context of deterring hostile reconnaissance, design and art can create physical examples of 'unexpected questioning' through playful disruption or a heightened sense of being on view (Dalton et al. 2015). Such playfulness can be regarded as a key strength in amplifying desired disruption effects in public spaces. This is particularly beneficial, considering that a constant presence of traditional performances of authority in public space risks trivializing the impact of necessary future displays of security strength. Furthermore, in a wider cultural context over-policing has the potential to foment radicalization, particularly among communities who feel particularly targeted because of a recurring, heightened authority presence in the spaces they use (Fussey 2007). All the above highlight the growing awareness of the necessity for security measures to be socially acceptable (Németh 2010) and this design-led approach has a positive influence on one's experience of space, "dwelling through mobility" (McFarlane 2011, 663), increasing social sustainability.

The beneficial impact of art in drawing people in public spaces, as identified by Whyte (1980) over 30 years ago, has been highlighted as an important component in security design. The Arts Council argues that "good art encourages greater use of public places and increases individuals' sense of security" (Arts Council 1991, 17), while the Mayor's Office in New York advocates its use for a similar purpose (Russell et al. 2002). More recently, the UK Home Office (2012) recommends attracting people to spaces using positive features, even incorporating public art, as a key strategy for enhancing security.

In a position paper discussing the logic of fear in terrorism and counter-terrorism, Braithwaite argued that counter-terrorism policy would be well served by "more proactively attempting to improve average participant enjoyment of public spaces" (Braithwaite 2013, 100). Could then investing in the potential of a space or the opportunities for creating a sense of place through a design-led approach for counter-terrorism provide a new era in security planning? An era of 'sustainable security' (Crampton 2013), in which sustainability does not refer to the financial viability of the scheme, but the basis for human well-being.

Notes

1. Warwick Business school (WBS) were partners in the project.
2. The University of Portsmouth were partners in the project.

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Appendix A: Questionnaire for the Glasgow Queen Street station.
Where 1–7 scale required: [Strongly disagree, Disagree, Somewhat disagree, Neither agree or disagree, Agree, Strongly agree]
How many times a month do you come through Glasgow Queen Street station?
[I've never been here before – Once a month or less – Once a week – Every day]

I feel at ease in Queen Street station [1–7]
I feel vulnerable in Queen Street station [1–7]
I believe I am aware of what is happening around me at the station [1–7]
Do you notice anything unusual about the station today / this week? (depending on how often they come through the station – interventions will be in place for one week)
Have you noticed *this* at the station today? [Show photograph of current intervention] Y/N
I felt curious when I was looking at the *text/mirrors* [1–7]
I felt awkward when I was looking at the *text/mirrors* [1–7]
What prevented you from going over and looking at the *text* / *mirrors*?
What do you think about the *text* / *mirrors* being at the station?
Gender [M/F] Age group

Appendix B: Questions used during the Guildhall Square surveys (as part of an extensive interview with Portsmouth University).

Gender [M/F] Age group
When you first entered the square, how confident were you that you could get the photographs you needed?
[Not at all 1 2 3 4 5 6 7 very confident]
Did you feel that people were watching you while you were taking photographs?
[Not at all 1 2 3 4 5 6 7 very much so]
How exposed did you feel in the space?
[Not at all 1 2 3 4 5 6 7 very exposed]