15Meters/11Seconds

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Abstract

People with high empathy will be influenced by people. Whereas, those people who exhibit high disorientation will enter a random pattern of movement. These two features underpin the key moments prior to a terrorist attack, in terms of deception outwitting perception or vice versa. Modelling this in the context of a terrorist attack requires a new form of granular analysis. 15meters/11seconds is the title of the research project modelled in this paper. It is a terrorist attack scenario which will be examined as a time/action study of the immediate minuets leading up to, and after a terrorist attack. Out of this, the ground rules are established for modelling an approach to the problem.

Keywords: Scripted Agent, Microsimulation, Counter Terrorism.

Background

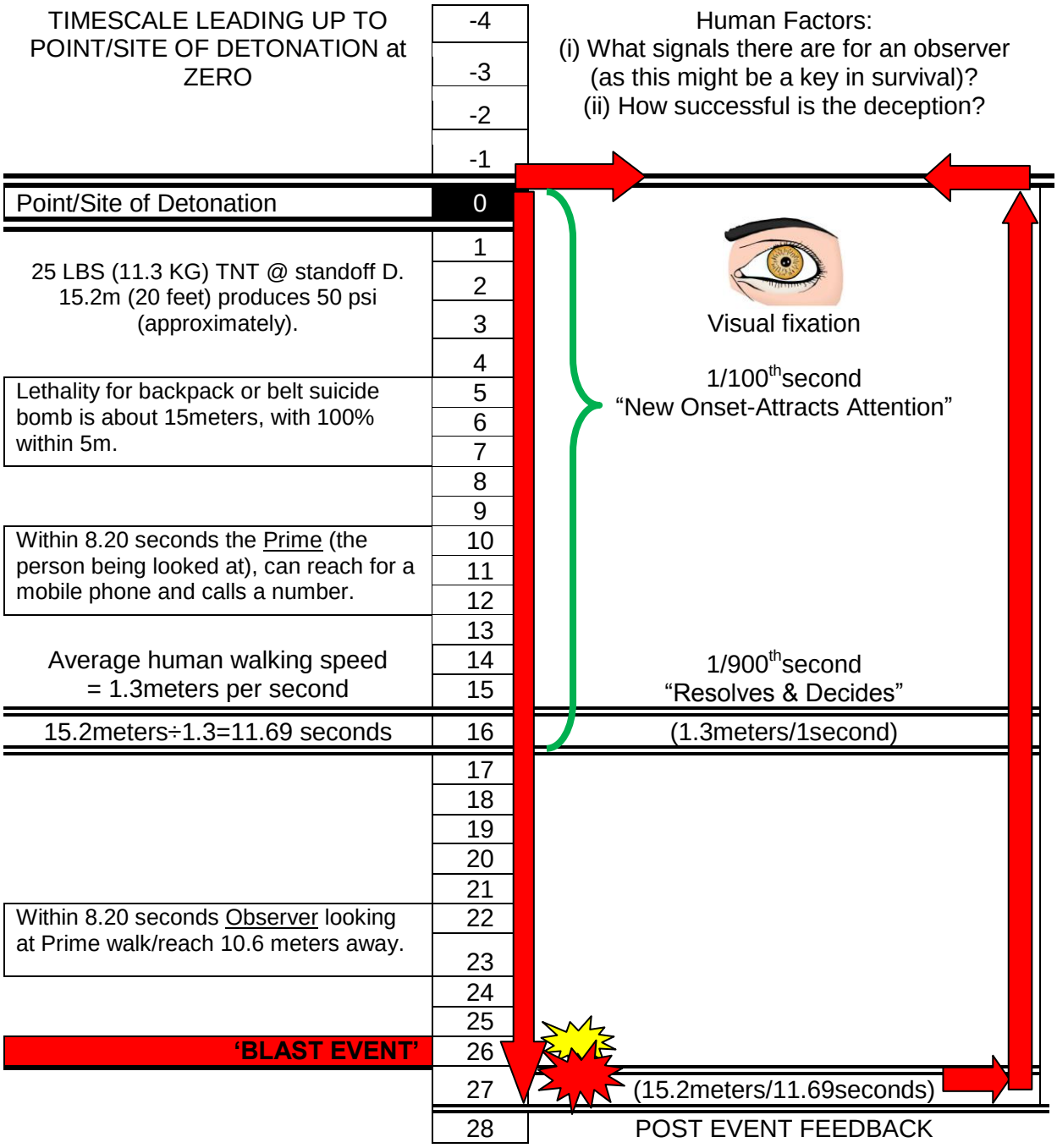
The terrorist attack scenario outlined in the 15meters/11seconds model is outlined in figure 1. The model reduces to a time/action study the first 11seconds, approximately, of an assailant initiating a terrorist attack, and modelling the behavioural aspects. The scenario is a person armed with a backpack loaded improvised explosive device (IED) whom after moving toward a group of people, takes out their mobile phone and rings a number which initiates the blast event. This takes approximately 8.20seconds to complete. This act, like the demeanour of the assailant is taken to have deception qualities. That is, the assailant is sufficiently hiding his or her true intentions so as to not tip-off his would be victims. The question is: will others see this as a threat, and move out of the immediate lethal zone (in this case calculated to be 15meters out from 'Point-of-Detonation at Zero'), which can be traversed in approximately 11seconds in sufficient time? The research is intended to bring together a range of different research domains, which usually are not integrated, namely: (i) traditional blast modelling, and stand-off distances; (ii) blast effects on people and materials; (iii) tactical analysis and information issues; and, (iv) the study of attention, perception and psychophysics.

Timescale Leading Up to Point/Site of Detonation at Zero

Reviewing the work on attention, perception and psychophysics provides insight into the time-frames in which humans typically observe and deal with and resolve distractions (the experiments and tests run within one second). The question is how does this research materiel apply in a time/action study of a terrorist bombing? This model is outlined in figure 1. The model identifies that there is a generic ‘count’ (represented by the vertical scale (-4 to 0), and 1 to 28), which is figurative of two scales in operation simultaneously. Firstly, the time taken to walk 15meters at average walking speed, reckoned to be 1.3meters per second. Secondly, the typical 15meter circumference zone emanating from a blast-point (at zero on

the figurative scale). At the same time there is the event being played out, namely the terrorist about to suicide bomb a group of people.

Figure 1: Timescale leading up to point/site of detonation at zero.



The US Army's IED training methodology begins with the following scenario:

"A Soldier is in the gunner's hatch of the lead vehicle. He is the first to see it, a pile of trash with a barely visible blue wire protruding from it. He quickly warns his vehicle commander, but he is too late. It explodes less than 15meters from his position. The driver of the vehicle instinctively speeds up to get out of the kill zone." (Zajac, 2011)

This scenario, exhibits two key factors. Firstly, it is almost an axiom that 'blast events' are treated as potentially over-to-quickly from a human factors view for there to be a meaningful reaction. However, examination of terrorist attacks reveals that a high level of information exchange actually occurs. Secondly, people may in fact be able to react even in narrow timeframes. The questions become:

(i) What signals there are for an observer (as this might be a key in survival)?

(ii) How successful is the deception?

Every act of terrorism involves an act of deception (Flaherty, 2003). That is, how successful at a micro level of a few minutes or seconds, or even a fraction of a second can an attacker maintain sufficient deception in their behaviour so as to not cue an observer that something is wrong with them, or that they pose a threat. According to work in the attention, perception and psychophysics field, the process of human visual fixation, interrogation and resolution (i.e. an observer decides what it is they are looking at) actually occurs within a one-second interval, and at the level of thousands of a second (Cole, 2010). Experimentation on human brain processes involved in observation and recognition indicates that at 1/100thsecond an observer will see something, perhaps two actions (which need to be interpreted). These could be the movement of a hand (indicated as “New Onset-Attracts Attention”, in Figure 1). However, even at this level there is a physical delay in the processing of that information, and that this occurs at a 1/900thsecond delay. Problematically, a person could either make a correct or wrong interpretation. Effectively, the implication is that people within close proximity of an attacker could, second by second, be making an assessment of what is the significance of their actions – ‘are they a threat?’ Do I move away? Do they stay?

In the case of blast events, most small to medium IEDs the first 15meters is generally taken to be catastrophic. The human body can survive relatively high blast overpressure without experiencing barotrauma. However, a five-psi (pounds per square inch) blast overpressure will rupture eardrums in about 1% of subjects, and a 45 psi overpressure will cause eardrum rupture in about 99% of all subjects. The threshold for lung damage occurs at about 15 psi blast overpressure. While, at 35-45 psi overpressure may cause 1% fatalities, and 55 to 65 psi overpressure may cause 99% fatalities (Glasstone, 1977). In terms of distance, if the charge weight was a standard 25 LBS (11.3 KG) TNT equivalent, then the standoff-distance would calculate to approximately 15.2meters (20 feet), which also exhibits 50 psi (approximately), which is catastrophic for humans. Bringing these two – the human event, and the blast analysis together is difficult. The analysis being developed to do this, is the idea of the ‘in situ’ attack.

In Situ Attacks

In situ type attacks propose that in areas holding numbers of people in close proximity, and who are located in physically cluttered spaces are optimum for producing higher than normally expected ratio of death to injury. As well, for this type of attack to be successful, it is dependent on the phenomenon occurring where many of the victims seemed to stay in location. On-board bus or vehicle bombings qualify as ‘in situ’ attacks, and other examples demonstrating a similar act of terrorism have been attacks in crowded places. For instance, table 1 gives several examples from Israel in 2002 help illustrate some of the particular characteristics (ADL, 2011).

The events recorded in table 1 have been selected from the months March to May 2002. Attacks from this period excluded from the list were shootings, bus bombings and checkpoint attacks. The remaining attacks were chosen for illustrating near similar conditions where there was a grouping of people in a market, station or club and approached by a suicide-attacker carrying an IED. The limited data presented in table 1 seems to suggest that the events 8 May and 31 March were different from the other events recorded. In both cases, these were in-doors so there may have well been impact from reflection of the blast pressure

pulse from inside wall services, as well as impact from weaponised debris. However, it is also fair to conclude that the people in both cases were relatively constrained by the restaurant or club furnishings from moving. As well, these cluttered environments aided deception and camouflaged the assailants (Flaherty, 2008).

Table 1: Terrorist examples from Israel in 2002.

Date 2002	Event description	Killing	Wounding	% Killed
19 May	A suicide bombing at an open-air market in Netanya. A Palestinian disguised as an Israeli soldier carried out the attack.	3	50	5.66
8 May	A Palestinian terrorist detonated a suitcase packed with explosives in a crowded gambling and billiards club near Tel Aviv,	15	58	20.54
31 March	Suicide bombing in Haifa, in the Matza gas station restaurant near a shopping mall.	14	40	25.92
30 March	A powerful explosion in a cafe on the corner of Allenby and Bialik streets in Tel Aviv on Saturday evening.	None	36	None
29 March	A 16-year-old female Palestinian suicide bomber attacked a Jerusalem supermarket.	2	20	9.09

Source: ADL, 2011.

In all the cases illustrated in table 1 there are a number of unknowns, in particular, the variation introduced by differing blast weights being used, the physical circumstances – an indoors club, as opposed to an open air station. However, the events of 8 May and 31 March do share some interesting parallels, namely:

1. These spaces are full of fixed infrastructure which stops people in-situ, hence a high level of fatalities.
2. Circumstances where people did not realise they were being deceived. This implies that the deception was significant enough to overcome people's concerns, suspicions or prejudice toward the attacker. In such circumstances, the same result will occur; namely that an 'In Situ' attack will be possible, where people simply stay close to the assailant.

The key issue is that in every act of terrorism there is a need (at a micro level) to assess what level of deception was employed. The reason for this is that in any simulation the level of deception being used will affect the level of situational awareness that people react to. However, in the case of the 19 May attack, use of a Palestinian disguised as an Israeli soldier to carry out the attack would appear to be a successful deception strategy. Yet due to factors such a lack of crowding and lack of environment weaponisation (Gupta, 2005), this attack was relatively unsuccessful.

An additional aspect, seemingly present in both the events of 8 May and 31 March that needs to be mentioned, is that the distance from the centre of the blast should lead to similar death and injury. Confinement in terms of building structures, such as walls or anything that can cause increased pressure from reflection (even though this drops off more rapidly than the blast overpressure), that prevent dispersion of people may increase the number of deaths relative to injuries. This may explain what have been called – the 'in situ' attacks. These are "where groups of people had been attacked in places and are trapped in situ, we see approximately a 20% jump in the number of dead as compared to the number of wounded; whereas most of the recorded attacks occurred in relatively open locations, where people were easily dispersed resulting in high numbers of wounded but few fatal causalities." (Flaherty, 2009) This appears to be a case in comparison with the other events of 29 and 30

March, and 19 May, which all had relatively low or no deaths recorded (Table 1). Whereas, in the case of the 29 March attack on the Jerusalem supermarket, while an indoor space, this may have had too few people shopping to have been killed.

In summary, the key elements of the 'in situ' attacks are that these are specific attacks, where three criteria are available to produce a specific event with a higher than typical lethal causality rate:

- There are large groupings of people (i.e. grouping);
- Close to each other (i.e. proximity); and
- Caught 'in situ' by various physical constraints and/or effective deception.

Terrorist Archetypes

Researching the victims' responses to the 2005 London Underground attacks (and this may also be the case with the 2004 Madrid station bombings as well) it is clear that a minority saw the attacks about to talk place, but were unable to react; and even immediately after the event at least two victims in the first 20 minutes (London 2005) saw a person trying to use their mobile phone to cancel work meetings, which they interpreted as 'selfish behaviour' (Drury, 2009). These same observations were made by survivors who were on the bus destroyed in the London 2005 attacks, recalling "exchanged glances with other commuters who were also annoyed by his behaviour" (Coroner's Inquests, 2011a). As well, as asked him to be more careful, the bomber however "simply didn't react at all", he said (Coroner's Inquests, 2011b). Finally, the terrorist was seen moving from side to side nervously, and jostled passengers with his backpack, which was seen as "very bad manners"(Coroner's Inquests, 2011a).

These witness statements point to how, at a granular level - deception, misconception and disbelief, are key tools in the terrorist's arsenal in the crucial last few minutes, and seconds leading up to a terrorist attack. This experience very much echoes the sentiments of more experienced surveillance operatives. For instance, an interview from the BBC Four's 'Vatican: the Hidden World', the head of Papal Security stated in regards to protecting the Pope in a mass public place such as the Vatican square:

"When you are actually there, honestly ... you really do not see or hear anything else, you are concentrating on anything that might be happening. It has become a habit of mine to watch a person's eyes or else the hands; it can be a quick way of assessing what kind of person you have in front of you. Of course you can still be deceived. ... In earlier times, probably no body imagined somebody would shoot at the pope ... [programme overviewed the attempted assassination of Pope John Paul II which took place on Wednesday, May 13, 1981, in St. Peter's Square, Vatican City ...] ... I definitely think everyone is more on guard now. In contrast with twenty years ago, today we assume that anything can happen." (teamWorx/BBC, 2010)

The key issue is the capacity to identify and interdict a potential suicide attacker. However, even though the 2011 Coroner's Inquests into the London Bombings of 7 July 2005 gained information that clearly identifies aberrant, nervous or odd behaviour as the telltale signs of an impending suicide attack. This is not necessary always to be the case. For instance,

"Even when a suicide attack is anticipated, law enforcement agencies may have a difficult time making the correct identification. Some indicators popularized in recent literature are tenuous and of limited practical use. For example, identifying a suicide bomber by looking for heavy clothing (inappropriate for the season and/or location) may not work; sheet explosives can be taped to the body and allow bombers to wear light clothing without any obvious, observable indicator of the presence of an explosive device. Likewise, looking for nervous behaviour (darting eyes, unusual perspiration, etc.) may not work; handlers can administer

Valium to suicide bombers to calm them and suppress obvious indicators of anxiety or fear." (Priem, 2007)

The use of drugs however can also leave visual cues. In the case of the 2008 Mumbai attacks, the attackers had taken cocaine and LSD during these. Also, there were indications that they had been taking steroids to sustain their energy and stay awake for 50 hours, which was immediately noticeable (McElroy, 2008). Instances where the attacker was calm (as opposed to nervous or drug-affected) was a feature of pilot Joe Stack's final exchange with the control tower at Georgetown Municipal Airport as he was cleared for take-off prior to his suicide attack where he slammed his plane into the Internal Revenue Service (IRS), housed in the 'Echelon I' building. In the actual audio recording of Stack's conversation he says – 'thanks for your help, have a great day' in very calm words (Statesman, 2010).

The 'euphoric' attacker has also been encountered (Piven, 2008). This is where people committing acts of violence and terrorism tend to display 'happiness', 'joy' and euphoria when committing these acts. The 'euphoric' or joy aspects of terrorist suicide can be identified in relation to the events surrounding Lt. Khaled al-Islambuli. He was an Egyptian army officer who planned and participated in the assassination of Egypt's president Anwar Sadat, on 6 October 1981 (he was captured and publicly executed by firing squad on 15 April 1982). After he shot and killed Sadat, he was expecting to be immediately killed by the bodyguard:

"It appears that he was fully expecting to be shot in the next moment, so he was quickly proclaiming to the world his devotion to his cause and its justifiable jihad-kill. One is reminded here of 'what is known in the Shia Islamic tradition as the bassamat al-farah, or 'smile of joy'—prompted by one's impending martyrdom.' This demeanour on the face of suicide bombers (Sunni for the most part) who were about to blow themselves up on Israeli buses has been widely reported by survivors." (Roberts, 2007)

If we consider the 2008 Mumbai attacks, the reason why the erratic tactics used by the attackers were so effective, was that the drugs cocktail consumed by them created fast moving, aggressive behaviour that was completely illogical and erratic. This type of attack represents a mixed archetype of 'drug-affected' and 'aggressive'. This particular combination made it almost impossible for the Indian security forces to get control of the combat. This type of battle has been called an "erratic assault/dynamic defence" (Flaherty, 2009). This is where one or both sides deliberately act without any plan as a means to create a chaotic and information overwhelm battle. Whereas, in the case of Stack's final exchange (Actual audio recording Stack's conversation) with the control tower at Georgetown Municipal Airport, this was clearly an act of deception. If he had tipped them-off as to his real plan, then he would have failed to attack the IRS building he had targeted, 10 minutes after he lifted-off. Notwithstanding this he had on the morning of the crash posted a suicide note on his website. In summary, five types of terrorist archetypes can be identified:

1. Nervous attacker.
2. Drug-affected attacker.
3. Calm attacker.
4. Euphoric attacker.
5. Aggressive attacker.

In summary, the function of this approach is that it leads to completely different tactics and strategies that need to be considered.

The Embedded Terrorist

Terrorist tactics have always favoured multiple, simultaneous deployment of weapons, either remotely or as part of a suicide-attack. Other attacks have involved the deployment of secondary devices intended to destroy emergency and security forces. However, these tactics do share a commonality namely, they are initiated remotely, and are external to the area that was attacked. That is, these weapons or IEDs have been pre-deployed in places assumed will cause more disruption or damage. Alternatively, the attackers have attacked other locations at the same time, or in a close sequence to each other, in which case these are attacks coming in externally. However, witness statements about the individual emerging from the event as a survivor seeking to use their mobile phone (the 2005 London Underground attack), also provides us with another type of directed attack; highly risky and aggressive, which however is more likely to produce even more devastation. Namely, the embedded terrorist - the deployment of additional suicide bombers with the initial attacker, whose aim (should they survive the initial blast event) is to emerge from among the casualties and wait for the opportune moment to unleash a directed attack on the emergency crews, security and survivors. The embedded terrorist notion is different, in that the second wave attack is internally located within the attack zone itself. Such an attack, given that this would be an 'in situ' attack, would cause an even higher number of casualties as these people (survivors and emergency crews etc), would be caught unable to move; thus realising an almost 20% increase in the number of dead (Flaherty, 2009).

Survivor Responses

The information is presented in Table 2, this has been gained from the CCTV film recorded during the 2004 Madrid train bombings, at the Atocha Station platform, the arrival of train number 21431 (Atocha Station, 2004). As can be seen in the immediate eight seconds leading up to the triple bombings two people appear to look around just after the first blast event (at 07:37 am), and just before the second and third blasts. It appears these are reacting to a noise or commotion in the direction from where the second blast will comes from at 07:38:37. However, the two looking back turn around (independent of each other) and continue moving peacefully out of the frame prior to the next blast occurring.

Important, for the analysis of circumstances that will lead to a scenario involving the 'embedded terrorist' and an 'in situ' attack being possible are that after the attack (in the first 20 minutes) are there considerable number of people remaining to render assistance. The basis of the original study on survivor reactions was to demonstrate that many of the traditional notions about panic following an attack (which tend to inform emergency and security planning) are not the truisms these are assumed to be. It is argued by the study, and this appears to be borne out by the data that even though feelings of panic are widespread, these do not translate into people physically rushing from an event, except in the initial stage where the blast event first occurs and begins to impact on people as can be seen in the CCTV that was taken at the 2004 Madrid train bombings, at the Atocha Station platform (train number 21431), filming the first eight seconds: 07:38:29 to 07:38:52. Table 2 illustrates and confirms this phenomenon. Even then is the response really panic? It appears an alternative explanation would be related to the 'flight or fight response' of the adrenaline-noradrenalin hormone system that would have been activated by the blast, or in immediate proximity to blast effect.

Table 2: Atocha Station Platform: 2004 Madrid train bombings - Train number 21431: Timeline 07:38:29 to 07:38:52.

Time	Seconds		Activity
07:38:29	**00**		Commuters moving out from a train, towards and up a stair case. Some in opposite direction.
07:38:30	**01**		
07:38:31	**02**		
07:38:32	**03**		
07:38:33	**04**		
07:38:34	**05**		Two commuters (independent of each other) at top of stairs moving out, appear to turn around and look back at the platform. NB. The first Bomb had exploded at 07:37. The two commuters appear to be reacting to a noise/commotion in the direction, from where the second blast, will comes from at 07:38:37.
07:38:35	**06**		
07:38:36	**07**		The two looking back turn around (independent of each other) and continue moving out of the frame.
07:38:37	**08**	**00**	**2nd BLAST (back down the platform), which occurred at 07:38:36/37.**
07:38:39	**09**	**01**	Blast back down the platform. People simultaneously rush away on mass towards and up a stair case. Some in opposite direction.
07:38:40	**10**	**02**	**3rd BLAST (back down the platform), which occurred at 07:38:40.**
07:38:41-52	**11-23**	**03>**	Blast effects engulf commuters rushing away from the blast point of origin.

Source: Atocha Station, 2004

A reanalysis of the 2005 London Underground attack survivors' reactions based on the 15meters/11seconds model is presented in table 3. This information is based on manipulated data from the 'Reactions to London bombings' study' (Drury, 2009).This consolidated table has been constructed in answer to the question: what are the likely archetypes and behaviours represented in a group affected by a blast event? For the purposes of this paper, not all the relationships identified in table 3 will be discussed, rather the focus will be on the salient issues. However, in terms of developing the simulation based on the 15meters/11seconds model, it will continue to focus on the data collected in this table in terms of generating further archetypes.

The table 3 data has been constructed, based on the original responses. For instance, the type-three archetype: people reassuring each other (which was 95.89% of the respondents), also expressed 'thinking they might die' (50.00% for that group), as well as a further 41.42% described an orderly evacuation. This process of identifying how the actual 146 responders (in the study) responded to multiple questioning, and then how other statements they made further divided the groups into sub, and sub-sub categories of behaviour; and so forth. This approach reveals some interesting revelations about 'panic', as there appears direct links between expressions of fear, linked however to seeing it in others, as well as concern for loved-ones even though it is known that few (33.33% of the lower sub-sub-sub-groups were actually with friends or family when the bombs exploded). We can assume from these results that 'panic' is an initial 'rush' as is displayed in table 2, and not a lasting state of flight from perceived danger. Fundamentally, this returns to a more conventional understanding of panic, as a disorder defined- "an anxiety disorder in which the individual has sudden and inexplicable episodes of terror and feelings of impending doom accompanied by physiological symptoms of fear (such as heart palpitations, shortness of breath, muscular tremors, faintness)." (Smith, 2002) This is different from the colloquial understanding of panic, which is understood commonsensical as immediate physical flight or running from a danger, and the inability to operate. However, in the case of the survivors there is panic

disorder exhibited briefly, but not the ramped flight so commonly understood to be – panic in civil emergency situations.

Table 3: Archetypes and behaviour(s) represented in a group affected by a blast event.

Archetype(s)	BEHAVIOURS:	SUB-GROUPS; SUB-SUB-GROUPS; & SUB[3]-GROUPS:			% OF THE 146 RESPONDENTS: No.:	%
1	Common commuter.				144	98.64%
2	Attracted toward 'something', i.e. seemed to notice something unusual.				2	1.36%
	BLAST EVENT					
3	Reassuring each other (by hugging or talking), pulling people from wreckage, holding people up as they evacuated.				**140**	**95.89%**
3.1	**Reported thinking they might die.**			**70**	**50.00%**	
3.1.1	Observed fear in others.		50	71.42%		
3.1.1.1	Described/referred to 'panic'/people 'Panicking'. Experience fear / observe in others. Self-report fear.	46	92.00%			
3.1.1.1.1	Expressed concern for strangers/Concern for others (strangers).	24	52.17%			
3.1.1.1.1.1	Showing concern for their friends and loved ones.	12	50.00%			
3.1.1.1.1.2	Reported being with friends or family when the bombs exploded.	8	33.33%			
3.1.1.1.2	Sources of death: more bombs (six); Smoke (two respondents); Suffocation (one); Fire (two).	11	23.91%			
3.1.1.1.2	Reported no such concern for affiliates.	7	15.21%			
3.1.2	Emotional concern for family who were not in danger.		2	2.85%		
3.1.3	Four denials of fear.		4	5.71%		
3.1.4	Felt 'selfish' or guilty (being overly concerned own personal safety). Isolated individuals behaved 'apart from the rest of the crowd (e.g., ignoring others)'		11	15.71		
3.1.4.1	Another survivor behaved 'selfishly' to them or to someone else/Reported receiving, participating in or witnessing personally selfish acts.	6	54.54%			
3.1.4.2	Reported unity did not report help given, received or observed.	1	9.09%			
3.2	**Described 'Orderly Evacuation'.**			**58**	**41.42%**	
3.2.1	Reported **helping others**. Said **they** helped others. Described feeling 'unity with others'. Said they helped someone else. Reported feeling unity, helping (each more than once). Helping another: ranging from comforting, to giving water.		57	98.27%		
3.2.1.2	Others affected by the explosions helping others.	50	87.71%			
3.2.1.2.1	**Being helped** by others/**Who were** helped by others.	29	57.99%			
3.2.1.2.2	Describe feeling a common fate with others caught up in the bombing.	11	22.00%			
3.2.1.2.3	Only two respondents endorsed the term 'panic'.	2	4.00%			
3.2.1.2.4	Not near any survivors.	3	6.00%			
3.2.2	Coming from the other direction gesturing – 'you first'.		1	1.72%		
3.3	**Observed/reporting risking their own safety to help strangers.**			**12**	**8.57%**	
3.3.1	Witnessed no selfish, competitive, or similarly reprehensible behaviour from others.		7	58.33%		
3.3.2	Reported seeing others help.		5	41.66%		
4	Described as 'selfish' for phoning work to cancel his meetings rather than call the emergency services.				**1**	**0.68%**
5	One said s/he 'panicked'.				**1**	**0.68%**
6	Unable to help others, because of some physical impediment.				**3**	**2.05%**
6.1	Reported being helped.			**2**	**66.66%**	
7	Stayed (first aid trained) running around trying to do what she could.				**1**	**0.68%**
				TOTALS	**146**	**99.98%**

Table 3 initially illustrates that some 41.42% of the respondents described an orderly evacuation, and that some 8.57% of the victims appeared to have stayed in the vicinity of the blast events to help other people. Overall, even though 95.89% of the victims reported initially that the dominant behaviour was to 'reassuring each other (by hugging or talking), pulling people from wreckage, and holding people up as they evacuated, or appeared to stay around helping others'. This paints a picture of there still being a number of people in the immediate vicinity of a blast event. As well, a much fewer number behaving selfishly (i.e. not offering any help to others). Table 3 also illustrates the phenomenon that people were in situ after the 2005 London Underground attacks for a minimum of 10 minutes (Barrett, 2005) to a maximum of 40 minutes (Channel4, 2010). As well, the 2011 Coroner's Inquests into the London Bombings of 7 July 2005 is supporting the notion that survivors did stay on to render aid, represented as 8.57% for the group in table 3 (Rayner, 2011).

Train Station Scenario Modelling Ground Rules

The train station scenario modelling ground rules are illustrated in figure 2. The scenario involves an assailant with backpack moving into the station with the intent to kill people around the 4:53 pm train standing on platform 9 at that time. The assailant has cues that some people will interpret negatively and change what they are doing to distance themselves.

A backpack IED is detonated at 4:51pm wherever the assailant is located. It should be platform 9 about halfway down. This kills or injures everyone in that cell (roughly 15meters by 10meters). In cells around this the sense of imminent danger is high and everyone changes their behaviour according to their own attributes (aggression, training in first aid, empathy and disorientation etc). People with high aggression try to flee the scene very fast with a goal of reaching an exit. People with high training will have the affected cell as the goal. Their empathy will be set high to attract empathisers.

People with high empathy will be influenced by the people with high training to help them. Those with high disorientation will enter a random pattern of movement. All others attempt to evacuate in an orderly manner. Both of these groups will have a 'meme' (i.e. an idea, behaviour or style that spreads from person to person within a culture or group) of the event to transmit to others. Further away in the station, people know something has happened but not what. They change the behaviour to one of moving towards the event until they receive the meme and then behave according to their attributes above.

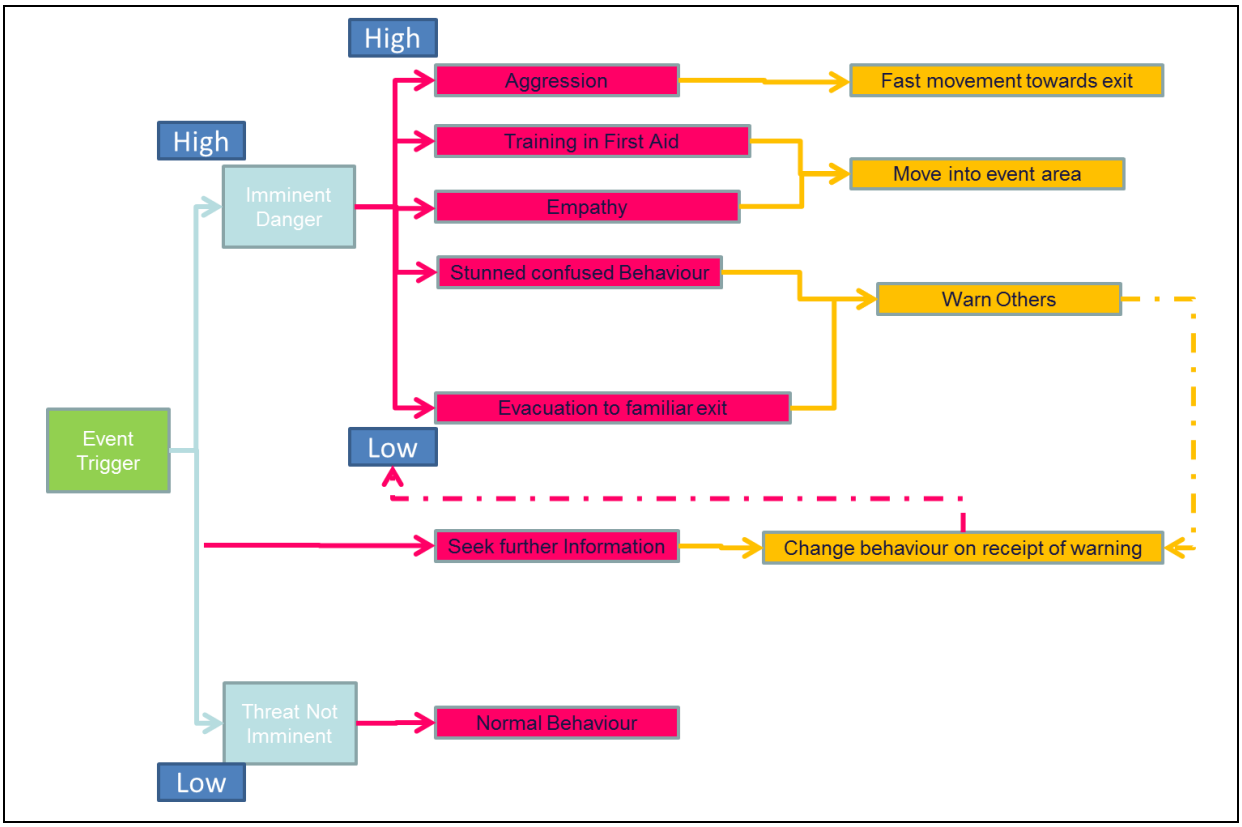
Those who enter the station after the event have no knowledge of anything and remain fixed to their original goal but change if they receive the meme. The characteristics of each of the characters are set out below. Firstly, the assailant characteristics:

- Aversion factor: This is the presentation of cues that perceptive people can understand causing them to move away from the person if they can.
- Imminent Danger: This is similar to the general population but if activated before his or her act of destruction would force him or her to change goal.
- Other factors: Associated with imminent danger might also be present if related to the change of goal.

The assailant's goal in this particular scenario is to move to platform 9 by 4:51pm. The current location of platform 8/9 will need to be divided into 15meter sections to represent the death and injury radius of a backpack IED. Secondly, the population characteristics are that:

- Aversion factor and resistance: Allows modelling of a part of the population who pick up on clues and will try to move away from the assailant.
- Imminent Danger: This will cause a change in behaviours dependent on several other personal attributes and the strength of the perceived danger.

Figure 2: Schematic of the scenario.



Fundamentally, there are four attributes, which operate when the imminent danger is high. They are not mutually exclusive but it is suggested that tests for each are used in the following order:

- Aggression: High aggression will cause the person to move quickly away, and will push and shove in crowds. As well as queue jumping at barriers.
- Training: The level of training that a person has received in First Aid. Highly trained will start to move towards the injured in an event.
- Empathetic: The level of willingness to help even if not trained. Will seek out and take direction from trained people.
- Disorientation: People move randomly about.

Those not assigned in one of these four categories will change behaviour to an evacuation. In areas where imminent danger is noticed but not high, then behaviour is towards moving toward the event, in order to find out some information before making a decision. This should set up a counter flow to people evacuating. Finally, a mechanism will be set up for memes passing between people who on receipt can change the actions into those above, while, those not affected will behave to reach their goal.

Outcomes Being Tested

Figure 3 illustrates the outcomes being tested in the train station scenario. In the first phase it is whether the level of cues alters the number of people that are injured or killed in the event by getting people to distance themselves away from the assailant. The null case is where no influence occurs. In the second phase there are a number of outcomes, namely observations identifying:

- Fast movement away from the event location.
- People moving towards the event location consistent with trained and empathetic people helping.
- Counter flow between people evacuating and those moving to find out more information.
- Moving the counter flow further from the event site as word spreads about the nature of the event.

A great deal of the research into evacuation strategies currently in use, including the models used to represent these in the design of urban environments, do not capture all the salient behaviours that are seen (Kobes, 2010). Another deficiency is that current solvers restrict the capacity of grid cells to a fixed value, and provide no ability to change capacity dynamically depending on the social state that is provided. The current development of the transport and intelligence modules is already showing promise in overcoming these restrictions (Piper, 2009). One of the objectives of this project is to validate these new models. Additional cells can be added for platform 11 and 12: These would be approximately 15meters in length and half the width of the platform (approx 5meters). This will require 14 sections for both platforms. As well, the addition of the assailant whose objective is to go to platform 9 (section 9-8).

The model can be further modified to include infection parameters. These can be set to everyone being susceptible but no latency, asymptomatic or ‘hero’ (a person who carries on regardless of illness) times are included. As well, the model randomly selects those who become symptomatic or dead. Symptomatic may die over the course of the emergency phase. Sections 9-8 and 8-8 will have an infectious person who remain in these sections and become infectious agents at the time of the bomb blast, for the minimum TIC (time in class, i.e. all time spent in class or category).

Finally, a recently developed module embeds intelligence within the simulation framework (Keep, 2011).This is a different problem to the common use of rules for many gridded problems currently employed in simulation. The research has identified an appropriate basis for the modelling of intelligence (reinforcement learning). The mechanism allows for the specification, acquisition and learning of properties between peeps (simulated individuals). Sentinel peeps added to each cell who will broadcast the imminent danger of the event for each cell. The strength of the imminent danger will decrease with distance away. Those on platform 8 and 9 will be aware of the danger but those further away will be less certain until those coming in will not have any knowledge. This will develop templates for each type of behaviour and the ‘Intelligent modules’ to change peoples’ various states.

Figure 3: Modifications to central template,

Peeps: Attributes and behaviours

Terrorist: Threat - Used to trigger citizens behaviour through threat perception.

Broadcast: Proximity to Blast (0 – 1) – drops of as one moves away from the blast. Used to change the behaviour through Danger perception. Becomes active at the time of blast only.

Citizen:

- Impatience
- Training
- Empathy
- Focus
- Extroversion
- Awareness
- Leadership

Peeps internal passive attributes that are set prior to the simulation for each individual peep

Broadcast on state change to primary assistance

- Danger Perception
- Threat Perception
- Leadership Perception

Peeps internal dynamic attributes that change during the simulation

Infection Parameters:

- Latent = 0
- Asymptomatic = 0
- Heroic = 0
- Symptomatic = 0 to infinity (defines the time people are alive after event)
- Death Chance = 1 (will become dead after expiry of Symptomatic time)
- Infection Chance = 1 (will all become injured or dead)

Mask Terrorist -> Citizen - ensure that only the terrorist can infect a citizen and not citizen to citizen.

Conclusion

The transport module to develop a model of the upper level of a capital city central station is currently under development. This development also includes the use of an 'event schedule' to move peeps from the city to one of several entrances to the station. This model provides a distributed pattern of likely behaviours, which can be used to better understand and predict post-blast-event recovery. The intelligence model has been created and tested in a limited environment of one corridor and spreading of influence in that environment. It has not, however been used to test the influence with a change of behaviour to assess the outcome of such behaviour changes. The scenario outlined here suggests a number of features of this type of interaction, which can be tested. In particular, development of a proof to show confinement without walls is an important consideration. In summary, statistically speaking through an analysis of the physical circumstances of attacks historically and observing key factors of 'grouping, proximity, and in situ', we can see that the proportion of people killed as opposed to being injured, if these conditions are met. The outstanding problem is that while confinement where there is limited reflection from the blast near structures (or no structures but where there is no ability to move, such as seating arrangements etc in a stadium) would not be different from an unconfined situation; thus leading to the question: so why the

dramatic change in death to injury? A proof to show confinement without walls is an important consideration should come from a review of incidents in terrorism databases where reflection is not a factor in confinement. The hypothesis is that people react to assailants negatively and where they can move away they will, and that this appears to actually occur in minute fractions of time.

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