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PARKES, Stephen <http://orcid.org/0000-0002-4379-2058>, JOPSON, Ann and MARSDEN, Greg

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Understanding travel behaviour change during mega-events: Lessons from the London 2012 Games

Stephen Parkes[1]*, Ann Jopson and Greg Marsden

Institute for Transport Studies, University of Leeds, Leeds, LS2 9JT, United Kingdom.

*corresponding author. Email address: stephen.parkes@nottingham.ac.uk

Abstract

This paper presents results from a longitudinal study of the travel behaviour change associated with the London 2012 Olympic and Paralympic Games (the 'Games'). The research examines commuter travel behaviour through a panel approach enabling an understanding of individual behaviour across three waves (before, during and after), with the study utilising unique access to a Transport for London panel study (n=1132). The findings indicate that a substantial amount of change occurred during the Games (54% made at least one change), with reducing or re-timing journeys being the most likely adaptations made. A key objective of this work was to advance the discussion about the theoretical constructs that are most applicable in the study of behaviour change associated with disruptive events, which was done through the application and critical evaluation of the Transtheoretical Model. The insights from the stages of change element of the model were relatively limited but the analysis shows significant differences in the underlying factors explaining change according to the type of change made (reduce, re-time, re-mode and re-route). Whilst the long-term behavioural impacts of events like the Games appear small, the study has uncovered a need to consider these behavioural choices as distinct rather than under the collective term of "travel behaviour change", as is current practice.

Keywords: Olympics and Paralympics; behaviour change; disruption; mega-event; Transtheoretical Model; stages of change

1. Introduction

Mega-events are events that draw substantial numbers of individuals to a location, placing the local environment and infrastructure under great pressure, and bringing disruption to residents. The Olympic and Paralympic Games are one of the most prominent examples of such events, a category which also includes, amongst others, Presidential inaugurations, the Football World Cup, and Papal visits (Ritchie, 1984). The characteristics of a mega-event, in particular the significance of their scale, mean that whilst they occur over only a few weeks, the preparation for them takes place over a number of years. A broad range of stakeholders contribute to these preparations, with a need to balance the desire of showcasing the city whilst maintaining as much continuity as possible for the resident population. A core element of this continuity involves the maintenance of the transport system to ensure the effective movement of goods and people around the city.

This paper presents a case study of the London 2012 Olympic and Paralympic Games to examine the travel behaviour impacts such a mega-event had on commuters. To counter the pressures facing the London transport network the organisers developed an extensive transport strategy, which included travel behaviour change measures, increased capacity, and traffic management improvements (Currie et al., 2013). Despite the improvements to infrastructure and services, as with all mega-events, there remained a substantial number of locations across the network where demand could significantly

[1] Present address: School of Geography, University of Nottingham, Nottingham, NG7 2RB, United Kingdom.

exceed capacity at certain times of the day during the Games in the absence of a change to the underlying behaviour of residents and commuters (these were known as 'travel hot-spots'). Therefore the interventions of the organisers focused, in part, on efforts to reduce the demand on the network at peak periods of the day at these travel hot-spots. These changes focused in particular on 'reducing, re-timing, re-routing, or re-moding journeys' ('reducing' includes working from home, working elsewhere, or taking annual leave) (TfL, 2013).

This paper provides a clear step forward in understanding the travel behaviour change of individuals in response to disruptive events. The availability of longitudinal panel data is unique in this context and enabled the authors to advance further than previous studies of Olympic and Paralympic Games (Giuliano and Prashker, 1986; Brewer and Hensher, 2001) in the understanding of travel behaviour of individuals in such contexts. In so doing, the work also reveals implications for the wider field of travel behaviour change in the conditions necessary to support the different response options.

As Section 2 of this paper will discuss, the pre-planned nature of this event meant that TfL sought to engage with the public and businesses to understand the pre-planning and preparation for change they were undertaking. Working with TfL provided an opportunity to apply and critically evaluate the Transtheoretical Model (TTM) (Prochaska and DiClemente, 1983; 1982), which focuses on a staged approach to behavioural change, and to understand the importance of various psychological constructs to understand the change processes. This is important if understandings of the behavioural insights from different mega-events are to be shared more effectively. The scale of the disruption meant that even those with no pre-disposition to change their usual journey to work were potentially faced with a need to do so. Studying the behaviour before, during, and after the Games meant that a greater understanding could be garnered about how individuals changed, what psychological factors helped them to do so, and whether a pre-disposition to change influenced the longevity of change observed.

By utilising the TfL classifications of behaviour change for the Games (reduce, re-time, re-route, re-mode), this paper is also able to report on an investigation of the importance of the differences between factors explaining the types of behavioural adaptations adopted. This is important in moving beyond a simple 'behaviour change' message as the behaviours are quite distinct.

This paper will first present an overview of the London 2012 Olympic and Paralympic Games before discussing the application of the TTM and the methodological approach that was taken in this research. The results are then presented, initially with a discussion of the travel behaviour changes observed both in the short and longer-term. The findings related to the application of the TTM are then presented and the insights gained from this are discussed. Finally, the conclusion section will draw together the key findings from this research and discuss the implications of this for both the behaviour change potential of mega-events (and other types of disruptions) and the methodological approaches that can be used in the study of them.

2. Travel Behaviour Change and Disruptive Events

2.1 The behaviour change impacts of disruptive events and targeted interventions

Mega-events and other planned disruptive events (e.g. prolonged road closures, public transport strikes etc.) present instances where the usual context within which transport journeys are made is drastically altered (Marsden and Docherty, 2013). The evidence shows that substantial changes in behaviour are achievable during the short period over which the event takes place. In Los Angeles during the 1984 Olympic Games, for example, 23.3% of commuters departed their homes earlier in response to the potential disruption and 10.0% changed their route to and from their workplace (Giuliano and Prashker, 1986). At the Sydney 2000 Games over 26.7% of those in employment took leave from work during the Games, many to avoid the anticipated disruption to travel (Brewer and Hensher, 2001). Such changes are notable but it is unclear how temporary these may be. Such events

appear to only exhibit temporary changes but the lack of study in this area is such that the evidence remains very limited.

Other disruptive events, both planned and unplanned, have also been studied for their impacts on the transport system. Pnevmatikou et al. (2015) reported on a prolonged (5-month) closure of a metro line in Athens, Greece, demonstrating that certain factors (in this case: disposable income, gender, and fixity of work schedules) helped determine alternative mode choice in response to the disruption. The study of an 8-day freeway closure (Fujii and Gärling, 2003; Fujii et al., 2001) demonstrated how pre-existing travel behaviour can be associated with the type of change an individual might make in response to a disruption. For example, a higher frequency of car commuting was shown to be associated with a lower frequency of changing to public transport modes during the closure (Fujii et al., 2001).

The disruptive events described show how travel behaviour at the time of the event can be extensive but there is also further interest in how particular disruptions generate changes afterwards. Walsh et al. (2015) studied a range of unplanned disruptive events (or 'wildcard events') which had consequential impacts on significant transport infrastructures. The authors highlight such events as opportunities for significant learning and improvement in infrastructure, and also for behavioural change. Shires et al. (2016) studied behaviour following the closure of the Forth Road Bridge in Edinburgh, Scotland, where journey times for car drivers who used the bridge doubled to 90 minutes via a detour. Around 60% switched to rail and there was a 12% reduction in the number of days people travelled to work. Despite the additional delays to journeys and overcrowding on some rail services 8% of respondents reported that they were likely not to return to their previous departure time, 7% not to return to their previous number of days travelling to work and 6% not to return to their previous mode (*Ibid*.).

Whilst this literature points towards the potential for mega-events and disruptive events more widely to have the potential to bring about changes in the transport system the reasons which explain why people adapt as they do are not well understood (most studies rely on recall). In addition, the context requiring the behavioural shift is generally time limited and the long-term effects could therefore be small. Current studies have also focused more on the outcomes than the underlying processes which explain those outcomes. There are some tentative parallels here with the work around behavioural changes associated with the life course, or life events (e.g. Chatterjee et al., 2013). In their recent work, Chatterjee and Scheiner (2015) provide a detailed examination of 'mobility biographies', which deals with how life events affect travel behaviour. The authors draw attention to a need to understand the current disconnect between key events and travel behaviour, which is particularly relevant to this study of mega-events. Verplanken and Wood (2006) suggest that destabilising environmental cues could render habit more open to change, so, even when the situation reverts to normal, new ways of doing things have been tried, some of which may stick. There remains, however, a distinct lack of theoretically informed understanding of the factors affecting the behaviour changes being made during events, and of the potential for longer-term sustainment of the changes that are made, which this paper seeks to address, albeit, importantly, doing this in a critical manner (Scheiner and Holz-Rau, 2013).

2.2 Case Study: The London 2012 Olympic and Paralympic Games

The Olympic and Paralympic Games bring an influx of individuals to locations where the transport networks are often already at capacity, which prompts substantial planning and preparation by the organisers to mitigate against the high levels of disruption such a concentration of travellers may create in the host city. The importance of effective transport preparations for Olympic and Paralympic Games has been continually demonstrated over many decades and recognised in the transport literature (Kassens-Noor, 2012; Kassens-Noor, 2010; Bovy, 2009; Frantzeskakis and Frantzeskakis, 2006; Hensher and Brewer, 2002; Essex and Chalkley, 1998). This section will provide a detailed examination of the background to the case study presented in this research and reflect on how changes in travel behaviour were sought by the organisers.

The London Olympic and Paralympic Games were held in the summer of 2012 and reports from the Games indicated that there were an additional 800,000 journeys made on the busiest days of the Games (Sumner, 2012). Whilst at the aggregate level such numbers appear relatively manageable against the overall number of trips typically made per day in London (25.5 million), these journeys were highly geographically specific and also involved significant additional loading at key underground stations and interchanges which already operate over capacity. Without intervention, such a concentration of passengers – added to existing levels - had the potential to create significant travel delays and disruptions, as evidence from past events has shown (see previous paragraph).

A key feature of the preparations made by the organisers of London 2012 was the Games Transport Plan, which was produced by the Olympic Delivery Authority (ODA, 2011). This included a transport strategy with three separate (yet overlapping) elements. These were: 'Capacity Creation Measures', 'Travel and Traffic Management Measures', and 'Travel Behaviour Change Measures' (Currie et al., 2013). TfL - an existing body in charge of managing the transport network - was given the responsibility of implementing the strategy.

The Capacity Creation Measures and Travel and Traffic Management Measures involved numerous projects completed in the run up to the Games. This included the Olympic Route Network (ORN) and Paralympic Route Network (PRN) (also known as designated 'Games Lanes') (see Figure 1), which were designed to provide a route through which the 'Games Family' (athletes, team officials, press, broadcasters and other officials) could be transported quickly and reliably, via existing roads, to venues. A further example is Stratford station (on the eastern edge of the Olympic Park), which was invested in to provide increased capacity and improved service, which would also provide a legacy to regular users once the Games had ended. Walking and cycling routes was another example of the variety of investment in infrastructure and services to help improve access to Games venues.

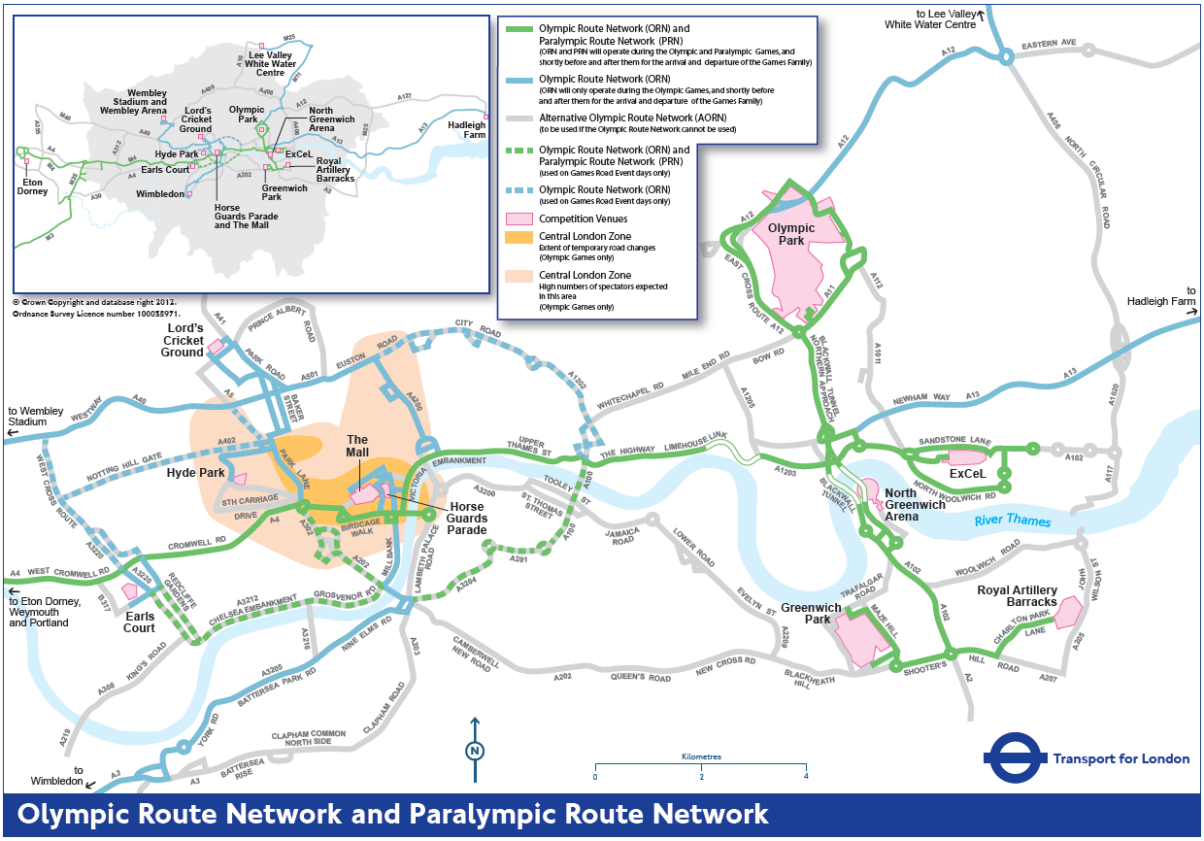

Figure 1: Map of the Games venues and Olympic/Paralympic Route Networks (TfL, 2012a)

The third set of measures (Travel Behaviour Change) is of most interest to this paper, specifically the Travel Demand Management (TDM) programme that was initiated. This programme was the largest ever produced for an event (Currie et al., 2013) and sought to encourage behaviour change over the period of the Games to reduce the pressures on the system (ODA, 2011). A key purpose of the TDM programme was to relieve the pressures on the travel hotspots - identified prior to the Games (for an example see Figure 2) - by encouraging shifts in travel behaviour through reducing, re-timing, re-moding, and re-routing. Engagement with users of the system (both residents and visitors) through TDM utilised a range of measures and tools, which included: the 'Get Ahead of the Games' programme[2], free travel cards, a spectator journey planner, and an 'advice to business' programme, which included tailored support for larger businesses (over 250 employees) (TfL, 2012b). The transport literature has captured the effects of similar interventions on travel behaviour change. For example, Fujii and Kitamura (2003) studied the impacts of a free one-month bus ticket on habitual drivers, albeit using a small sample size. In this case habitual bus use increased whilst automobile use declined in the short-term (one month) post-event. Similar findings were reported by Thøgersen (2012) who studied the provision of free travel cards in Copenhagen, notably identifying that greater effects were seen in those who had already experienced a recent life event (in case moving residence or workplace). These studies help to show that interventions such as this have the potential to enact more substantial shifts in travel behaviour by helping to alter the context within which individuals are travelling, although the lack of understanding of the longer-term situation is indicative of the wider transport literature that this paper is contributing to.

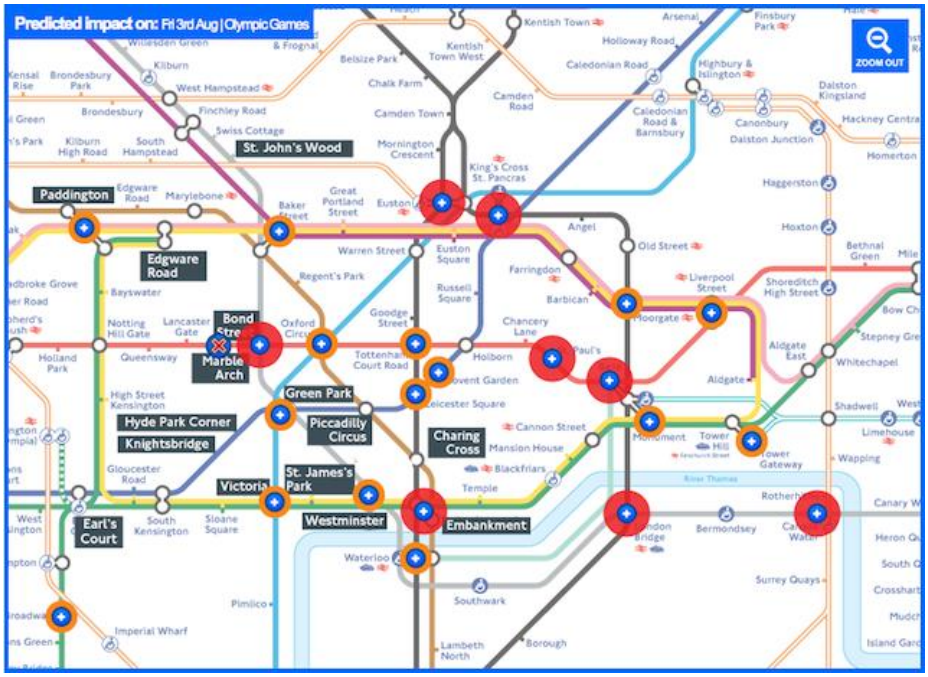

Figure 2: Example of travel hotspots[3] during the Olympic Games (Inside the Games, 2012)

The prominence of an Olympic and Paralympic Games as a global event means that they experience significant scrutiny in all aspects of their organisation and performance. Whilst this presents a potentially challenging context within which the organisers must operate, there are also potential advantages to this. The media hype around the Games is argued to help generate 'the big scare' (Currie et al., 2013; Currie and Shalaby, 2012), which creates an environment where the perceived impacts of the event are believed to be much more negative than the reality. This helps to

[2] The GAOTG programme was a channel through which travellers were engaged with, mainly through the website or social media to provide advice and information before and during the Games.

[3] Red circles indicate stations predicted to be 'exceptionally busy' and orange circles indicate 'busier than usual' stations

constructively support greater amounts of travel behaviour change by prompting individuals to engage more with their behaviour change options.

With regard to London 2012, and the transport experience, the overall view of the performance of the network was reported as positive. As expected, there were significant pressures placed on the system, for example, a 28% increase in London Underground journeys compared to the same period in 2011 (TfL, 2012b). There was also evidence of some smaller disruptions; including confusion over lane closures for the ORN and isolated systems failures on the underground network (BBC, 2012a, 2012b, 2012c; The Independent, 2012; Meikle & Topham, 2012) yet these did not compromise the running of the wider system, which echoed the evaluation conducted by TfL (2013; 2012b).

Given the opportunity the Games presented for the study of the travel behaviour implications of a large-scale disruptive event the authors sought to conduct research to this effect in London during the event. TfL were approached and agreed to incorporate survey items to understand the factors explaining the changes that might be made as part of a longitudinal panel analysis that they were commissioning. This provided a valuable opportunity for detailed research with a large sample over an extended period of time, which has clear value for improvements in how travel behaviour change is understood. Section 3 sets out the rationale for the choice of the TTM in this study.

3. The Transtheoretical Model

The TTM is a socio-psychological theoretical model that has been applied to study the process of behaviour change at the individual level. The framework originated in the health behaviour field and was developed to unify a number of health behaviour theories (Prochaska and DiClemente, 1983; 1982). It comprises of four constructs: the stages of change, the processes of change, self-efficacy, and decisional balance, and has been used widely to study problem behaviours including, for example, smoking cessation and increasing physical exercise. Critically, for this study, the relevance of the TTM is that it views change as a temporal process, with the stages depicting the individuals' progression towards behaviour change. Importantly, it also accounts for the considerable activity the individual goes through beneath the surface before any noticeable change is observed (Jones and Sloman, 2003), which is of interest given the substantial pre-Games programme of messages and supporting measures. The Olympics and Paralympics engagement was attempting to lead people through a process of change. A key question, of course, was whether any of the changes which were made in the period of the Games persisted afterwards when the context returned to a pre-Games state. Previous studies of disruptive events – including Olympic Games (Brewer and Hensher, 2001; Giuliano and Prashker, 1986) and transport strikes (Van Exel and Rietveld, 2009; Coindet, 1998) - have shown that substantial changes are possible in the short-term, yet often do not sustain longer-term. It could be the case that this kind of short-term response is not so amenable to deploying attitudinally derived psychological models of behaviour, a point that is supported by the experience of Beatty et al. (2002) in the application of a reduced TTM model in the study of a national fuel shortage. However, Beatty et al. relied on recall of behavioural response during the fuel shortage and had no before data. There is no published example of the application of a longitudinal behaviour change study on which to determine the efficacy of such models.

The TTM is applied in this paper with the aim of studying in greater detail the changes in travel behaviour of commuters in London associated with the Games. Three constructs of the TTM are applied, with the aim of assessing their value when applied in this context. These constructs are the stages of change, the processes of change, and self-efficacy, which will each be described in the remainder of this section. Firstly, the stages of change, which relate to the position the individual considers themselves to be in the behaviour change process. Table 1 provides an overview of the stages of change, which an individual will move through as they change behaviour (Prochaska and Velicer, 1997). An individual in the latter stages, for example action, has progressed to a point where there is a greater likelihood of changing their behaviour in comparison to any of the previous stages. These individuals are expected to make a change soon and find it easier to do so than those in the earlier stages. Notably, the TTM sees change as something which occurs in a spiral – meaning that it

is not necessarily definitive and linear, accounting for relapses in behaviour (Prochaska et al., 1992). Relating this to the travel behaviour change programme initiated by TfL, success of this programme may be observed through initially raising people's awareness of a need to think about changing behaviour, through to supporting them and the businesses they work for to make that happen. This is the initial focus of this research and is considered the first key outcome of the study. The stages of change were measured in the surveys reported in this paper by presenting the statements from Table 1 with respondents then asked to indicate which one best described them. Minor changes were made to the wording of the statements, which were included in Wave 3, to account for the temporal shift between stages.

Table 1: The Stages of Change (as presented in Wave 1)

Pre-contemplation	Contemplation	Preparation	Action	Maintenance
I am not considering changing the way I normally travel to work.	I am considering changing the way I normally travel to work but I am not in a position to make this change yet.	I am doing things to prepare myself to change the way I travel to work.	I have tried changing the way I travel to work once or twice since the beginning of this year.	I have regularly tried changing the way I travel to work since the beginning of this year.

A reported advantage of the TTM is that it provides an insight into the process of behaviour change experienced by the individual (Anable et al., 2006). In transport, it has been applied to study specific modes, for example, cycling (Nkurunziza et al., 2012a; Rose and Marfurt, 2007; Gatersleben and Appleton, 2007) and car use (Bamberg, 2007; Beatty et al., 2002), along with wider modal change (Shannon et al., 2006). The TTM has typically been used to tailor stage specific interventions to help facilitate changes in behaviour. For example, Gatersleben and Appleton (2007) studied cycling to work, using the stages of change to group participants. This enabled them to then explore the motivations of each group, allowing them to build a picture of what interventions would be needed to encourage a greater degree of cycling from the sample.

The second construct of the TTM included in this research are the processes of change, which are described as the activities an individual engages in as they progress through the stages (Prochaska and Velicer, 1997). There are ten processes relating to the activities or resources the individual is able to utilise to support themselves in making a change in their behaviour. Figure 3 shows how the processes of change map on to each stage, as characterised by the literature (Nigg et al., 2011; Burkholder and Nigg, 2002), and therefore what type of activities or resources are of particular importance to an individual at each stage. For example, those in the preparation stage would be engaging with particular processes as they seek to take steps to be able to act on their intention to change behaviour soon. In this study it is possible to assess whether, in the conditions of a mega-event, the processes of change retain the same relevance to particular stages. It is also possible to understand if differences exist between the four types of change studied (reduce, re-time, re-mode, re-route).

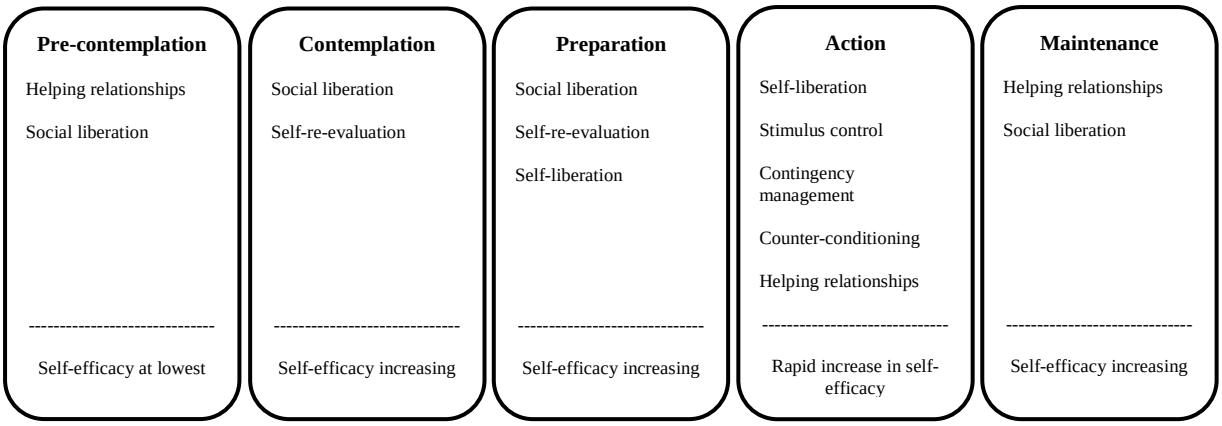

Figure 3: The Transtheoretical Model (adapted from Burkholder and Nigg, 2002; Nigg et al., 2011)

Table 2 lists these processes and the statements presented to respondents in Wave 1 of the panel survey, with minor changes being made to the wording of statements to reflect the temporal changes across the three waves. Note that only eight of the processes were included in the surveys and these were measured as individual items using a 5-point Likert scale (1 = strongly agree/5 = strongly disagree). 'Dramatic relief' and 'consciousness raising' were omitted due to constraints to the number of items in the surveys and they were deemed to be least relevant for understanding behaviour change in the context of the London 2012 Games (see Parkes, 2014, for further details).

Table 2: The Processes of Change statements (as presented in Wave 1)

Environmental re-evaluation	Changing the way I travel to work might encourage others to change.
Social liberation	Colleagues/friends are discussing changing the way they travel.
Helping relationships	My employer has encouraged me to change the way I travel to work.
Self-liberation	I can change the way I travel to work if I try hard enough.
Counter conditioning	Changing the way I travel during the Games will improve my travel experiences.
Stimulus control	I will plan my time during the Games so that I am able to change my work travel.
Contingency management	Changing the way I travel may have the added benefit of finding new or better options for my journey to work.
Self-re-evaluation	I believe that changing the way I travel during the Games will show me to be a proactive person.

The final construct of the TTM included is self-efficacy. This relates to the confidence an individual has in their own ability to cope with the situation they are faced with (Prochaska and Velicer, 1997). As the individual moves through the stages, the theory suggests that this is matched by increases in their self-efficacy until it peaks in the maintenance stage (this is shown in Figure 3), which highlights the importance the framework places on confidence in the behaviour change process. Self-efficacy is examined in the surveys through the ease or difficulty of changing specific behaviours (mode, time of travel, route, and working from home) and is measured on a 5-point Likert scale (1 = very easy/5 = very difficult).

Decisional balance (the perceived pros and cons of changing) is the fourth construct of the TTM. This construct was not included explicitly in the panel surveys in the same way as the other constructs, with further attitudinal questions being asked of the respondents instead. This is perhaps a reflection of one of the minor constraints of applying the TTM through the TfL Panel Survey. Decisional balance was therefore not included in the analysis and discussion presented in this paper. This is supported by similar studies, where adaptation of the TTM is shown to be common in research in the transport field. Many examples have only used the stages of change construct of the model (Nkurunziza et al., 2012b; Gatersleben and Appleton, 2007; Rose and Marfurt, 2007) to study travel behaviour. Shannon et al. (2006) used only the stages of change and self-efficacy constructs in their investigation of active commuting in a university setting. Beatty et al. (2002) used a more comprehensive application of the TTM but only used six of a possible 10 processes of change. Furthermore, some studies are shown to have used certain elements of the TTM as part of a wider adapted model (Bamberg et al., 2011; Bamberg, 2007; Jones and Sloman, 2003). Whilst not covering every aspect of the whole TTM, the application of the model in this paper is therefore ultimately more comprehensive than previously reported transport studies.

4. Methodology

The data presented in this research was derived from a three-wave longitudinal panel study conducted between July and December 2012. Commissioned by TfL and conducted by the consultants AECOM, the purpose of these online surveys was to examine the before, during, and after situation around the impacts of the Games on travel behaviour. Overall findings of the panel study have been published independently by TfL (2013; 2012b). The collaboration between the authors and TfL, detailed in Section 2, allowed the authors to contribute to these surveys through the design of certain questions (specifically the TTM items, as described in Section 3) and in the provision of comments on the overall design of the three surveys and it is the relationship between the travel outcomes and the TTM measures which are the focus here.

The sample used throughout the panel study was recruited from the TfL customer database, which comprised customers from the congestion charging system, London bike hire scheme, and oyster card users, all of whom were willing to be contacted for such research purposes, along with those registered with TfLs information services. At the time this database totalled approximately 200,000 individuals. Further on-street recruitment at potential Games-time travel hotspots was also conducted by AECOM to reduce potential survey bias by including individuals who were likely to be affected by the disruption but were not necessarily users of the services included in the customer database (i.e. car drivers).

The sample (n=1799) included as part of the AECOM and TfL panel study (and reported in TfL, 2013; 2012b) included London residents, workers and regular visitors with the purpose being to study travel behaviour change in order to understand the impacts of the Games. TfL did not report any bias in the sample (TfL, 2013) and the sampling was designed to be representative of the population of study although exactly what the population of affected travellers would be is not easy to define. However, it can be understood that, given the predominant (albeit not exclusive) focus on commuting in the TfL panel study, unemployed and retired individuals are likely to be underrepresented in the sample. The authors are unfortunately unable to report on the specific response rate for the surveys but it expected to have been low given the high number of potential respondents contacted and the eventual number of responses received (n=1799). There may be a response bias in that individuals more likely to be affected would be expected to be more likely to participate in the survey and to respond across multiple waves (although we note the large proportion who were not anticipating making a change in Wave 1). Whilst a bias towards those impacted will help with understanding the underlying behaviours, when percentage changes are referred to in the results it should be noted that these should be interpreted as the upper bounds of the total behavioural response made and the purpose of this paper is not to estimate a population wide change.

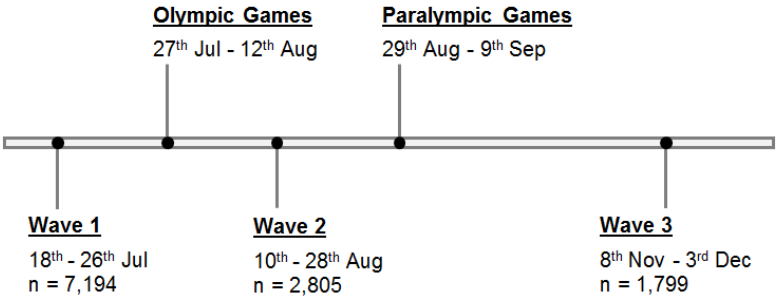

Figure 4: Data collection timeline for the London 2012 Games

Figure 4 details the specific timeline over which the surveys were conducted, which produced a final sample of 1799 individuals who responded to Waves 1 to 3. The sub-sample examined in this paper consisted of 1132 individuals who had responded in all three waves and had completed the stages of change items. This remains larger than the samples of comparable studies (Nkurunziza et al., 2012a; Gatersleben and Appleton, 2007; Beatty et al., 2002). It is recognised that there was a considerable attrition between Wave 1 and Wave 3. To understand this further, analysis was conducted on the Wave 1 sample between those who continued to Wave 3 (n=1799) and those who dropped out (n=5395) in order to understand whether there were any major differences between these two groups. The descriptive statistics for the socio-demographic attributes are summarised in Table 3 and this shows that there was very little difference in the characteristics of the two groups, which reduces concern that the level of attrition may have biased the sample and the results presented in this paper. Further analysis of other variables also supported this position. For example, the stages of change responses in Wave 1 were shown to be very similar with the degrees of variance limited to only one or two percent (as was the case with the socio-demographics).

Table 3: Socio-demographics of Wave 3 responders and non-responders

Socio-demographics	**Wave 3 non-response (n=5395)**	**Wave 3 responders (n=1799)**
Gender		
Male	45.5	46.4
Female	54.5	53.6
Age		
18-24	9.1	6.6
25-34	32.2	28.0
35-44	24.1	23.3
45-54	21.0	24.6
55-64	11.8	15.3
65+	1.9	2.2
Household structure		
One person household	18.0	20.5
One family household - Couple with no children	30.7	32.7
One family household - Couple with children	28.7	28.2
One family household - Lone parent with children	3.8	3.7
Two or more unrelated adults	15.5	12.6
Multi-family households	3.4	2.3
Household income		
Up to £19,999	7.9	6.3
£20,000 up to £39,999	19.1	22.6
£40,000 up to £59,999	21.5	23.6
£60,000 up to £79,999	17.6	18.5
£80,000 up to £99,999	12.1	10.9
£100,000 or more	20.4	16.7
No source of income	1.4	1.5
Employment position		
Manager & Senior Official	29.1	28.6
Professional & Associate Professional	43.9	43.3
Admin, Secretarial & Skilled Trades	14.5	18.3
Personal Service, Sales & Customer Service	6.9	3.9
Process Plant Machine Operative, Elementary & Other	5.4	5.7
Access to cars		
None	33.6	32.3
1	39.3	41.9
2+	27.2	25.8
Access to bicycles		
None	51.4	51.2
1	23.9	25.1

2+	24.7	23.7
Num. employed in business		
< 250	46.6	43.6
> 250	53.3	56.4

5. Findings

The panel study included in this research has provided a valuable opportunity to examine behaviour change longitudinally, as well as enabling the innovative application of the TTM to further understand the factors that underpin the change observed. This section will initially report on the degree of behaviour change observed as well as examining the temporal dimension and longevity of change. The TTM results from Wave 1 (pre-Games) are then examined, as this shows the underlying factors affecting and supporting change at the outset, immediately prior to the disruption.

5.1 The travel behaviour impacts of the Games

Figure 5 presents the broader shift in travel behaviour change observed amongst the sample from Wave 1 to Wave 3 of the panel study. 'Change' in this figure refers to either reducing, re-timing, re-routing, or re-moding, and notably helps to demonstrate the importance of the intention to make a change as well as the extent to which changes were sustained. Considering the intention to change first, the figure shows that nearly two-thirds of individuals intended to make a change to their behaviour during the Games. Of this group, 76.3% went on to make a change suggesting that intention was a good predictor of actual change. 40.1% of those with no intention to change did also go on to change, suggesting that there was a degree of spontaneity in some of the decisions to change.

The degree to which changes were sustained by those with an intention to change was low, but not zero. 11.6% of those who intended to change prior to the Games went on to sustain a change. Of those with no intention to change pre-Games, only 6.9% continued with their change. Analysis of these individuals using a Pearson's chi-square test showed that those with an intention to change in Wave 1 were significantly more likely to go on to sustain a change (x^2 (1) = 16.631, $p < .001$). Overall, 6% of the total sample sustained their change after the Games, which included 3% of the sample sustaining changes to time, 1% to mode, 2% to route, and 2% continuing to reduce their journeys more than pre-Games (note that in some cases individuals maintained more than one change in behaviour).

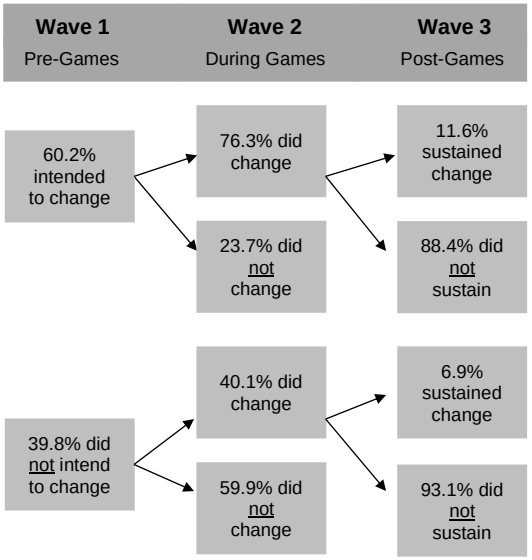

Figure 5: Commuter travel behaviour change - Waves 1-3

The Games organisers sought to encourage a change in a range of aspects of the commute journey during the Games, including: reducing the number of journeys, re-moding, re-timing, and re-routing travel. Analysis found that reducing and re-timing journeys were by far the most common changes made to the commute journey (31% and 25% respectively) whilst 16% re-routed and 11% re-moded.

5.2 Insights from the Transtheoretical Model

The application of the TTM in this research sought to demonstrate both the temporal process of behaviour change, along with an understanding of the factors underpinning the behaviour observed. The allocation of stages of change was self-reported, as described in the methodology section. Notably, 68.4% of the sample was placed in the pre-contemplation stage (in Wave 1, prior to the Games), suggesting that a substantial number of individuals were not currently considering making a change to their current commute journey. When the stages of change were examined with regard to the types of change that were made in response to the Games, some interesting points emerged, including the fact that many of those who were in pre-contemplation went on to make a change. This is counter to what those in the pre-contemplation stage would be theoretically understood to be in a position to do, as posited in the TTM. It is possible that the decisions to change were taken as late as the day of travel and that the decisions did not require significant pre-planning as they form part of occasional behaviour. For example, Heinen and Chatterjee (2015) find that across the UK 69% of adult travellers use more than one mode a week for some purpose.

As Figure 6 demonstrates, taking the self-reported stages from Wave 1, re-timing was the most common change made within each stage with the exception of pre-contemplation. Re-moding and re-routing were also shown to be more prevalent in the latter stages of change (contemplation – maintenance). In contrast, those in pre-contemplation were shown to utilise reducing and re-timing journeys far more than re-moding or re-routing. Statistical analysis (through Pearson's chi-square tests) indicated that in fact those in pre-contemplation were significantly less likely to have re-timed (x^2 (4) = 43.529, $p < .001$), re-moded (x^2 (4) = 51.718, $p < .001$), and re-routed (x^2 (4) = 32.157, $p < .001$) their journeys. Reducing on the other hand was shown to have no statistically significant association with the stages (x^2 (4) = 1.709, *NS*). This suggests that reducing was potentially an easier change to make, regardless of the individuals' preparedness to change.

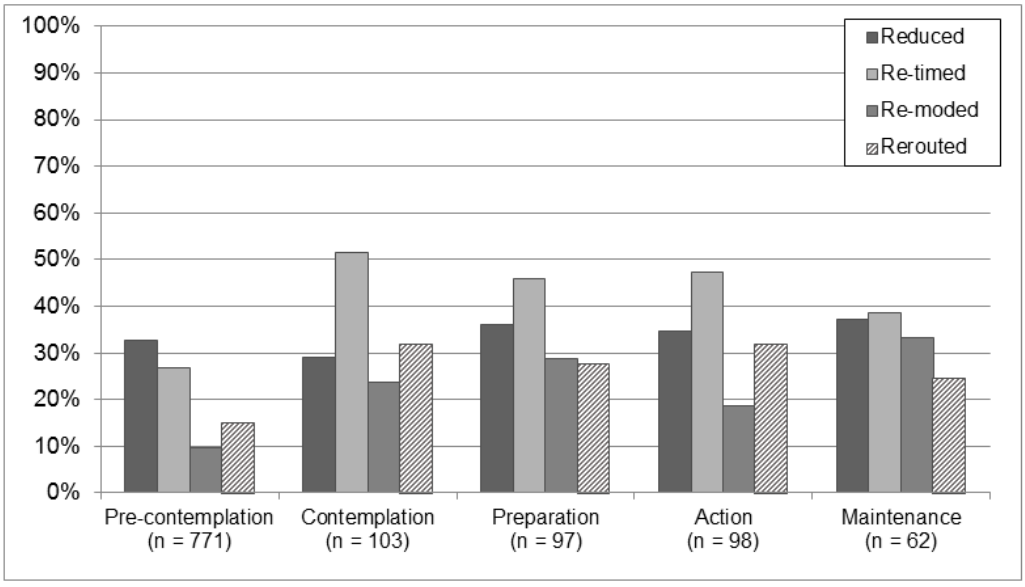

Figure 6: The stages of change and the types of change made

With differences in the types of changes made between stages identified, it was also useful to establish whether variances in the number of changes also existed (shown in Figure 7). Statistical analysis demonstrated that those in pre-contemplation were, as expected, significantly more likely to have made no changes, in contrast to those in the remaining stages (x^2 (4) = 44.835, $p < .001$).

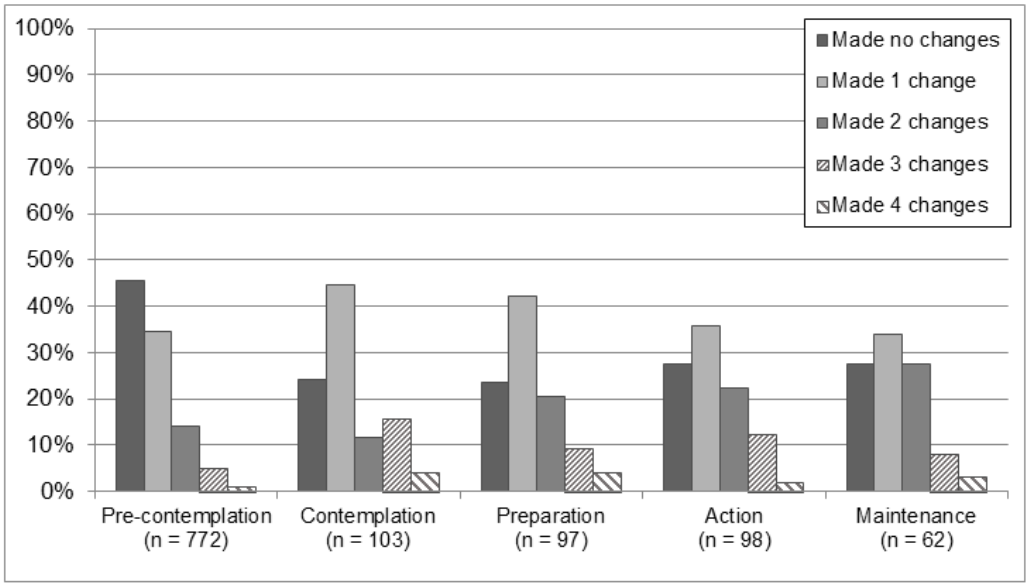

Figure 7: The stages of change and the number of changes made

At this point, it is possible to reflect initially on the insights provided by the TTM in the context of a large-scale disruption. The first key outcome of this research was focused on understanding whether the Games - and the associated travel behaviour change programme - directly elicited progression through the stages of change. However, what has instead emerged is evidence that changes in behaviour were made across the five stages of change (as shown in Figures 6 and 7). Whilst in the case of pre-contemplation it was shown that this group was significantly more likely to have made no changes, the fact remains that a large number of individuals changed behaviour across the range of stages suggesting that the stages of change were limited in the insights they could provide. In this context, perhaps because change was occurring over a compressed time period or for a short time only, the stages were not helpful in understanding the likelihood of different changes occurring.

Self-efficacy and the processes of change were the remaining elements of the TTM that were included in the study. These constructs focus on a greater depth of understanding of the factors underpinning the behaviour observed, and specifically whether different types of change required different 'tools' to enable the change. Considering the processes of change first, these were compared to the different types of change made. Mann-Whitney tests were conducted, which established whether there were any significant relationships between a process and those making the particular change. Table 4 shows where a relationship was shown to be significant. For example, those who reduced were significantly more likely to have agreed with the social liberation statement (see Table 2) than those who had not reduced. This same interpretation applies for the entire table.

Table 4: Summary of statistically significant relationships between processes of change and types of change

Processes of change	Reduced	Re-timed	Re-moded	Re-routed
Environmental re-evaluation	×	✓***	×	×
Social liberation	✓**	✓***	×	✓*
Helping relationships	×	×	×	×
Self-liberation	×	×	✓***	✓*
Counter conditioning	✓*	×	✓*	×
Stimulus control	✓***	✓***	✓*	✓*
Contingency management	×	×	×	×
Self-re-evaluation	×	✓***	✓***	✓*

*Significant at < .05 **Significant at < .005 ***Significant at < .001

These results indicate that some processes were particularly relevant for the majority of different types of change, for example: stimulus control ("I will plan my time during the Games so that I am able to change my work travel") and self-re-evaluation ("I believe that changing the way I travel during the Games will show me to be a proactive person"). However, some processes were of particular relevance for only certain types of change, for example: self-liberation ("I can change the way I travel to work if I try hard enough") was linked to those re-moding or re-routing. The results also showed that some processes had no relationship with any type of change, for example: contingency management ("Changing the way I travel may have the added benefit of finding new or better options for my journey to work"). These findings are important to note, as they help to identify certain processes which were important for supporting change in the context of a mega-event. This helps us to understand both that those making certain changes were more reliant on particular processes, and also that there were certain processes that were important in supporting change amongst the wider sample of changers.

Self-efficacy offers further insight to enable an understanding of the behaviour change enacted in response to the disruption of the Games. Self-efficacy in this study relates to the ease or difficulty of making a particular change, with the analysis conducted in this study seeking to compare those who changed and those who did not. The only significant difference between these two groups was for re-moding where those that did re-mode were found (through Mann-Whitney tests) to be significantly more likely to have stated that changing mode would be easy/very easy (U = 32671.500, -4.696, p < .001).

5.3 Two-step cluster analysis

Whilst the granularity of the TTM stages were not found to be sufficient or helpful in explaining change, the presence of different underlying factors affecting different behavioural adaptations led to an exploration of whether it was possible to create meaningful groupings of people with particular characteristics that were more likely to be susceptible to particular types of change (and therefore for the design of more targeted behaviour change materials). This leads to the second key outcome relating to the theoretical approach of this research and in order to examine this, a cluster analysis was conducted. A two-step cluster analysis was chosen owing to the large sample sized analysed (Norušis, 2008), and was conducted using IBM SPSS Statistics 19. The analysis included eight variables from the processes of change items and seven that represented the self-efficacy items of the survey. The results of the analysis indicated a four cluster solution.

The criteria and procedure used to reach this solution followed a Two-Step cluster analysis, a decision which was informed by the literature (Mooi and Sarstedt, 2011). The variables included in the analysis were categorical and therefore a log-likelihood distance measure was used (the alternative, 'Euclidean Distance', is only suitable when all variables are continuous). An objective of the cluster analysis was to establish how many clusters would emerge from the further analysis of the processes of change and self-efficacy variables and therefore the exact numbers of expected clusters was not included in the criteria. Bayes information criterion (BIC) was used for the clustering criterion.

An initial step in the analysis of the clusters was to compare the distribution of individuals in each cluster to the stages of change. Theoretically, individuals with similar responses to the processes of change and self-efficacy variables would be expected to also be united by their stage of change. Interestingly however, the individuals in each cluster were not unified by their stage of change but rather each cluster consisted of individuals from all possible stages.

The four clusters were subsequently analysed in order to examine their socio-demographic profiles, the median responses to the processes of change, and the ease or difficulty of making a change. These insights allowed an interpretation of the background to each cluster and also how they were differentiated through the analysis. Figure 8 presents line graphs that highlight the differences in median responses to the processes of change (measured on a 5-point Likert scale, agree/disagree) and self-efficacy (measured on a 5-point Likert scale, easy/difficult) variables. The 'Middle Ground Modifiers' were the group that were relatively neutral in their responses, with the majority of processes of change having a median value of 'neither agree nor disagree', and self-efficacy responses showing that changes were generally not considered easy or difficult. The 'Able and Engaged' were shown to have responded with more agreement to the processes of change, along with considering changes to travel behaviour easier to make. 'Unlikely Adapters' in contrast generally showed disagreement with the processes of change and considered changes in behaviour difficult. The final group, the 'Adept but Underutilising', were interesting owing to their varied responses. On one hand, the group regarded making changes easy or very easy, however on the other hand their responses to the processes of change were more diverse.

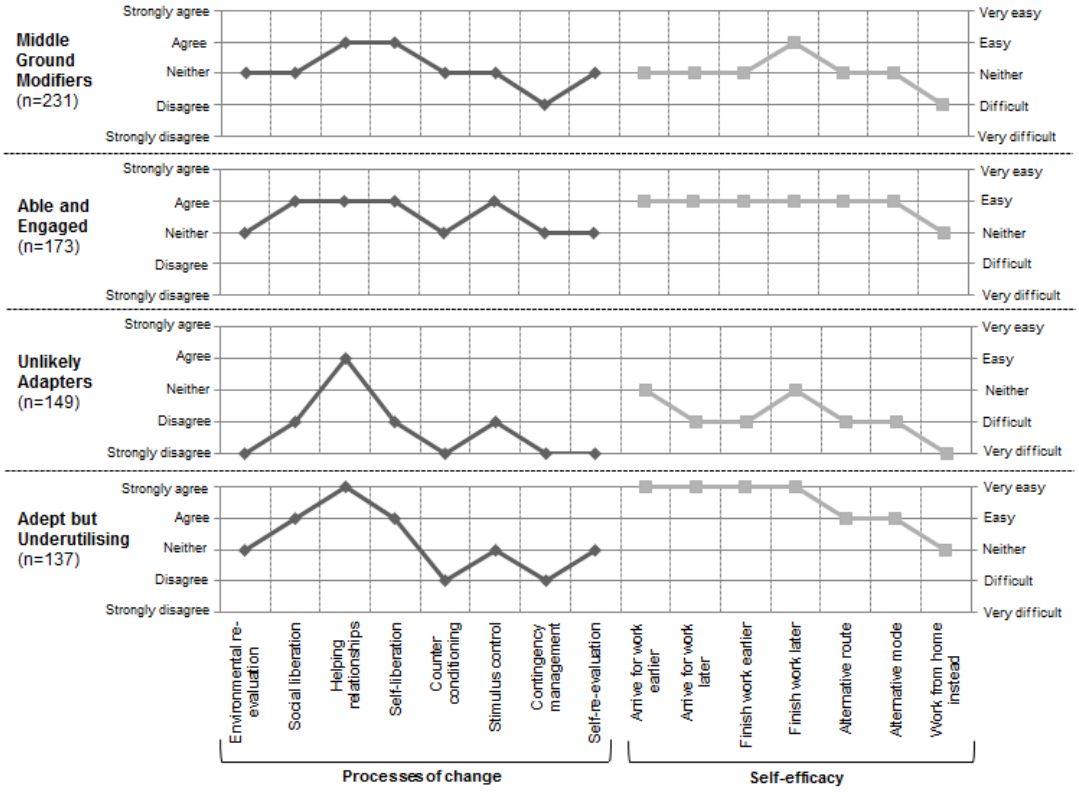

Figure 8: Median scores for processes of change and self-efficacy by cluster

The socio-demographics of each cluster are presented in Table 5 and help to demonstrate in more detail the different characteristics of each group. The Middle Ground Modifiers were shown to have a higher proportion of females (53.7%) than males and almost 40% of the group were between the ages of 18 and 34. 52.6% of the individuals in the cluster were in a household with an annual income of less than £60,000, a higher proportion than the remaining clusters. The Middle Ground Modifiers had the lowest proportion of individuals in 'Manager & Senior Official' roles (23.5%) although 43.5% were in positions described as 'Professional & Associate Professional'. Two-thirds of the individuals in the cluster had access to a car whilst less than half could access a bicycle (48.6%).

The Able and Engaged also had a greater proportion of females (55.3%) and had the highest number of individuals aged 18-34 (44.8%). This group also had the lowest number of individuals in households with children (25.1%) and household incomes in this cluster were more evenly distributed than the Middle Ground Modifiers with only 39.7% being in households with incomes less than £60,000. 22.3% were in households earning more than £100,000, which was the second highest across the four clusters. A large number of individuals were in employment positions of 'Manager & Senior Official' or 'Professional & Associate Professional'. The Able and Engaged had the highest proportion of no car households (39.2%) along with the lowest proportion (16.4%) of those with access to two cars or more. Access to one bicycle or more was restricted to less than half (44.8%). Individuals in the cluster were also most likely to be in businesses over 250 employees (65.9%).

The Unlikely Adapters had the highest proportion of females (57.1%) and was also characterised by a higher proportion of individuals in the older age categories (65.8% aged between 35 and 64). Similarly to the Middle Ground Modifiers, the Unlikely Adapters cluster was shown to have a high proportion of individuals from households with lower incomes (51.3% with incomes less than £60,000). This was reflected by a lower proportion of individuals in 'Manager & Senior Official' positions (27.0%) and a greater number in lower skilled positions. Nearly two-thirds of individuals had access to a car (63.1%) whilst only 44.2% had access to a bicycle.

The final cluster is the Adept but Underutilising who, in contrast to the remaining clusters, had a greater proportion of males (54.1%). This group was also characterised by a greater degree of individuals from the older age categories (68.6% aged between 35 and 64). This cluster had the lowest proportion of individuals in one person households (14.7%) and the highest of those with children (33.0%). Higher income households were also more predominant in this cluster with 68.2% of individuals being from households earning £60,000 or more (31.9% of the cluster earned £100,000 or more). These incomes were reflected in the high proportion of individuals in managerial or professional positions of employment (86.0%). 64.7% of the group had access to at least one car and 57.0% had access to a bicycle (the highest across all clusters).

Table 5: Socio-demographics of the clusters

Socio-demographics	Clusters (%)			
	Middle Ground Modifiers (n = 231)	**Able and Engaged** (n = 173)	**Unlikely Adapters** (n = 149)	**Adept but Underutilising** (n = 137)
Gender				
Male	46.3	44.7	42.9	54.1
Female	53.7	55.3	57.1	45.9
Age				
18-24	6.1	7.0	2.7	2.9
25-34	33.5	37.8	30.9	27.0
35-44	23.9	23.8	34.2	33.6
45-54	26.1	22.7	24.2	22.6
55-64	10.0	8.1	7.4	12.4
65+	0.4	0.6	0.8	1.5
Household structure				
One person household	18.4	21.6	23.8	14.7
One family household - Couple with no children	33.3	34.5	34	35.3
One family household - Couple with children	26.8	22.2	28.6	30.1
One family household - Lone parent with children	3.1	2.9	2.0	2.9
Two or more unrelated adults	15.4	16.4	9.5	14.0
Multi-family households	3.1	2.3	2.0	2.9
Household income				
Up to £19,999	2.3	1.4	3.6	0.0
£20,000 up to £39,999	20.2	16.5	20.7	10.7
£40,000 up to £59,999	30.1	20.8	27.0	21.2
£60,000 up to £79,999	18.4	23.7	17.1	23.9
£80,000 up to £99,999	11.6	15.1	14.4	12.4
£100,000 or more	17.3	22.3	17.1	31.9
Employment position				
Manager & Senior Official	23.5	35.1	27.0	40.1
Professional & Associate Professional	43.5	40.9	47.3	45.9
Admin, Secretarial & Skilled Trades	23.0	17.6	13.5	12.4
Personal Service, Sales & Customer Service	5.2	3.5	2.0	0.7
Process Plant Machine Operative, Elementary & Other	4.7	2.9	10.2	0.7
Access to cars				
None	32.6	39.2	36.9	34.3
1	43.9	44.4	42.3	40.9
2+	23.4	16.4	20.8	24.8
Access to bicycles				
None	51.3	55.2	55.7	43.0
1	30.0	22.1	22.8	25.9
2+	18.6	22.7	21.4	31.1
Num. employed in business				
< 250	39.4	34.1	40.9	35.0
> 250	60.6	65.9	59.1	65.0

In terms of the degree, and types, of change demonstrated by the different clusters, the Able and Engaged displayed the greatest amount of change (72% making at least one change), as shown in Table 6. The remaining clusters also displayed significant changes (a reflection of the broad shifts in travel behaviour observed during the Games), but this was between 7-11% less than that shown by the Able and Engaged. In terms of the specific types of change, it was evident that responses were varied

amongst clusters. For example, the Able and Engaged made substantially more changes to mode (24.7% of individuals in the sample changed) compared to other clusters. The Adept but Underutilising, who considered change to be easier, made the smallest amount of changes to both mode and route.

Table 6: The degree of change amongst the clusters

Type of change made	Clusters (%)			
	Middle Ground Modifiers (n=231)	**Able and Engaged (n=173)**	**Unlikely Adapters (n=149)**	**Adept but Underutilising (n=137)**
Any Change	61.3	72.0	63.4	65.2
Reduce	34.6	38.7	33.6	32.8
Re-mode	15.9	24.7	12.0	10.4
Re-route	21.5	21.0	21.8	17.2
Re-time	34.1	43.2	29.6	32.8

The cluster analysis presented here has provided valuable added insight into the potential to develop alternative groupings of commuters which could be characterised a priori to understand the likely scale and nature of behavioural change. It would be instructive, in building up an understanding of travel behaviour responses to major events to understand the extent to which these underlying processes might apply in other contexts. In addition, it would be useful to understand the extent to which they could apply to more common behaviour change interventions such as line or route closures or efforts to shift mode. The work begins to open up the possibility of understanding not just if the behaviour of individual's changes in these events but how different that change is to other behavioural adaptations they make.

6. Conclusion

This paper set out to examine the behaviour change implications of the London 2012 Games on commuter travel in London. The extensive changes in travel behaviour observed during the Games were a reflection of the significant shift in the context around which journeys were being made during this period. This paper has sought to understand in greater depth - both longitudinally and through a socio-psychological framework – the changes to commute journeys observed. The results demonstrate that whilst reducing and re-timing were the most common changes made during the event these changes very significantly relapsed once the Games had ended, along with the less prominent changes to mode and route of travel. Such relapses, when the system returns to the status quo, suggest that individuals had substantial ability and flexibility to adapt their travel in the short-term yet the majority chose not, or were unable, to sustain these changes. Many who changed their travel had reported no pre-disposition to change their usual journey to work prior to the Games further emphasising that, over the short-term, the context around the Games was such that widespread change became much more prevalent, even outside of those who were already working towards changing their behaviour. Messaging on Games related behaviour change therefore has to reach well beyond traditional audiences for travel behaviour programmes.

A key objective of this work was to advance the discussion about what theoretical constructs appear most relevant in the study of behaviour change associated with disruptive events, which was done through the application and critical evaluation of the TTM. An initial outcome was the understanding that those with a specific intention to change behaviour during the Games or equally, at the minimum, contemplating (in reference to the stages of change) making a change to the usual journey to work was an indicator of the likelihood that people would change, and the number of changes they would make.

Despite this, the fact that 55.2% of those placing themselves in the pre-contemplation stage (not considering making a change) did also go on to make a change limited the reliability of the stages of change for predicting the behavioural response. This also poses a challenge to planners wanting to know how much change they can expect a priori. Beyond that, the stages of change did not prove to be a useful predictor of change. This may be because of the nature of this particular event, which had a specific time and geographical focus. It may also be that it invoked responses people use in any case on other days (e.g. strikes, bad weather, transport breakdown, working from home, or childcare arrangements) rather than evoking a "new" behaviour or one which is motivated by some underlying message to do something different for the long run. We suggest there is a need to begin to approach the study of event based travel behaviour change in more of a theoretical manner rather than the current preponderance of descriptive reporting. Otherwise, we will not be in a position to move beyond the importance of the specific context of the event and place, and therefore achieve the greater insights and learning such events can provide for travel behaviour.

The study has also identified important differences in the processes of change which underpin the four behavioural responses of reduce, re-time, re-mode and re-route. These are distinct behaviours but are typically folded into one "travel behaviour change" message in promotion campaigns. The barriers people face and the support which people might need, or messaging that might be effective would be different for each behaviour. Importantly, for example, those re-timing were shown to be particularly influenced by their peers. Specifically, the greater exposure they had to discussions around changing behaviour (social liberation) and the influence they might have on encouraging others to change too (environmental re-evaluation) were shown to be significantly important to change. Re-moding by contrast requires a degree of preparedness and perceived easy use of alternatives.

We have conducted exploratory analysis of the potential to identify different characteristics of different user groups to explore the ability of a transport planning agency to estimate the likely potential of people to be able to change their behaviour. In this study four clusters were identified with characteristics that captured likelihood of making many changes or just retiming for example. The combination of longitudinal data matched with theoretical constructs is unique and has been facilitated by the special data set available through the collaboration with TfL. However, it is also limited to the London context for now and more work is required to understand if it could apply to other kinds of forced behaviour change initiative or more generally to messaging about promoting different behaviours.

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References

Anable, J., Lane, B. & Kelay, T. (2006) *An evidence base review of attitudes to climate change and transport.* Report to the Department for Transport. Department for Transport. London.

Bamberg, S. (2007) Is a stage model a useful approach to explain car drivers' willingness to use public transportation? *Journal of Applied Social Psychology,* 37**,** 1757-1783.

Bamberg, S., Fujii, S., Friman, M. & Gärling, T. (2011) Behaviour theory and soft transport policy measures. *Transport Policy,* 18**,** 228-235.

BBC. (2012a) 2012 Olympics transport strategy hailed a success. *BBC,* 13 August. [Online]. Available: http://www.bbc.co.uk/news/uk-england-london-19240713. [Accessed 12 February 2016].

BBC. (2012b) London 2012 Games Lanes: Traffic delays of two hours. *BBC*, 23 July. [Online]. Available: http://www.bbc.co.uk/news/uk-england-london-18953088. [Accessed 12 February 2016].

BBC. (2012c) London 2012: Olympics road restrictions begin amid confusion. *BBC*, 25 July. [Online]. Available: http://www.bbc.co.uk/news/uk-england-london-18977640. [Accessed 12 February 2016].

Beatty, S., Meadows, M. & White, D. (2002) Stages of change in drivers' willingness to reduce car use, before and during the UK fuel crisis. *Transport lessons from the fuel tax protests of 2000* eds G. Lyons & K. Chatterjee, Ashgate, England.

Bovy, P. (2009) Beijing 2008 Olympic Games success: Massive public transport developments and major road traffic reduction. *Public Transport International*, May/June.

Brewer, A.M. & Hensher, D.A. (2001) Impact of staging a major event on commuters' travel and work behaviour. Australian Transport Research Forum (ATRF). Hobart, Australia.

Burkholder, G.J. & Nigg, C.C. (2002) Overview of the Transtheoretical Model. *Promoting exercise and behavior change in older adults: Interventions with the Transtheoretical Model* eds Burbank, P.M. & Riebe, D., pp.57-84. Springer, New York.

Chatterjee, K. & Scheiner, J. (2015) Understanding changing travel behaviour over the life course: Contributions from biographical research. A resource paper for the Workshop "Life-Oriented Approach for Transportation Studies". Presented at IATBR, Windsor, UK, 19-23 July 2015.

Chatterjee, K., Sherwin, H., Jain, J. (2013) Triggers for changes in cycling: The role of life events and modifications to the external environment. *Journal of Transport Geography*, 30, 183-193.

Coindet, J. (1998) Home-to-work trips during the transportation strikes in Ile-de-France at the end of 1995. *Journal of Transportation and Statistics*, 1, 43-51.

Currie, G., Jones, A. & Wooley, J. (2013) The travel demand management programe for the London 2012 Olympic Games - Impacts and lessons. *Proceedings of the World Conference on Transportation Research (WCTR).* Rio de Janeiro, Brazil.

Currie, G. & Shalaby, A. (2012) Synthesis of Transport Planning Approaches for the World's Largest Events. *Transport Reviews*, 32**,** 113-136.

Essex, S. & Chalkley, B. (1998) Olympic Games: Catalysts of urban change. *Lesiure Studies*, 17 (3), 187-206.

Frantzeskakis, J. & Frantzeskakis, M. (2006) Athens 2004 Olympic Games: Transportation Planning, Simulation and Traffic Management. *ITE Journal*, 76(10), 26-32.

Fujii, S. & Gärling, T. (2003) Development of script-based travel mode choice after forced change. *Transportation Research Part F*, 6(2), 117-124.

Fujii, S., Gärling, T. & Kitamura, R. (2001) Changes in Drivers' Perceptions and Use of Public Transport During a Freeway Closure: Effects of Temporary Structural Change on Cooperation in a Real-Life Social Dilemma. *Environment and Behavior*, 33(6), 796-808.

Fujii, S. & Kitamura, R. (2003) What Does a One-Month Free Bus Ticket Do to Habitual Drivers? *Transportation*, 30(1), 81-95.

Gatersleben, B. & Appleton, K.M. (2007) Contemplating cycling to work: Attitudes and perceptions in different stages of change. *Transportation Research Part a-Policy and Practice*, 41**,** 302-312.

Giuliano, G. & Prashker, J.N. (1986) Changes in travel demand characteristics during the 1984 Los Angeles Olympics, Irvine, Calif., Institute of Transportation Studies, University of California, Irvine.

Heinen, E. & Chatterjee, K. (2015) The same mode again? An exploration of mode choice variability in Great Britain using the National Travel Survey. *Transportation Research Part A: Policy and Practice*, 78, 266-282.

Hensher, D.A. & Brewer, A.M. (2002) Going for gold at the Sydney Olympics: How did transport perform? *Transport Reviews*, 22(4), 381-399.

Inside the Games (2012) London 2012 urge transport users to check travel plans well in advance of the Games. [Online]. Available at: http://www.insidethegames.biz/articles/15691/london-2012-urge-transport-users-to-check-travel-plans-well-in-advance-of-the-games. [Accessed 12 February 2016].

Jones, P. & Sloman, L. (2003) Encouraging behavioural change through marketing and management: what can be achieved. *Procedeedings of the 10th International Conference on Travel Behaviour Research, 10-15 August 2003,* Lucerne, Switzerland.

Kassens-Noor, E. (2010) Sustaining the Momentum. *Transportation Research Record: Journal of the Transportation Research Board,* 2187**,** 106-113.

Kassens-Noor, E. (2012) *Planning Olympic Legacies: Transport dreams and urban realities*, Oxon, Routledge.

Marsden, G. & Docherty, I. (2013) Insights on disruptions as opportunities for transport policy change. *Transportation Research Part A: Policy and Practice,* 51, pp.46-55. doi: 10.1016/j.tra.2013.03.004

Meikle, J. & Topham, G. (2012) Olympic travel disruption as Central line fails. *The Guardian,* 3 August. [Online]. Available: http://www.theguardian.com/sport/2012/aug/03/olympic-travel-chaos-central-line?INTCMP=SRCH. [Accessed 12 February 2016].

Mooi, E. & Sarstedt, M. (2011) A Concise Guide to Market Research: The Process, Data, and Methods Using IBM SPSS Statistics, Berlin, Springer.

Nigg, C.R., Geller, M.S., Motl, R.W., Horwath, C.C., Wertin, K.K. & Dishman, R.K. (2011) A research agenda to examine the efficacy and relevance of the Transtheoretical Model for physical activity behavior. *Psychology of Sport and Exercise,* 12, 7-12.

Nkurunziza, A., Zuidgeest, M., Brussel, M. & Van Maarseveen, M. (2012a) Examining the potential for modal change: Motivators and barriers for bicycle commuting in Dar-es-Salaam. *Transport Policy,* 24**,** 249-259.

Nkurunziza, A., Zuidgeest, M. & Van Maarseveen, M. (2012b) Identifying potential cycling market segments in Dar-es-Salaam, Tanzania. *Habitat International,* 36**,** 78-84.

Norušis, M.J. (2008) SPSS 17.0 Statistical Procedures Companion, Prentice Hall.

ODA (2011) *Transport Plan for the London 2012 Olympic and Paralympic Games*. 2nd ed. London: Olympic Delivery Authority.

Parkes, S. D. (2014) The longevity of behaviour change: A case study of the London 2012 Olympic and Paralympic Games. Ph.D. Thesis, University of Leeds, UK.

Pnevmatikou, A., Karlaftis, M.G., Kepaptsoglou, K. (2015) Metro service disruptions: How do people choose to travel? *Transportation*, 42(6), 933-949.

Prochaska, J.O. & DiClemente, C.C. (1982) Transtheoretical therapy: Toward a more integrative model of change. *Psychotherapy: Theory, Research & Practice,* 19**,** 276.

Prochaska, J.O. & DiClemente, C.C. (1983) Stages and processes of self-change of smoking: Toward an integrative model of change. *Journal of Consulting and Clinical Psychology,* 51**,** 390-395.

Prochaska, J.O., DiClemente, C.C. & Norcross, J.C. (1992) In search of how people change: Applications to addictive behaviors. *American Psychologist,* 47**,** 1102.

Prochaska, J.O. & Velicer, W.F. (1997) The transtheoretical model of health behavior change. *American Journal of Health Promotion,* 12**,** 38-48.

Ritchie, J.R.B. (1984) Assessing the Impact of Hallmark Events: Conceptual and Research Issues. *Journal of Travel Research,* 23**,** 2-11.

Rose, G. & Marfurt, H. (2007) Travel behaviour change impacts of a major ride to work day event. *Transportation Research Part a-Policy and Practice,* 41**,** 351-364.

Scheiner, J. & Holz-Rau, C. (2013) A comprehensive study of life course, cohort, and period effects on changes in travel mode use. *Transportation Research Part A,* 47, 167-181.

Shannon, T., Giles-Corti, B., Pikora, T., Bulsara, M., Shilton, T. & Bull, F. (2006) Active commuting in a university setting: Assessing commuting habits and potential for modal change. *Transport Policy,* 13**,** 240-253.

Shires, J., Marsden, G., Docherty, I. & Anable, J. (2016) Forth Road Bridge Closure Survey: Analysis of Commuter Behaviour: Final Findings Report. Leeds, University of Leeds and University of Glasgow.

Sumner, H. (2012) Delivering London 2012: Transport legacy. *Proceedings of the Institution of Civil Engineers-Transport,* 165**,** 267-275.

TfL. (2012a) Olympic and Paralympic route network map [Online]. Available: webarchive.nationalarchives.gov.uk/20120411171933/http://www.tfl.gov.uk/corporate/projectsandschemes/18196.aspx. [Accessed 12 February 2016]

TfL. (2012b) *Travel in London – Report 5* [Online]. Available: http://content.tfl.gov.uk/travel-in-london-report-5.pdf. [Accessed 12 February 2016].

TfL. (2013) Olympic Legacy Monitoring: Personal Travel Behaviour during the Games. London: Transport for London.

The Independent. (2012) London 2012: Olympic spectators hit by Tube delays. *The Independent*, 7 August. [Online]. Available: http://www.independent.co.uk/sport/olympics/news/london-2012-olympic-spectators-hit-by-tube-delays-8014847.html. [Accessed 12 February 2016].

Thøgersen, J. (2012) The importance of timing for breaking commuters' car driving habits. In Warde, A., & Southerton, D. (Eds.) The Habits of Consumption. Volume 12. Helsinki Collegium for Advanced Studies: Helsinki.

Van Exel, N.J.A. & Rietveld, P. (2009) When strike comes to town... anticipated and actual behavioural reactions to a one-day, pre-announced, complete rail strike in the Netherlands. *Transportation Research Part A - Policy and Practice*, 43, 526-535.

Verplanken, B. & Wood, W. (2006) Interventions to break and create consumer habits. *Journal of Public Policy & Marketing*, 25 (1), 90-103.

Walsh, C.L., Glendinning, S., Castán-Broto, V., Dewberry, E. & Powell, M. (2015) Are wildcard events on infrastructure systems opportunities for transformational change? *Futures*, 67, 1-10.