



# SELECTED PROCEEDINGS

## THE TRAVEL BEHAVIOUR IMPACTS OF THE LONDON 2012 OLYMPICS AND PARALYMPICS

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# THE TRAVEL BEHAVIOUR IMPACTS OF THE LONDON 2012 OLYMPICS AND PARALYMPICS

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## **ABSTRACT**

This paper examines the impact of the London 2012 Olympic and Paralympic Games on the work journeys of individuals in London. Through a longitudinal panel study, it examines how individuals react to the potential disruption of the Games and how this influences their travel behaviour. It begins to explore whether any change that occurs in their travel behaviour during the Games is sustained. It seeks to understand the reasons behind any changes witnessed and whether the potential disruption they faced may have acted as a stimulus for changing behaviour. This study applies the Transtheoretical Model to explain behaviour change and to understand the underlying motivations and attitudes that the individual possesses. The results indicate that prior to the Games a large proportion of individuals were not considering changing their usual journey to work, although the evidence suggests that there was significant change during the Games. This research explores the role of disruptive events in stimulating change and the implications of this for future behaviour change initiatives. It also contributes towards an improved understanding of the longevity of behaviour change, in which there is uncertainty.

*Keywords: Behaviour change, Transtheoretical Model, Stages of change, Olympics, Paralympics, Disruption*

## **INTRODUCTION**

The Olympic and Paralympic Games present host cities with a significant transport problem, one that is often unprecedented. The influx of athletes, officials, volunteers and spectators combines with existing pressures - largely caused by commuters at peak travel times – to create a significant demand on the city's transport system. The busiest days during an Olympic and Paralympic Games can see up to an additional 800,000 journeys being made (Sumner, 2012) and past experiences highlight the risks of poor planning. The 1996 Atlanta Games experienced transport failures which led to significant disruption to journeys in the host city (Kassens-Noor, 2012). This emphasises the importance of considering the risk of travel disruption in the planning for the Games.

As part of the planning for the London 2012 Games, there was active engagement with businesses and their employees to raise awareness of the need to adapt existing travel practices to minimise the threat of disruption. This led many individuals to rethink and readdress their travel, at least in the short-term during the Games. It also provoked new thinking by employers as to how their organisations' practices could be adapted to allow their employees to travel differently – or less even. The objectives of this research are concerned with understanding if, and why, travel patterns in London, changed due to the potential

disruption that was faced as a result of the Games. It is also concerned with understanding how this disruption may have acted as a stimulus for changing behaviour and what the implications of this are for future behaviour change initiatives.

This paper will provide an overview of the macro impacts of the Games on travel patterns. It will examine, with a specific focus on commuter behaviour, changes to mode, route, journey departure times and the reduction of journeys and examine what impact the Games had on these. The method used is a longitudinal behaviour change panel study that will examine behaviour change before, during and after the Olympics and Paralympics. This is in order to understand the extent to which the new behaviours that may have been adopted in the two month (mid-July to mid-September) disruptive period of the Games are sustained after the Games (and threat of travel disruption) have concluded. Behaviour change will be examined through the application of the Transtheoretical Model (TTM) (often referred to as Stages of Change) and this framework, along with the concept of 'disruption' will be discussed in more detail.

## **BACKGROUND**

### **The London 2012 Olympic and Paralympic Games**

The London 2012 Olympic and Paralympic Games were the culmination of a significant amount of preparation that began even before London was awarded the Games in 2005. The London 2012 Transport Plan (ODA, 2011) laid out the organisers' vision of how they planned to address the added demand that the Games would create on London's transport network and how they aimed to keep London 'moving' during the Games. Responsibility was given to Transport for London (TfL) - an existing public body in charge of managing London's transport network – to implement strategies that would enable the continued movement of people and goods around the city throughout the Games (ODA, 2011).

A key element of the Games Transport Plan was the development of a travel demand management (TDM) programme. TDM was used, in addition to significant infrastructure improvements, to encourage behaviour change over the period of the Games to reduce the pressures on the system (ODA, 2011). Through the deployment of this strategy, TfL pursued a programme of engagement with businesses, and their employees, with the objective facilitating a change in how people travel to and from work. Given the pressure work journeys place on the network, particularly in creating the 'peak' journey times, the targeting of these journeys in particular is understandable. TfL's aim was to encourage individuals to travel by different modes and routes to work, alter their working hours, work from home or at other locations, utilise teleworking tools or take annual leave during the Games (ODA, 2012). In TfL's own words, they wanted people to 'reduce, retime, reroute and revise' their work journeys (TfL, 2012a).

Aside from TDM, there were other projects of note that were pursued as part of the preparation for the Games. The Olympic Route Network (ORN) (or 'Games lanes') focussed on creating a road network that would enable the Games family (athletes, team officials, press, broadcasters and other officials) to move around London quickly and with minimal disruption to their journeys. Stratford regional station (the closest station to the Olympic Park) was enhanced, meeting both the short-term needs of the Games and benefitting passengers in the long-term. Walking and cycling routes were also created to improve access to Olympic venues around London using these modes. The 'Javelin' was a temporary train shuttle service that carried passengers between central London and Stratford regional station. Figure 1 below provides a snapshot of the stress to the transport

system that was anticipated on 3<sup>rd</sup> August 2012 (the busiest day for events during the Games). This figure provides an example that illustrates the increased pressures that were predicted to be placed on London Underground stations during the Games.

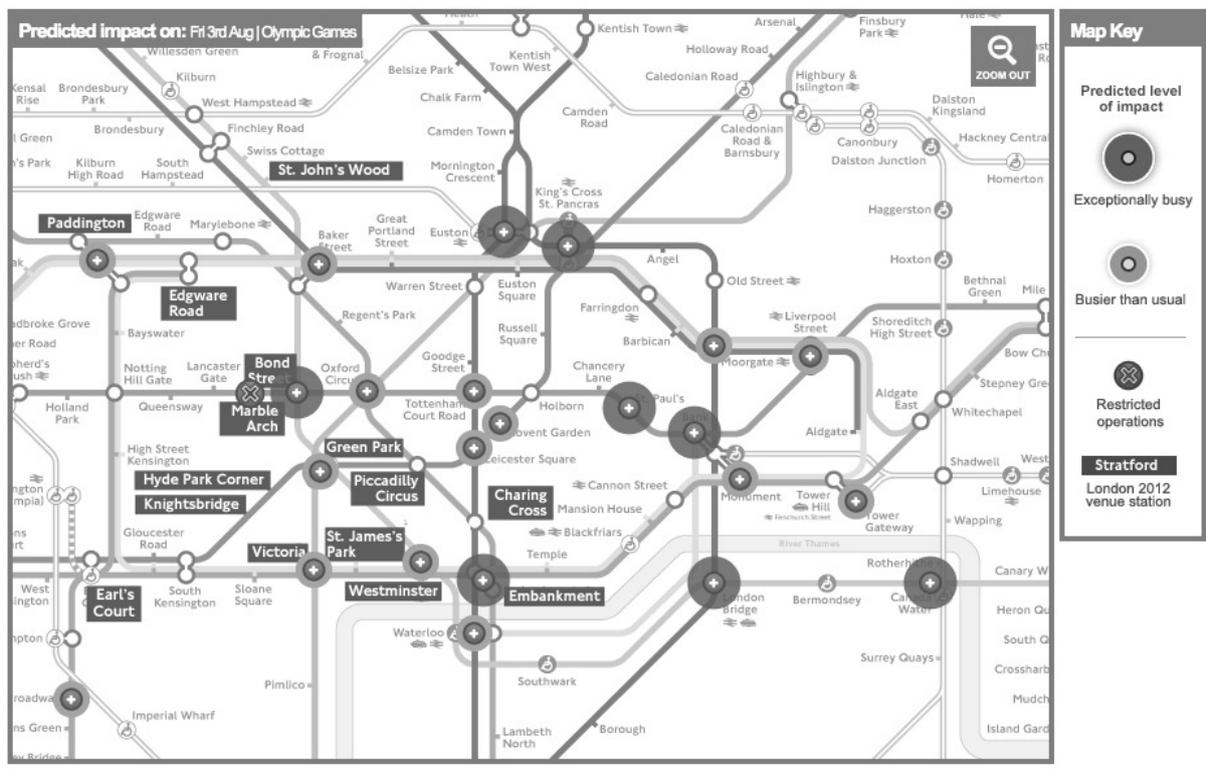


Figure 1: Example of travel hotspots during Olympic Games (source: East London Olympics, 2012)

The overall performance of London's transport network during the Games is reported as being positive. TfL's analysis of travel during the Games period highlights significantly increased pressure on the system (e.g. a 28% increase in underground journeys made compared to the same period in 2011) but that it still ran smoothly (TfL, 2012b). There is evidence of minor disruptions including confusion over lane closures for the ORN and isolated systems failures on the underground network (BBC, 2012a; BBC, 2012b; BBC, 2012c; The Independent, 2012; The Guardian, 2012) yet these did not compromise the running of the wider system.

### **WHY STUDY CHANGE THROUGH MAJOR 'EVENTS'?**

Travel can often become habitual due to the repetitive nature of the journeys people make, a particular example being the journey to work. Such habits form when the behaviour in question is frequently and successfully repeated, in stable contexts and with positive outcomes (Verplanken and Aarts, 1999; Thøgersen, 2009; Eriksson et al., 2008). In the instance when a particular behaviour has become habitual, the element of deliberation is all but removed with the behaviour being performed with great automaticity (Aarts et al., 1998; Gärling and Axhausen, 2003). In such circumstances it is traditionally held that these habits must be 'broken' to achieve a change in behaviour (Gärling and Axhausen, 2003).

Marsden and Docherty (2013) argue that existing changes in policy (a macro level facilitator of travel behaviour change) are limited and incremental, in part, due to the belief that habits will be difficult to change. With this in mind, 'major events' (such as the Olympic Games) along with other disruptive events including natural disasters (e.g. an earthquake), policy

interventions (e.g. congestion charging) and fuel shortages (e.g. UK September 2000) provide an interesting and emerging route through which to potentially elicit a change in travel behaviour (Marsden and Docherty, 2013; Noland et al., 2003). Disruptive events such as these can require the individual to make distinct and significant changes to their travel (albeit over the short-term). Through this enforced change, it is possible to understand more about the choices and constraints that shape travel behaviour (Marsden and Docherty, 2013).

There are a range of studies that have sought to examine the impact such disruptive events have on the travel behaviour of individuals affected by them. In the context of Olympic Games, Giuliano and Prashker (1986) examined the 1984 Los Angeles Olympics to understand how commuter behaviour changed during the Games period. The authors examined the travel of employees from four businesses within the city (N=1,992) during the two week period of the Games. It is reported that the biggest shift in behaviour was witnessed in the departure times for both the outward and return journeys the workplace. 10% of individuals changed their normal route to work during the Olympics but changes of mode were reported as being limited, contradicting the authors initial estimates. Whilst it is interesting to draw comparisons with London, Los Angeles is a very different city and the modes available in 1984 were much more limited than London in 2012. The study is a valuable starting point for understanding how disruptive events have the potential to enact a change in behaviour, if only for a short period of time.

Fuel shortages are a further disruption that has garnered attention for the way that they have shown to produce a shift in travel behaviour over the short-term. The September 2000 UK fuel shortage - the result of protests and blockades at oil refineries against the rising cost of fuel – had wide ranging impacts on people's travel, particularly those more dependent on motorised transport. Noland et al. (2003) examined this event and found that those individuals already capable of travelling to work by non-motorised forms (and therefore less reliant on fossil fuels) were least disrupted. The authors concluded that whilst the dependency on motorised transport makes encouraging a shift in permanent behaviour difficult, the fact that many individuals did effectively avoid the disruption to motorised transport means that there is a capability to travel in alternative ways. The authors also examined how individuals, post-disruption, felt they would be able to cope with a further disruption. The majority of people considered themselves well placed to deal with a further fuel shortage, and do so more effectively. This reflected the findings of Beatty et al. (2002) who found that with regard to future disruptive events, when forced to, many people have the "capacity and capability" to reduce their car use, at least in the short-term (p.201).

Planned and unplanned disruptions present clear differences in the supply conditions and the ability to plan a response to them. Nonetheless, literature on both types suggests that one should anticipate a broad range of behavioural responses. The key question for examining their legacy is whether this can be done in a way to encourage a positive change in behaviour.

## **THE TRANSTHEORETICAL MODEL**

This study applies the TTM as a means through which to understand, in detail, changes in the commuting behaviour of individuals in London. The use of this framework allows for a greater understanding of the underlying motivations individuals hold and the tools they use to allow them to enact the change in their behaviour. A greater understanding of these underlying psychological factors can help to provide reasons why the change we witness occurs. The TTM was developed in the late 1970s and early 1980s (Prochaska and DiClemente, 1994) and was originally designed to unify a wide range of health behaviour

theories. It has subsequently been used extensively to understand changes in problem behaviours such as smoking, excessive alcohol consumption and physical exercise. The use of the TTM in a transport context remains an emerging area of research although there are several examples to note at this stage, for example: Beatty et al. (2002), Gatersleben and Appleton (2007) and Nkurunziza et al. (2012).

The TTM consists of four separate constructs: [1] Stages of change, [2] Processes of change, [3] Decisional balance and [4] Self-efficacy. The stages of change construct is perhaps the most prominent of the constructs, illustrating why the TTM is also commonly known as the ‘stages of change’. The TTM, through the stages of change, sees change as a process in which behaviour change can occur in a spiral (as opposed to linearly) whereby individuals may relapse several times before they successfully maintain a change. Anable et al. (2006) recognises that the TTM’s view of behaviour change as a process rather than “a single massive step” is a key strength (p.77). The TTM allows us to understand individuals’ willingness to change and therefore how this influences the responses to the disruption of the Games that are witnessed. The stages of change are as follows:

Table 1: The Stages of Change (adapted from Prochaska and Velicer, 1997)

<b>1</b>	<b>Pre-contemplation</b>	Not aware of the need to change and therefore has no intention of changing in the next 6 months.
<b>2</b>	<b>Contemplation</b>	More aware of the issues and therefore intend to change in the next 6 months although at present the cons are outweighing the pros.
<b>3</b>	<b>Preparation</b>	Intending to change behaviour in the near future (1 month) and have therefore taken steps to prepare (e.g. bought a bicycle).
<b>4</b>	<b>Action</b>	Make changes to behaviour although it is not consistent change.
<b>5</b>	<b>Maintenance</b>	Have made the changes to their behaviour and have managed to increase the consistency of this and now trying to prevent relapsing into old ways.
<b>6</b>	<b>Termination</b>	Have fully changed their behaviour and do not expect to change back.

The stages detailed above show the notable contrast there can be between individuals in different stages. A person in the latter stages of change, for example in action or maintenance, has been through a process that has significantly increased their ability to change the way they travel when compared to their mind-set in the earlier stages. This increased readiness means that the individual is expected to make a change soon and more easily than those in the earlier stages. The termination stage is often excluded from discussions of the stages of change but it is considered to be the stage at which the behaviour has been fully adopted and a relapse to old behaviour has not occurred. In the context of the 2012 Games, the awareness raising program that the organisers initiated was intended to help to inform individuals of the potential problems they faced with their everyday travel. This was designed to encourage a shift in individuals from the earlier stages (particularly pre-contemplation) to the latter stages to achieve the change in behaviour that was desired as part of managing the potential disruption of the Games.

As individuals seek to change their behaviour, they engage in activities that enable them to achieve this. Through their work to develop the TTM, Prochaska and DiClemente brought together a range of ideas from various health behaviour theories which in part led them to establish the processes of change (Prochaska and DiClemente, 1994; Prochaska and Velicer, 1997). These have been adapted for the context of this research and are shown below along with descriptions of what each one relates to. Note that 8 of the 10 processes are included here.

Table 2: The processes of change

<b>Environmental Re-evaluation</b>	The impact the behaviour has on the social and physical environment.
<b>Social Liberation</b>	The opening up of more opportunities for the individual to consider changing their behaviour. This is particularly focused on social opportunities and in this instance refers to discussing other travel options with colleagues or friends.
<b>Helping Relationships</b>	The support in changing behaviour the individual receives from those close to them, in this instance from their employer.
<b>Self-liberation</b>	The belief and commitment the individual has in themselves to change.
<b>Counter Conditioning</b>	Replacing existing travel behaviour to improve travel experiences.
<b>Stimulus Control</b>	Prompts the individual to change their behaviour by adding additional support to help them make the change, e.g. through better planning of their time to enable the make changes when or where they deem necessary.
<b>Contingency management</b>	Refers to how the individual sees the potential benefits of changing their behaviour, specifically that changing the way they travelled might give the added benefit of finding new or better routes for their journey.
<b>Self-Re-evaluation</b>	Individuals' belief that changing the way they travel during the Games would show them to be a proactive person.

Figure 2 below provides an overview of the TTM and highlights the interaction of the processes through the stages.

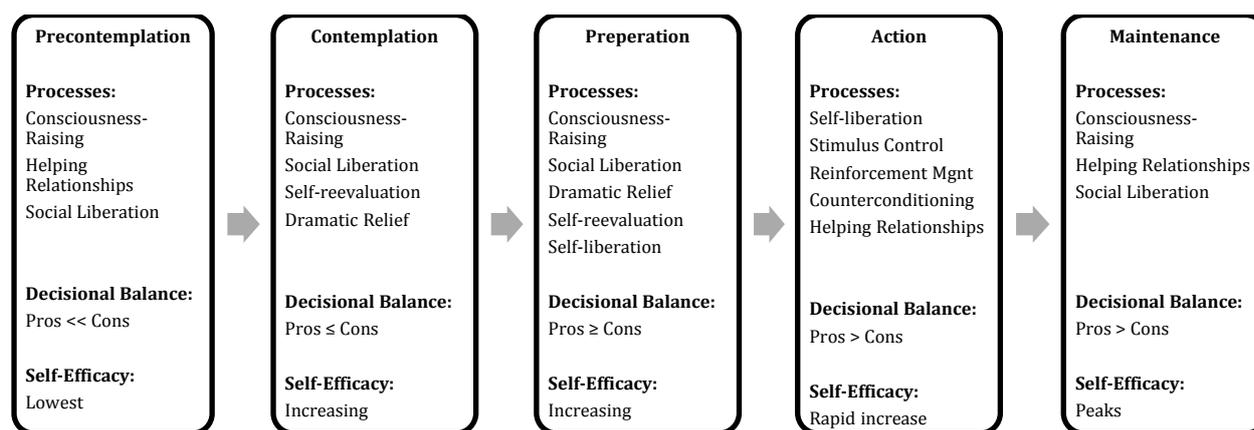


Figure 2: The Transtheoretical Model (from Nigg et al., 2011)

Figure 2 illustrates how the four constructs interrelate and shows in particular how decisional balance and self-efficacy alter as the individual progresses through the stages. Self-efficacy is the confidence an individual has in their own ability to cope with the situation they are faced with (Prochaska and Velicer, 1997). As they move through the stages their confidence to change increases, which contributes to their ability and willingness to change. Decisional balance, put simply, refers to the pros and cons of changing behaviour and can relate to both the individual and others who may be directly or indirectly affected. This construct informs us of the changing attitudes displayed by the individual over a period of time. Figure 2 shows how in the earlier stages, the cons of changing behaviour generally outweigh the pros but as the individual moves through the stages this balance shifts in the opposite direction.

Whilst the TTM has been applied widely amongst the health behaviours field, it has also featured in the transport context. Gatersleben and Appleton (2007); Rose and Marfurt (2007) and Beatty et al. (2002) all applied the TTM to examine the individuals' behaviour change responses to disruptions. Gatersleben and Appleton's (2007) study on cycling to work

detailed the impact of an intervention to promote cycling and highlighted how the TTM enables a better understanding of the psychological factors that influence people's willingness to change. Rose and Marfurt (2007) also examined cycling to work, specifically the impact of a promotional 'cycle to work day'. The authors highlight the role of this event as being to stimulate travel behaviour change. They found that approximately one in four of those that travelled to work by bike for the first time on the cycle to work day continued to do this five months after the event. Beatty et al's. (2002) work examining the UK fuel shortage in 2000 focused on drivers' willingness to reduce their car use as a result of the disruption. In their application of the TTM, the authors found that 'pre-contemplators' (those least likely to consider reducing car use) were more likely to continue driving throughout the disruption. They surmise that this was a result of this group taking more actions to enable them to continue travelling as they wish.

The Olympics and Paralympics are particularly interesting because they are an event whereby change may have appeared necessary or attractive even for those without a pre-disposition to change. By using a longitudinal panel approach we are able to marry up behavioural responses over time with underlying psychological constructs and how these change over time. By measuring change at an individual level before, during and after the event it will be possible to understand the process through which individuals changed and what tools they applied to enable them to make that change.

## **METHODS**

The panel study conducted as part of this research was carried out in conjunction with TfL and was completed electronically by respondents. As this was a panel study design; each wave was completed by the same participants (identified by a unique ID) allowing the examination of change at an individual level over the course of the disruption. All three pre-determined waves of the study (before, during and after the Games) were completed although there is scope for a fourth wave later in 2013 to capture the longer-term situation.

The sample was recruited from the TfL customer database (comprising customers from the congestion charging, Barclays bike hire system, oyster card<sup>1</sup> users) along with on-street recruitment at potential Games time travel hotspots. The final sample of valid responses was 1,132; greater than the sample sizes of comparable studies (Beatty et al., 2002; Gatersleben and Appleton, 2007; Nkurunziza et al., 2012). The survey was carried out as an online survey only. This design may have some limitations as it requires access to a computer and internet, thereby potentially biasing the sample towards individuals with regular access to these resources. The design was however the most effective for gathering the range of data that was collected from this large sample. Socio-demographic and detailed travel pattern data (for both work and non-work journeys) was collected in each wave along with data relating to the TTM. This allowed detailed data to be collected relating to the travel patterns of individuals immediately before, during and after the disruption to provide an in-depth understanding of if, and how, behaviour changed. The timings of the survey waves are detailed below in table 3:

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<sup>1</sup> The smart card ticketing system used on the London transport network

Table 3: Key dates from panel survey

<b>Wave 1</b>	18 <sup>th</sup> to 26 <sup>th</sup> July
<b>Olympic Games</b>	27 <sup>th</sup> July to 12 <sup>th</sup> August
<b>Wave 2</b>	10 <sup>th</sup> to 28 <sup>th</sup> August
<b>Paralympic Games</b>	29 <sup>th</sup> August to 9 <sup>th</sup> September
<b>Wave 3</b>	8 <sup>th</sup> November to 3 <sup>rd</sup> December

Table 4 below shows the stages of change question presented to respondents in the pre-Games survey. The labels illustrate which stage each statement relates to. This paper presents the analysis of the stages of change and processes of change constructs of the TTM. The self-efficacy and decisional balance constructs are omitted at this point to allow for more analysis of the travel behaviour change. Stages of change data was collected for before (wave 1) and after (wave 3) the Games although excluded from the 'during' survey as this focused more closely on travel patterns.

Table 4: Stages of change question from pre-Games survey

<p>Thinking in general about your usual journey to work which of the following statements best describes you?</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> I am not considering changing* the way I normally travel to work (<b>pre-contemplation</b>)</li> <li><input type="checkbox"/> I am considering changing* the way I normally travel to work but I am not in a position to make this change yet (<b>contemplation</b>)</li> <li><input type="checkbox"/> I am doing things to prepare myself to change the way I travel to work (<b>preparation</b>)</li> <li><input type="checkbox"/> I have tried changing* the way I travel to work once or twice since the beginning of this year (<b>action</b>)</li> <li><input type="checkbox"/> I have regularly tried changing* the way I travel to work since the beginning of this year (<b>maintenance</b>)</li> </ul> <p>*By changes we mean do you ever use a different mode of transport, take a different route, travel at different times of the day, avoid travelling and work from home etc.</p>
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## RESULTS

The panel survey provided a sample of 1,132 employed individuals with valid responses. The sample was split 48% males and 52% females. 35% of respondents were aged between 18 and 34, 53% between 35 and 54 and 12% were aged over 55. Respondents were more likely to be in professional or managerial positions with 36% and 30% respectively. Households that consist of a couple with no children were the most frequently occurring with 34%, closely followed by couples with children (28%) and then one person households (19%). Household income was quite evenly spread amongst the sample with those with an income between £20,000 and £39,999 and £40,000 and £59,999 making up 19% and 26% of the sample respectively. Notably, 21% of respondents lived in households with an income of over £100,000 (compared to 7% earning between £80,000-£89,000 and 6% earning between £90,000 and £99,999). A third of respondents (33%) did not have access to a car for their own use whilst 43% had access to one car. Half of respondents did not have access to a bicycle (52%), whilst 24% could access one for their own use.

Figure 3 below illustrates the distribution of respondents among the five stages of change before and after the Games. This is based on their selection of one statement describing the stages that they considered to be the most appropriate to them. As figure 3 shows, a significant proportion of respondents placed themselves in the pre-contemplation stage before the games and thereby indicated that they had no intention to make a change to their usual travel. 68.2% in total regarded themselves as being in this stage whilst 9.1% and 8.6%

placed themselves in the contemplation and preparation stages respectively. 8.7% were in action and 5.5% in maintenance.

The post-Games columns indicate that once the Games-time potential disruption had passed there is a movement towards pre-contemplation from the remaining stages with an additional 20.8% of people populating the stage. This indicates that of those who were either considering or intending on changing prior to the Games, a clear proportion have now moved to a position where they have no intention of changing from their current behaviour. Also included here is the termination stage, which refers to the stage in which individuals consider themselves to have fully adopted their new behaviour and do not anticipate changing back.

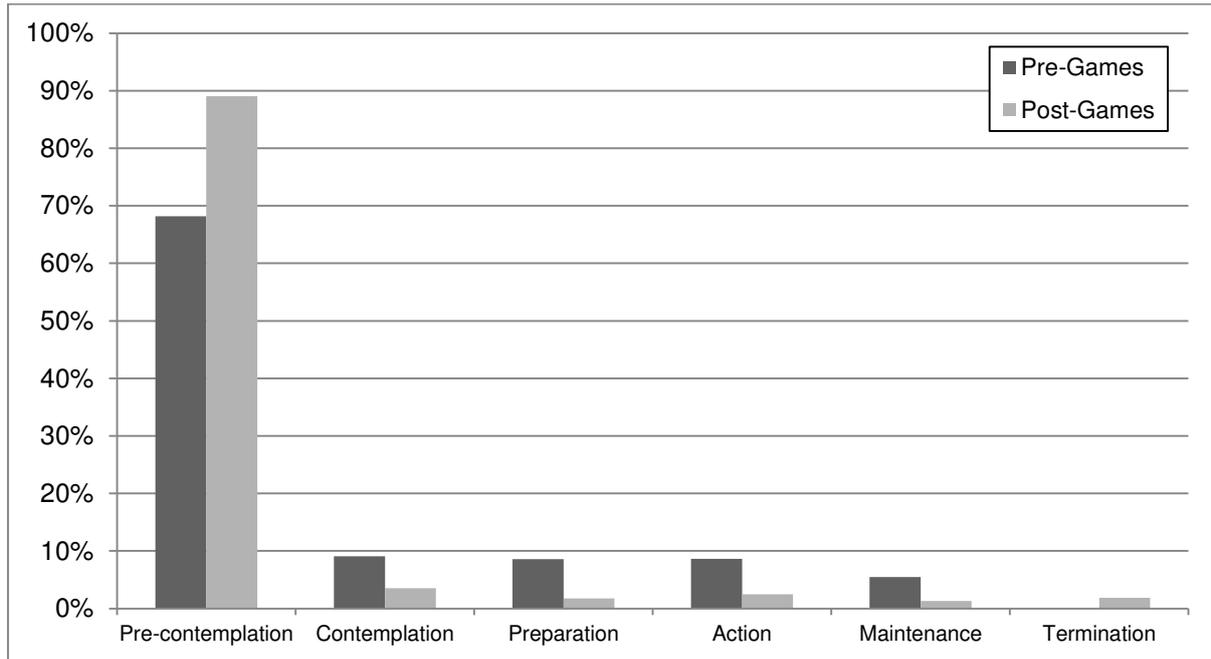


Figure 3: Stage allocations before and after the Games

Figure 4, shown below, highlights that 80% of those who made no changes were in the pre-contemplation stage. This figure is expected given the high proportion of individuals in the pre-contemplation stage. It is interesting to note, however, that the share the pre-contemplation has decreases as the number of changes increases. On the other hand, the remaining stages appear to increase as the number of changes made increase.

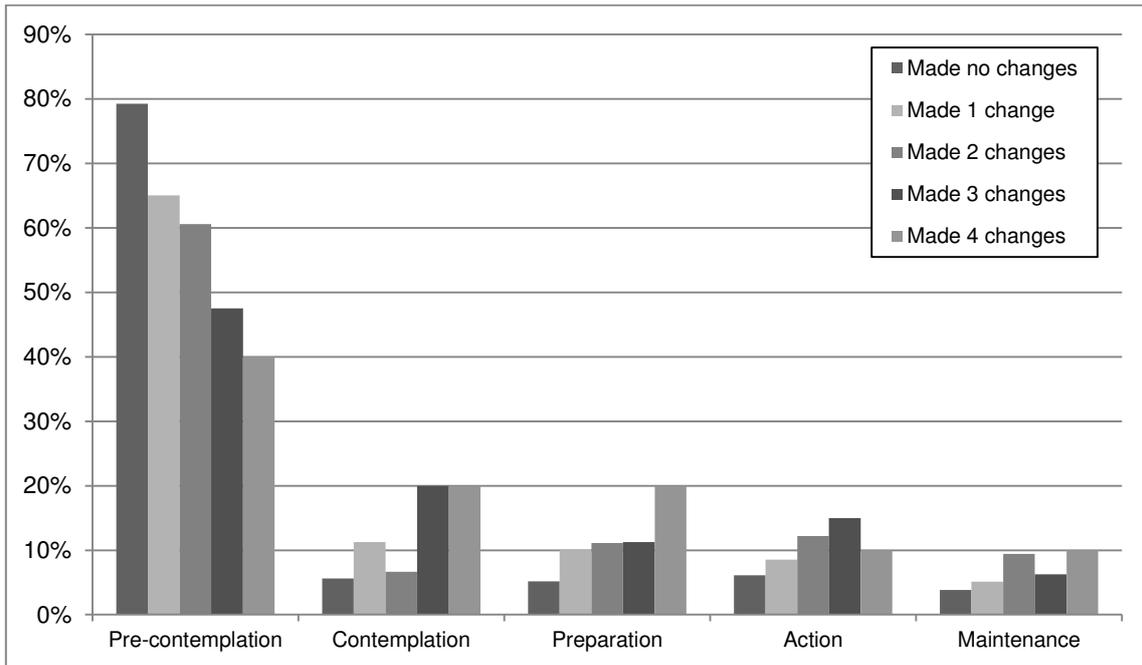


Figure 4: Pre-Games stage allocations and the number of changes made

During the Games, 33% of people reduced their commuter travel and 19% changed their normal route. For the outward journey to work 26% changed their time whilst 21% changed the time they returned home. 14% indicated that they had changed their mode. The results shown in figure 5 illustrate that 67.5% of those reducing were in the pre-contemplation stage whilst re-moding was the least utilised amongst the pre-contemplators (45.8%). Re-moding or rerouting is the change most likely to have been made by those in the remaining stages. This figure does indicate that there are no clear trends in the stage of change and the type of change made.

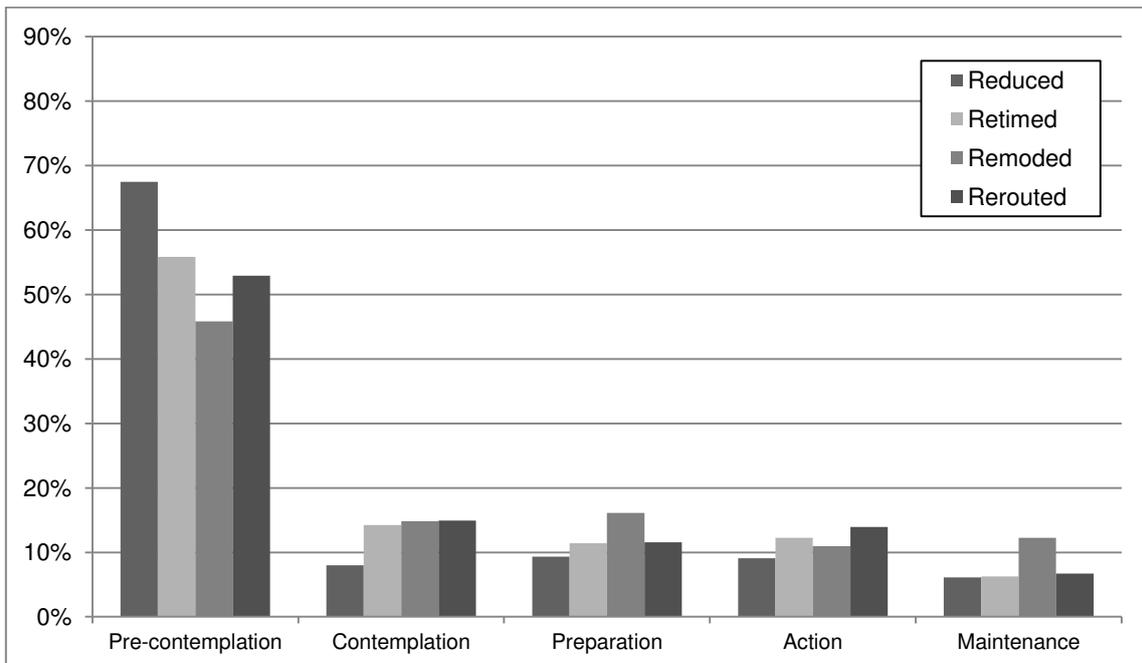


Figure 5: Pre-Games stage allocations and the type of change made

The overall mode split for commuters is shown below to illustrate any changes that occurred over the course of the Games. This reflects the main mode<sup>2</sup> chosen by individuals for their commute to their main place of work. National Rail and London Overground became more popular modes during the Games and then increased further once the Games had ended. The London Underground and DLR (Docklands Light Railway) saw a slight decrease but has since increased. This is also the case for the bus but to a much lesser extent. Car use (amongst drivers) decreased during the Games but then increased once the Games had ended. On the other hand bicycles, as the main form of transport, see a clear rise during the Games but then decreases to a level lower than the pre-Games figure. Finally, walking decreased during the Games and then again once the Games had ended. The post-Games decrease in both walking and cycling may be a reflection of the seasonality of these modes as the UK moved into autumn at the end of the Paralympic Games in September 2012.

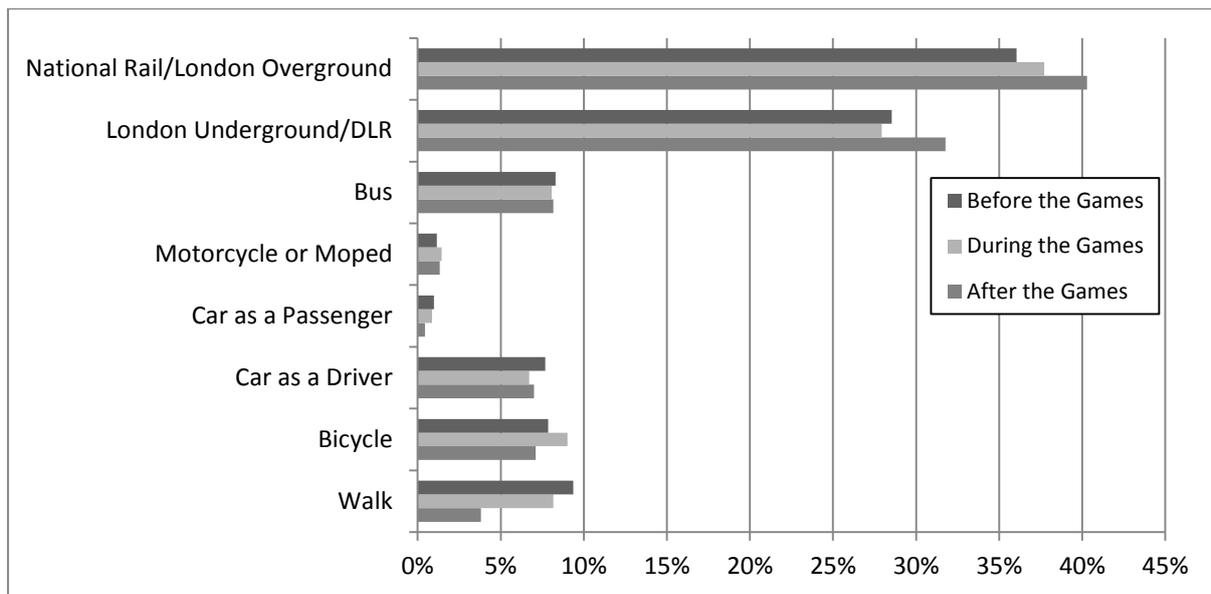


Figure 6: Main mode travelling to main place of work

There are a wide range of reasons for choosing to change behaviour. With regard to changing route or mode, there is a clear indication from the figure below that those that changed during the Games did so largely to avoid the potential disruption from the Games. Avoiding delays, congestion and overcrowding were the three main reasons for changing mode or route. When directly comparing route and mode change, it appears that those changing to avoid Games related disruption were more likely to do so by changing route. On the other hand, those making changes to reduce costs and improve their health were more likely to change modes to achieve this.

<sup>2</sup> The one that covers the longest distance in their journey

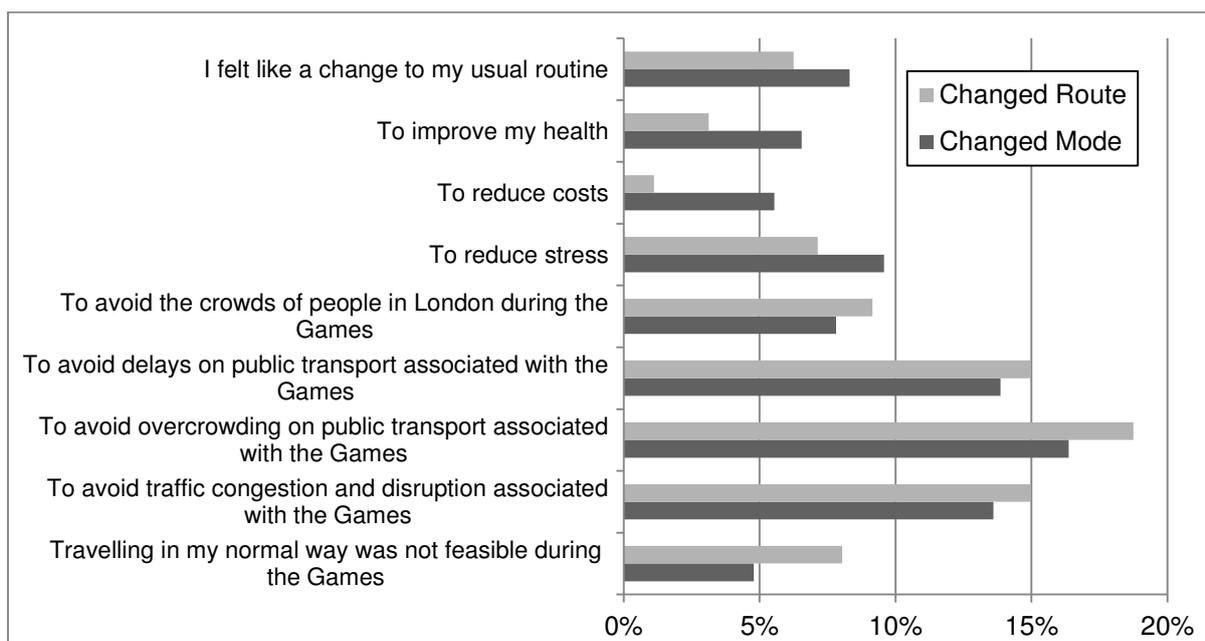


Figure 7: Reasons for changing mode or route for commute

### Description of results by stage

Analysis of the characteristics of the stages of change illustrates how the gender split is comparable across the first three stages whilst differing in the action and maintenance stages (see table 5 below for more details). Contemplation and action are populated by a higher number of younger individuals. Couples with no children are the largest group in each stage apart from the preparation stage. Household income does not differ greatly across the stages and those earning over £100,000 comprise at least a fifth of each stage. The exception is the contemplation stage where lower incomes between £20,000 and £39,999 were most common. Pre-contemplators were most likely to have access to one car (45%) and maintainers were most likely to have access to none (43%). A lack of access to bicycles was seen across all stages, with 43% of individuals in preparation and up to 56% in contemplation having access to no bicycles. The characteristics of the stages highlight the differences in who inhabits each stage although no clear trends emerge.

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Table 5: Stages of change – Key demographics

	Pre-contemplation	Contemplation	Preparation	Action	Maintenance
<b>Gender</b>					
Male	49%	49%	48%	41%	52%
Female	51%	51%	52%	59%	48%
<b>Age</b>					
18-24	4%	5%	9%	0%	3%
25-34	29%	42%	32%	36%	20%
35-44	27%	25%	21%	31%	39%
45-54	26%	20%	31%	24%	21%
55-6	13%	8%	7%	7%	15%
65+	1%	0%	0%	3%	1%
<b>Household Structure</b>					
One person household	20%	20%	20%	20%	15%
One family household - Couple with no children	34%	34%	25%	36%	42%
One family household - Couple with children	27%	29%	31%	21%	30%
One family household - Lone parent with children	4%	3%	4%	1%	1%
Two or more unrelated adults	13%	12%	16%	20%	10%
Multi-family households	2%	3%	4%	3%	1%
<b>Household Income</b>					
Up to £19,999	2%	16%	5%	0%	2%
£20,000 up to £39,999	19%	31%	23%	19%	19%
£40,000 up to £59,999	26%	18%	25%	23%	19%
£60,000 up to £79,999	21%	17%	13%	23%	13%
£80,000 up to £99,999	13%	17%	10%	13%	15%
£100,000 or more	19%	1%	24%	22%	31%
<b>Employment position</b>					
Manager & Senior Official	29%	25%	25%	31%	35%
Professional & Associate Professional	44%	39%	40%	43%	41%
Admin, Secretarial & Skilled Trades	18%	24%	27%	17%	20%
Personal Service, Sales & Customer Service	3%	5%	4%	6%	1%
Process Plant Machine Operative, Elementary & Other	6%	7%	4%	4%	3%
<b>Access to cars</b>					
None	31%	38%	40%	31%	43%
1	45%	43%	40%	40%	31%
2	18%	14%	15%	21%	21%
3	5%	5%	4%	7%	4%
4+	1%	1%	1%	1%	0%
<b>Access to bicycles</b>					
None	53%	56%	43%	55%	45%
1	23%	27%	31%	21%	25%
2	14%	11%	17%	17%	18%
3	6%	5%	7%	3%	6%
4+	4%	2%	3%	5%	6%

The post-Games analysis of the stages of change highlights the movement between the stages. Notably, the largest movements from all stages are to the pre-contemplation stage (which retains 93.5% of its population). Between 73.5% and 84.5% of individuals from the remaining stages moved to the pre-contemplation stage. As a result there is little retention within the other stages. The highest numbers of individuals remaining in the same stage are those in action (10.2%). Due to the dominance of the pre-contemplation stage here there is limited movement amongst the remaining stages. 9.3% of those in preparation do take one step back to contemplation, whilst 5.2 move forwards to the action stage.

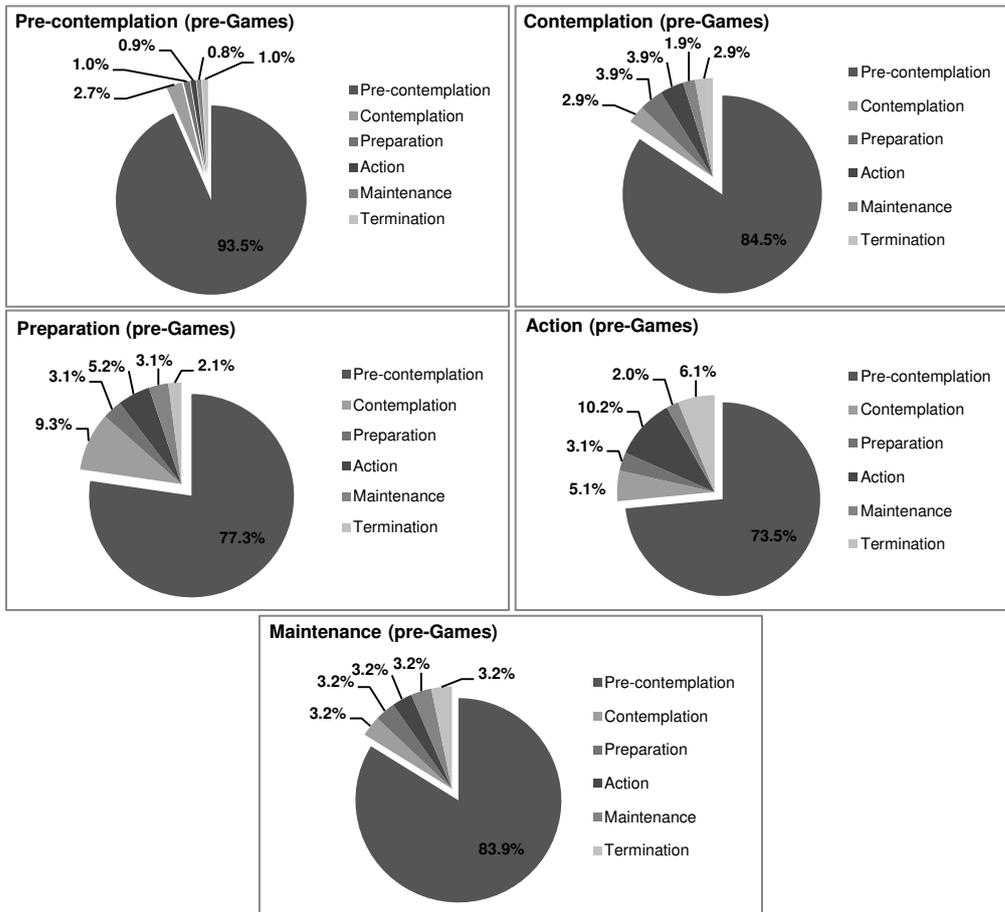


Figure 8: Movements between stages of change (pre to post-Games)

### Processes of Change

Individuals progressing through the stages of change are expected to utilise varying processes at different points (Mutrie et al. 2002; Nigg et al. 2011). Table 6, below, details which processes were most used by those changing their behaviour for their work journey. The figures shown reflect the responses of those individuals that changed their behaviour whilst those in parentheses are derived from those that didn't.

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Table 6: Use of the processes of change for individuals changing travel behaviour before and during the Games

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree	Median (for those that changed)
Environmental Re-evaluation	1.7% (0.9%)	14.6% (9.5%)	35.0% (42.3%)	30.1% (28.4%)	18.5% (18.9%)	3
Social Liberation	9.2% (7.4%)	48.4% (41.2%)	21.3% (22.2%)	14.8% (20.4%)	6.4% (8.8%)	2
Helping Relationships	2.4% (3.6%)	7.0% (7.2%)	24.7% (30.0%)	34.9% (33.2%)	31.1% (26.0%)	4
Self-Liberation	9.5% (7.4%)	43.3% (42.6%)	20.1% (19.4%)	16.0% (21.7%)	11.3% (8.3%)	2
Counter Conditioning	3.2% (2.3%)	13.7% (7.3%)	31.2% (33.2%)	25.3% (31.4%)	26.5% (25.9%)	4
Stimulus Control	5.0% (1.8%)	34.7% (19.8%)	29.2% (33.8%)	19.2% (29.3%)	11.8% (15.3%)	3
Contingency Management	1.0% (0.9%)	12.9% (7.6%)	19.0% (20.2%)	32.6% (42.2%)	34.4% (29.1%)	4
Self-Re-evaluation	2.3% (1.3%)	18.3% (13.8%)	34.4% (37.1%)	20.1% (24.6%)	24.9% (23.2%)	3

Changed travel behaviour during the Games (Didn't change travel behaviour during the Games)

Table 7: Results of Wilcoxon signed-rank test for individuals who changed behaviour during the Games

	Environmental Re-evaluation	Social Liberation	Helping Relationships	Self-Liberation	Counter Conditioning	Stimulus Control	Contingency Management	Self-Re-evaluation
Environmental Re-evaluation		T = 14165.50, p < .001	T = 55032.50, p < .001	T = 31623.00, p < .001	T = 57649.00, p = 0.13	T = 35042.00, p < .001	T = 35087.50, p < .001	T = 54934.00, p = .820
Social Liberation	T = 14165.50, p < .001		T = 17129.50, p < .001	T = 55692.50, p = .003	T = 20586.00, p < .001	T = 40565.50, p < .001	T = 14839.00, p < .001	T = 24606.00, p < .001
Helping Relationships	T = 55032.50, p < .001	T = 17129.50, p < .001		T = 32160.50, p < .001	T = 72971.50, p < .001	T = 35949.50, p < .001	T = 77621.50, p = .983	T = 63056.00, p < .001
Self-Liberation	T = 31623.00, p < .001	T = 55692.50, p = .003	T = 32160.50, p < .001		T = 23563.50, p < .001	T = 48648.00, p < .001	T = 10644.00, p < .001	T = 29757.00, p < .001
Counter Conditioning	T = 57649.00, p = .013	T = 20586.00, p < .001	T = 72971.50, p < .001	T = 23563.50, p < .001		T = 20480.50, p < .001	T = 22862.00, p < .001	T = 41957.00, p = .003
Stimulus Control	T = 35042.00, p < .001	T = 40565.50, p < .001	T = 35949.50, p < .001	T = 48648.00, p < .001	T = 20480.50, p < .001		T = 13198.50, p < .001	T = 28219.00, p < .001
Contingency Management	T = 35087.50, p < .001	T = 14839.00, p < .001	T = 77621.50, p = .983	T = 10644.00, p < .001	T = 22862.00, p < .001	T = 13198.50, p < .001		T = 17196.00, p < .001
Self-Re-evaluation	T = 54934.00, p = .820	T = 24606.00, p < .001	T = 63056.00, p < .001	T = 29757.00, p < .001	T = 41957.00, p = .003	T = 28219.00, p < .001	T = 17196.00, p < .001	

The analysis of the processes of change indicates which processes were most utilised by those that made a change. The statements most agreed with (see The Transtheoretical Model section for descriptions) were social liberation and self-liberation, both with a median of 2. On the other side, helping relationships, counter conditioning and contingency management were the three processes least utilised. All have medians of 4 indicating that individuals were more likely to disagree with these statements. Further analysis of this data using the Wilcoxon signed-rank test indicates that there was a significant difference in the use of the social liberation and self-liberation processes and the helping relationships, counter conditioning and contingency management processes (see table 7 for the results).

## CONCLUSIONS

The panel survey indicated that before the Games a significant proportion of the sample (67.9%) was not in a position where they were intending to change their normal journey to work. The evidence suggests that despite this there was a significant amount of change in behaviour during the Games. It was found that under the presence of the disruption of the Games, individuals were not limited by their stage of change and behaviour change was reported across all five stages. It was found however, that those in the latter stages appeared more likely to make multiple changes in behaviour. A notable outcome of the analysis of the processes of change was that they indicated that individuals did not on the whole utilise 'helping relationships' (i.e. support from their employer) to enable them to change. On the other hand, colleagues and friends were relied upon more, specifically in that they were someone with whom the individual could discuss their travel options. There is evidence of changes in the main mode for work journeys although largely incremental. Interestingly, the main reasons given for changes were related to avoiding Games related disruption.

This paper has provided an overview of the impact the London 2012 Games had on travel behaviour. The use of the TTM has shown that, when faced with a disruptive event, even those with an existing unwillingness to change, have the ability to change. Individuals who were not currently considering changing their journey to work found themselves doing so, and in multiple ways. Further exploration of these results will help further inform us of the impact of this disruptive event and help to inform about how such events may be used to stimulate wider travel behaviour change. There is uncertainty as to the longevity of behaviour change initiatives, such as those introduced in the 2012 Games, and this research offers a novel and interesting opportunity through which to further contribute to this theoretical debate. From a research perspective, this study contributes towards an improved understanding of behaviour change and it also furthers work on the TTM and aims to contribute to an improvement in how it can be applied more widely in the transport context. From a policy perspective, the research can inform future policy decisions relating to other large-scale disruptions and behaviour change initiatives. Lessons learnt at London 2012 can be used to benefit future events such as the Rio 2016 Olympic and Paralympics Games. This is a timely piece of research given its proximity to the London 2012 Games and the application of the TTM to understand the impact of the Games produces a novel combination.

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