Behavior within Buildings – An International Survey

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hiding wayfinding questionnaire study is presented which analyses the importance of a set of D. Braff SHeh ding waymum abuilding evacuation perspective. The main path selection criteria tested in this inding criteria are handedness and length of the first leg of the path. The study involved 1166 participants 36 countries. The results suggest that the handedness, a genetic factor, and the side of the road people 36 collisions and the side of the road people on a cultural factor, exert a significant influence on path choice. The results of this study clarify conservations existing in urban wayfinding studies regarding the importance of the length of the first leg Path selection criteria along with their relative rankings are suggested for inclusion in wayfinding has used within evacuation models. It is not clear how large an effect these influences will have on analysis. This will be examined by introducing these factors into a new wayfinding algorithm analy introduced into the building EXODUS evacuation model.

TYWORDS: wayfinding, escape routes, path selection, human behavior, human factors.

#### NTRODUCTION

Whin the building environment, wayfinding describes the process by which an individual located within a amplex enclosure decides on a path or route in order to reach a goal location. Within the building occution context, wayfinding describes the process in which the individual attempts to find a path which but them to relative safety, usually the exterior of the enclosure. In most evacuation modeling tools, the rocss of wayfinding is either ignored or grossly simplified. In a recent review of 30 evacuation models explanding features were only mentioned in the context of two models [1]. On the whole, evacuation adels assume that the simulated agents have complete knowledge of the structure and so follow a Mential or distance map to their nearest exit – essentially selecting the path of minimum travel distance. home models may even assume that a proportion of the occupants have partial knowledge of the structure ad so are familiar with only some of the exits [2,3]. At least one model incorporates agent interaction with st allowing agents completely unfamiliar with the structure to follow a signage chain leading to an tail [2,3]. Recently, there has been some effort to incorporate a modified form of urban wayfinding criteria building evacuation models [4]. However, this may be questionable as the wayfinding process buildings may be different to that within urban environments. If our computer models are to represent the wayfinding process adopted by humans during building evacuation we must first berstand how humans wayfind within such environments. Key to this is developing an understanding of securitia used by humans in deciding which path to take.

The lack of sophistication in the manner in which wayfinding is treated within building evacuation models the in part to the general lack of detailed knowledge concerning wayfinding within complex building Touls. While there are numerous wayfinding studies in urban environments [5-8], there is very little Mille there are numerous wayfinding studies in urban environments. Due to the difficulty in conducting research performed within complex building environments. Due to the difficulty in conducting byfinding research, especially research which involves international participants, most of the research that anducted makes use of surveys, questionnaires or virtual environments.

Golledge's urban wayfinding study [5,6] involved a sample of 32 adults, 16 male and 16 female. The was mostly students, with half the population being trained in geography. The participants in but to an identified starting study were asked to identify the path they would take on a map to get from an identified end point. The maps used varied from uniform grids, to uniform grids with diagonals grids with dentified end point. The maps used varied from uniform grius, to differ the grids with curved paths plus blockages. Participants were then asked to rank the criteria they used in the curved paths plus blockages. ting their path using a seven point scale; participants selected the criteria from a list of 10 provided. relief path using a seven point scale; participants selected the criteria selected by the participants, in order of preference (with mean rating shown in brackets) are: thest distance (4.2), least time (4.1), fewest turns (3.6), most scenic/aesthetic (3.5), first noticed (2.5),

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longest leg first (2.3), many curves (2.3), many turns (1.8), different from previous (1.8) and shorteg

Conroy has studied route choice decisions made at consecutive road junctions over the duration of a security of urban block of ur Conroy has studied route choice decisions made at consecutive road junctions of articles of urban block shapes journey [7]. The study involved a virtual urban environment containing a variety of urban block shapes journey [7]. The study involved a virtual urban environment containing a variety of urban block shapes journey [7]. journey [7]. The study involved a virtual urban environment containing a value of 28. The geometry was the equivalence of 28 and 10 females with a mean age of 28. The geometry was the equivalence of 28 and 10 females with a mean age of 28 and 20 females and 10 females with a mean age of 28. The geometry was the equivalence of 28 and 29 females and 10 females with a mean age of 28 and 20 females and 10 females with a mean age of 28 and 20 females with involved 30 participants, 20 males and 10 lemales with a filean age of 250 males and would take approximately 8.5 min to cross diagonally walking at an average of 650 m × 650 m and would take approximately 8.5 min to cross diagonally walking at an average of 650 m × 650 m and would take approximately 8.5 min to cross diagonally walking at an average of 650 m × 650 m and would take approximately 8.5 min to cross diagonally walking at an average of 650 m × 650 m and would take approximately 8.5 min to cross diagonally walking at an average of 650 m × 650 m and would take approximately 8.5 min to cross diagonally walking at an average of 650 m × 650 m and would take approximately 8.5 min to cross diagonally walking at an average of 650 m × 650 m and would take approximately 8.5 min to cross diagonally walking at an average of 650 m × 650 m and would take approximately 8.5 min to cross diagonally walking at an average of 650 m × 650 m and would take approximately 8.5 min to cross diagonally walking at an average of 650 m × 650 m and would take approximately 8.5 min to cross diagonally walking at an average of 650 m × 650 m and would take approximately 8.5 min to cross diagonally walking at an average of 650 m × 650 m and of 650 m × 650 m and would take approximately 6.5 mm to closs diagonal, and average hard average participants spent on average 10 minutes immersed in the virtual world. The participants were instructionally opposite bottom corrections and make their way to the diagonally opposite bottom corrections. Participants spent on average 10 minutes immersed in the virtual world. All plants were instructed and the property at the top corner and make their way to the diagonally opposite bottom corner, From enter the geometry at the top corner and make their way to the diagonally opposite bottom corner, From the geometry at the top corner and make their way to the diagonally opposite bottom corner, From the geometry at the top corner and make their way to the diagonally opposite bottom corner, From the geometry at the top corner and make their way to the diagonally opposite bottom corner, From the geometry at the top corner and make their way to the diagonally opposite bottom corner, From the geometry at the top corner and make their way to the diagonally opposite bottom corner, From the geometry at the top corner and make their way to the diagonally opposite bottom corner. enter the geometry at the top corner and make their way to the diagonally opposition between the desire analysis of the paths chosen, Conroy concludes that route selection is a competition between the desire to maintain desire to maintain desire. analysis of the paths chosen, Conroy concludes that route sold the desire to maintain a heat select the simplest route (i.e. straightest route to the destination) and the desire to maintain a heat select the simplest route (i.e. straightest route to the origin (most direct route). Conrov goes on to select the simplest route (i.e. straigntest route to the destination) and the closest to the direction of the destination from the origin (most direct route). Conroy goes on to suggest to closest to the direction of the destination from the origin (most direct route). Conroy goes on to suggest to closest to the direction of the destination from the origin (most direct route). closest to the direction of the destination from the origin (most direction). 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The study of Scharine and McBeath [9] investigated the choice people make in taking a left or right involved 112 participants who were it. The study of Scharine and McBeain [9] investigated the choice people make in all galettor negligible when all other conditions were equal. Their experiment involved 112 participants who were library patro when all other conditions were equal. The sample consisted of 87 % right-handed people in the sample consisted of 87 % right-handed people right-handed people right-handed peopl when all other conditions were equal. Then experiment involved to February patrol when all other conditions were equal. Then experiment involved for the first state of 87 % right-handed people. Participes 82 from the USA and 30 from the UK. The sample consisted of 87 % right-handed people. Participes to the end of an aigle formed by a shalf-of-82 from the USA and 30 from the UK. The sample consider the end of an aisle formed by a shelf of book I were asked to retrieve an object which was hidden at the end of an aisle formed by book shelves and then the consider formed by book shelves and then the consider formed by book shelves and then the consider formed by book shelves and then the consideration of t were asked to retrieve an object which was indden at the chie of an allow of a shell of 000ks be participants had to walk down a 10 m long corridor formed by book shelves and then turn either into participants had to walk down a 10 m long corridor formed by book shelves and then turn either into the participants had to walk down a 10 m long corridor formed by book shelves and then turn either into the participants had to walk down a 10 m long corridor formed by book shelves and then turn either into the participants had to walk down a 10 m long corridor formed by book shelves and then turn either into the participants had to walk down a 10 m long corridor formed by book shelves and then turn either into the participants had to walk down a 10 m long corridor formed by book shelves and then turn either into the participants had to walk down a 10 m long corridor formed by book shelves and then turn either into the participants had to walk down a 10 m long corridor formed by book shelves and then turn either into the participants had to walk down a 10 m long corridor formed by book shelves and the participants had to walk down a 10 m long corridor formed by the participants had to walk down a 10 m long corridor formed by the participants had to walk down a 10 m long corridor formed by the participant had to walk down a 10 m long corridor formed by the participant had to walk down a 10 m long corridor formed by the participant had to walk down a 10 m long corridor formed by the participant had to walk down a 10 m long corridor formed by the participant had to walk down a 10 m long corridor formed by the participant had to walk down a 10 m long corridor formed by the participant had to walk down a 10 m long corridor formed by the participant had to walk down a 10 m long corridor formed by the participant had to walk down a 10 m long corridor formed by the participant had to walk down a 10 m long corridor formed by the participant had to walk down a 10 m long corridor formed by the participant had to walk down a 10 m participants nad to walk down a 10 in long control formed by ook shortes and their turn eliner mone left aisle or the right aisle to retrieve the object. They found that 66 % of the right-handed sample prefered to the right aisle or the right aisle or the right aisle to retrieve the object. tert aisie of the right aisie to retrieve the object. They sample preferred to turn right. This indicates that to turn right while only 33.3 % of the left-handed sample preferred to turn right that the parties in which the parties is the parties of the parties to turn right while only 33.3 70 of the left-handed sample protection in which the person is likely to turn handedness of the participant is a strong indicator of the direction in which the person is likely to turn is addition, 67.1 % of the sample who drive on the right side preferred to turn right while 46.7 % of the addition, 07.1 70 of the sample who drive on the left-side prefer to turn right. This indicates that while the side of the road that ye drive on has an influence, it is not as strong as the handedness. Furthermore, it appears that handedness at driving side are additive factors, with approximately 70 % of right-handed, right-side driving same preferring to turn right, while approximately 48 % of the right-handed, left-driving sample prefer to the right. The sample size of left-side drivers was considered too small to draw definitive conclusions Is study would suggest that there is both a genetic component to wayfinding (handedness) and a cultur

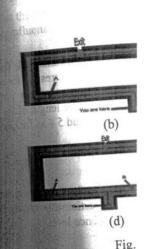
While these studies indicate that there are a number of factors that influence wayfinding, the studies component (driving side). either drawn from too small a sample or are not directly related to wayfinding within building Furthermore, the study of Golledge, conducted in the USA and Conroy, conducted in the UK, do 1 consider handedness or driving side of the participants and the likely impact this may have on wayfinding To address these issues and identify the factors which impact wayfinding within building environment. authors have undertaken two large-scale international surveys. The first survey explored factors asserting the handedness desired sides of the survey and the survey of the first survey explored factors asserting the handedness desired sides of the survey with; handedness, driving side, and preference for longest leg first (LLF) or shortest leg first (SLF). second survey was designed to explore a wider range of potential factors which influence wayfinding results from the first questionnaire are presented in this paper. Once the factors which influence way within building are established, they will be incorporated within the wayfinding algorithm established. [4].

Participants were invited to complete an on-line questionnaire. The call for participation to composition survey was undertaken via covered distribution on-line survey was undertaken via several different media e.g. website link, leaflet distributor forums, email mailing lists friends/family/collection THE WAYFINDING QUESTIONNAIRE forums, email mailing lists, friends/family/colleagues, a national appeal broadcast on BBC radio, balling, etc. Whilst the survey is currently on line (http://doi.org/10.1001) balling, etc. Whilst the survey is currently on line (<a href="http://fseg.gre.ac.uk/wayfinding/index.asp">http://fseg.gre.ac.uk/wayfinding/index.asp</a>), at the balling, etc. Whilst the survey is currently on line (<a href="http://fseg.gre.ac.uk/wayfinding/index.asp">http://fseg.gre.ac.uk/wayfinding/index.asp</a>), at the other presents of writing this paper, the results presented represent data at the contraction of the other paper. of writing this paper, the results presented represent data collected from approximately July 2009 and 2010. The survey consisted of three sections and required 2010. The survey consisted of three sections and required approximately 10–15 min to complete.

The first part consisted of five separate wayfinding tasks where the participants were shown five hypothetical building layouts in turn (see Fig. 1) hypothetical building layouts in turn (see Fig. 1), each with two paths, labeled A and B, leading in the participant was provided with written in formal in the participant was provided with which we have a superior with the participant was provided with which we have a superior with the participant was provided with which we have a superior with the participant was provided with the participant w The participant was provided with written information stating that each path was path, the participant was provided with the building level. they were completely familiar with the building layout. On selecting the preferred path, the part

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Question 1 is intended to investigate the of the LLE path (See Fig. 1a). In the second (see and twee the LLF path on the left (se put having the least bearing to the consideration, Questions 4 (Fig. 1d) an the exit, thus both paths have an equa and 5 were kept the same. However a Question 4 and Path A in Question 5 ( that both paths are of the same leng ampensate for this visual illusion.



e second part of the survey th influenced their wayfinding d equion and were also given th ors provided was:

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make in taking a left or nels to ticipants who were library paro o right-handed people, Partie le formed by a shelf of books Th helves and then turn either into the of the right-handed sample pre o turn right. This indicates that the which the person is likely to turn in d to turn right while 46,7 % of the at while the side of the road that you more, it appears that handedness and nt-handed, right-side driving sample ed, left-driving sample prefer to tun to draw definitive conclusions. This yfinding (handedness) and a cultural

influence wayfinding, the studies at ited to wayfinding within building Conroy, conducted in the UK, do ut y impact this may have on wayfinding ading within building environments, to first survey explored factors associate t (LLF) or shortest leg first (SLF). The factors which influence wayfinding. e the factors which influence wayfinds the wayfinding algorithm established

The call for participation to complete website link, leaflet distribution, onto al appeal broadcast on BBC radio, sa e.ac.uk/wayfinding/index.asp), at the m ted from approximately July 2009 to 1 imately 10-15 min to complete.

the participants were shown five differ paths, labeled A and B, leading to and that each path was equal in length and secting the ecting the preferred path, the participant

rate both paths on a scale of 1 to 6 where 1 is highly undesirable, 2 is very undesirable, 3 is a scale of 1 to 6 where 1 is highly desirable. On complete the desirable, 5 is very desirable and 6 is highly desirable. ded to rate both paths on a scare of 1 to 0 where 1 is nightly undesirable, 2 is very undesirable, 3 is a desirable, 4 is a little desirable, 5 is very desirable and 6 is highly desirable. On completing this, the desirable, 4 is a little desirable that they were now in an emergency evacuation citation. edestrable, 4 is a little destrable, 5 is very destrable and 6 is highly desirable. On completing this, the same asked to imagine that they were now in an emergency evacuation situation in the same nt was then asked to imagine that they were now in an emergency evacuation situation in the same and choose their preferred exit path. For the emergency evacuation option, the participant was and choose their preferred exit path. For the emergency evacuation option, the participant was and choose men pictorica care paul. For the emergency evacuation option, at that both routes were considered safe and free of smoke or other fire hazards.

is intended to investigate the participant's preference for selecting the left-hand or right-hand is intended to investigate the participant's preference for selecting the left-hand or right-hand [see Fig. 1a]. In the second (see Fig. 1b) and third (see Fig. 1c) questions, the building geometries [see Fig. 1b] and the second (see Fig. 1b) or right (see Fig. 1c). The LLE path is also in the left (see Fig. 1b) or right (see Fig. 1c). (see Fig. 1a). In the second (see Fig. 1b) and third (see Fig. 1c) questions, the building geometries that the left (see Fig. 1b) or right (see Fig. 1c). The LLF path is also the most direct the least bearing to the exit. In order to remove the most direct have the LLF path on the left (See Fig. 10) or right (see Fig. 1c). The LLF path is also the most direct from the least bearing to the exit. In order to remove 'the most direct path' factor from having the least bearing 4 (Fig. 1d) and 5 (Fig. 1e) were designed where the start of the start having the least bearing to the CAIL. In order to remove 'the most direct path' factor from Ouestions 4 (Fig. 1d) and 5 (Fig. 1e) were designed where the start position is in line with hath paths have an equal bearing to the exit Initially the length of the cast. ideration, Questions 4 (Fig. 14) and 3 (Fig. 16) were designed where the start position is in line with thus both paths have an equal bearing to the exit. Initially the length of the paths in Questions 4 that the same. However a pilot study indicated that people personnel the same. thus both pauls have an equal occaring to the exit. Initially the length of the paths in Questions 4 is were kept the same. However a pilot study indicated that people perceived the angled path, Path B in 19 and Path A in Ouestion 5 (Fig. 1d and Fig. 1e) to be elightly longer in were kept the Same. However a place study included that people perceived the angled path, Path B in find 4 and Path A in Question 5 (Fig. 1d and Fig. 1e), to be slightly longer in spite of being reminded both paths are of the same length. Hence the angled paths were made slightly shorter in order to cessate for this visual illusion.

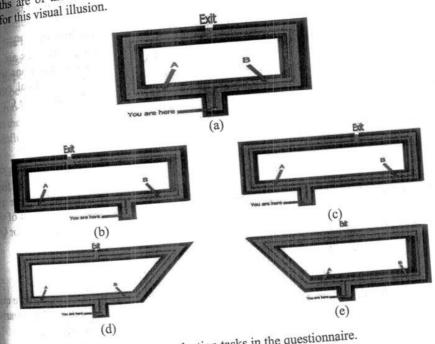


Fig. 1. Path selection tasks in the questionnaire.

hathe second part of the survey the participants were given a list of factors and were asked to choose those influenced their wayfinding decisions in the first part of the survey. Participants could select more than The option and were also given the opportunity to list other factors that influenced their decision. The list of ctors provided was:

- I prefer to take the path with the longest leg first
- I prefer to take the path with the shortest leg first
- I have a preference for paths on my left
- I have a preference for paths on my right
- I have a preference to take the clockwise paths
- I have a preference to the take the anticlockwise path
- I choose the path which appeared to be the most direct

be third part of the survey involved collecting participant demographic information. Two pilot studies by conducted to check the general level of understanding of the questions. A few modifications were to the questionnaire based on the pilot studies and this data was not included in the overall destionnaire results.

## THE SAMPLE POPULATION

A total of 1200 participants from 36 countries took part in the survey of which 1166 were considered to the survey of the survey A total of 1200 participants from 50 countries with the largest response to the survey are: UK eligible to take part in the analysis. The countries with the largest response to the survey are: UK eligible to take part in the analysis. The country (56 %); Germany, 46 (4 %) and Netherlands (56 %); USA, 113 (10 %); Australia, 72 (6 %); India, 62 (5 %); Germany, 46 (4 %) and Netherlands (56 %); USA, 113 (10 %); Australia, 72 (0 %), Indian, 12 (0 %), Indian, (2%). Of this sample, a total of 330 (29%) of the participant.

Germany, Netherlands, etc, and 830 (71%) drive on the left-side of the road e.g. UK, Australia, India

Germany, Netherlands, etc, and 830 (71%) drive on the left-side of the road e.g. UK, Australia, India Germany, Netherlands, etc, and 650 (17 %) different are right-handed while 156 (13 %) are left-handed. Furthermore, 1010 (87 %) of the participants are right-handed while 156 (13 %) are left-handed of the population of the popul Furthermore, 1010 (8/70) of the participants are right average of 10-13 % of the population being a sample of left-handed people is equivalent to the world average of 10-13 % of the population being to the left side of the road (830) 728 (89.00) sample of left-nanded people is equivalent to the work of the road (830), 728 (88 %) are handed [10]. Of the sample population who drive on the left-side of the road (830), 728 (88 %) are handed [10]. handed [10]. Of the sample population who divide the handed (note, the right-handed left-driving sub-population is referred to as RHLD). Of the left-driving sub-population is referred to as RHLD). handed (note, the right-handed interest handed left-driving sub-population is referred by sample, 102 (12 %) are left-handed (note, the left-handed left-driving sub-population is referred by sample, 102 (12 %) are right-handed (1866, disc), and the road (336), 282 (84 %) are right-handed (referred LHLD). Of the sample that drive on the right-side of the road (336), 282 (84 %) are right-handed (referred to 20 LHDD) to as RHRD) while 54 (16 %) are left-handed (is referred to as LHRD).

## THE MAIN RESULTS AND DISCUSSION

The findings from Part 1 of the study are first presented, followed by the findings from Part 2. The Part results are first summarized and then the responses to each of the wayfinding questions are examined turn. It is important to note that the results for the path selection under normal conditions were virtual identical to those under emergency conditions and so only the results under normal conditions are presented. All the conclusions presented in this paper are statistically significant using the Chi-Square to with Yates [11] correction.

### Discussion of Part 1 Results

In this section the results from the path selection tasks for Questions 1-5 are first summarized. This is the followed by a detailed investigation of the results from each path selection task. The results for each path selection exercise are examined in detail with a focus on: Question 1 - impact of the participant handedness and driving side on the path selection; Questions 2 and 3 - impact of the length of the first a on path selection (together with participant handedness and driving); Questions 4 and 5 - as for Questions and 3 but with the path directness removed as an influencing factor.

## Overview of Path Selection Results

A summary of the path choice made by the entire sample population (1166) for each of the five questions's shown in Fig. 2. In the first four wayfinding tasks (Questions 1-4), the participants clearly have a preference for right-hand paths which is statistically significant at a 0.001 confidence level.

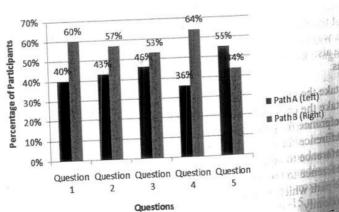


Fig. 2. Percentage of the sample population selecting Paths A and B in wayfinding tasks.

This strong preference for right-hand paths is examined in more detail in the following sections results suggest that on the whole people generally hand paths the results suggest that on the whole people generally have a slight preference for right-hand paths.

in the fifth wayfinding task there is mere is apparent difference in path selection a

Question 1: The Influence of Handeds

In the first question, both path options ass on the left and the other path w hose the right-hand path and 40 % (4 the stiff of the ngeneral are more likely to turn righ

in the right-handed sub-population (1 tal 87 % of the entire sample is rig rest-hand paths is as small as 4 % co 1%(111) have chosen the left-hand estribution is also valid at a 0.001 le have a strong preference for left-hance people's preference for right/left-hand

A chi-square test of independence people are independent of the hander people is independent of their hande eft-handed sub-population have be siggests that the null hypothesis can ery strong influence on the right/left

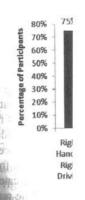


Fig. 3. Percentage

Question 1. The Influence of the Dri

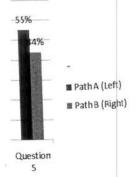
he right-side driving sub-popula diving on the right-side of the ficance ( $\chi^2 = 57.26$ ). In fact, pe thand paths than the right-hand 143). This is because the majority anggests that in addition to han aplementary (additive) fashio hand path (see Fig. 3). The r Which suggests that driving (730) of the left-side driving popular in the case of the leftposition reducing the state fact people (genetic fact ostion, reducing the overall come to influencing wayfir

survey of which I'l est response to the si Germany, 46 (4 %) ve on the right-side o of the road e.g. UK, while 156 (13 %) are of 10-13 % of the popul of the road (830), 728 ferred to as RHLD). Of -driving sub-population i6), 282 (84 %) are right. IRD).

ed by the findings from Par he wayfinding questions are on under normal conditions were vin the results under normal conditions cally significant using the Chi-Square to

tions 1-5 are first summarized. This is the th selection task. The results for each per Question 1 - impact of the participant and 3 - impact of the length of the first ing); Questions 4 and 5 - as for Question

ation (1166) for each of the five questions ions 1-4), the participants clearly have at a 0.001 confidence level.



g Paths A and B in wayfinding tasks. more detail in the following sections ght preference for right-hand paths. How

wayfinding task there is a significant preference for the left-hand path. The reasons for this in wayfinding the selection are examined in the next sections.

The Influence of Handedness on Path Selection both path options were identical, the only variable that was different was that one path first question, poin path was on the right. Taken across the entire sample (1166), 60 % (700) the left and the other path and 40 % (466) chose the left-hand path (see Fig. 2). The standard path and 40 % (466) chose the left-hand path (see Fig. 2). the left and the hand 40 % (466) chose the left-hand path (see Fig. 3). The chi-square goodness of the left-hand path and 40 % (466) chose the left-hand path (see Fig. 3). The chi-square goodness of the left-hand path (see Fig. 3) are chi-square goodness of the left-hand path (see Fig. 3). the right-name pair (see rig. 3). The chi-square goodness of  $(x^2 = 42.39)$  suggests that this distribution is valid at a 0.001 level of significance. Thus people  $(x^2 = 42.39)$  suggests that this distribution is valid at a 0.001 level of significance. Thus people  $(x^2 = 42.39)$  suggests that this distribution is valid at a 0.001 level of significance. Thus people  $(x^2 = 42.39)$  suggests that this distribution is valid at a 0.001 level of significance. ral are more likely to turn right than left.

nght-handed sub-population (1010), 64 % (646) chose the right-hand path (see Fig. 3). Considering nght-handed start paul (see Fig. 3). Considering of the entire sample is right-handed, it is not surprising that the increase in the preference for and paths is as small as 4 % compared to the entire sample. In the left-handed sub-population (156), 18 (11) have chosen the left-hand path and 29 % (45) have chosen the right-hand path (see Fig. 3). This botton is also valid at a 0.001 level of significance ( $\chi^2 = 23.52$ ) which implies that left-handed people and the strong preference for left-hand paths. Thus handedness of people is a strong factor which determines ok's preference for right/left-hand paths.

disquare test of independence was also performed to check if the right/left-hand paths chosen by to disquare tost in the handedness of the participants. The null hypothesis is that the path choice of the path is independent of their handedness. The paths chosen by the right-handed sub-population and the the handed sub-population have been considered for this analysis. The chi-square result ( $\chi^2 = 60.69$ ) gests that the null hypothesis can be rejected at a 0.001 significance level. Thus handedness does have a toy strong influence on the right/left-hand path choice.

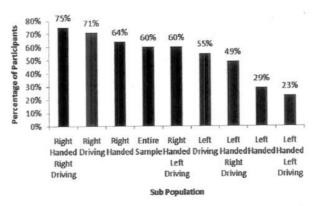


Fig. 3. Percentage of each sub-population choosing right-hand paths.

estion 1: The Influence of the Driving Side on Path Selection

he right-side driving sub-population (336), 71 % (239) have chosen the right-hand path (see Fig. 3). type driving on the right-side of the road have a strong preference to right-hand paths at a 0.001 level of bilitaince ( $\chi^2 = 57.26$ ). In fact, people driving on the right-side of the road have a stronger preference to paths than the right-handed sub-population where only 64 % chose the right-hand paths (see This is because the majority (84 %) of the right-side driving sub-population is also right-handed. suggests that in addition to handedness, the driving side also influences the choice of right-hand paths implementary (additive) fashion. In the left-side driving population (830) 55 % (457) have chosen the hand path (see Fig. 3). The right-hand path preference has fallen by 5 % compared to the entire which suggests that driving on the left-side influences people to choose left-hand paths. However, (730) of the left-side driving sub-population is right-handed which explains why right-hand path is opular. In the case of the left-side driving sub-population, right-handedness and left-side driving are position, reducing the overall number of people who select the right-hand path. This suggests that ness of people (genetic factor) is a more influential factor than the driving side (cultural factor) t comes to influencing wayfinding path choices.

A chi-square test of independence was also performed to check if the right/left-hand paths chi people are independent of the driving side by considering the right-side driving and left-side driving people are independent of the driving side has a strong influence populations. The chi-square result ( $\chi^2 = 24.31$ ) suggests that the driving side has a strong influence populations. The cni-square result (2 - 24.51) suggested. It is interesting to note that even thought right/left-hand paths chosen at 0.001 significance level. It is interesting to note that even thought left-hand paths chosen at 0.001 significance level. It is interesting to note that even thought left-hand paths chosen at 0.001 significance level. majority in the right-side drive and left-side drive sub-populations has preferred the right-hand driving side still has a significant influence on the path choice.

# Question 1: The Influence of the Handedness and Driving Side on Path Selection

Clearly, the handedness and driving side are factors which each have a significant influence on clearly, the nandedness and driving side are lateral not be first question of the selection. In this section the influence of a combination of the two factors is considered. Figure 3 shows percentage of each sub-population choosing right-hand paths in the first question of the question percentage of each sub-population choosing against are arranged in descending order of preference relating to the geometry in Fig. 1a. The sub-populations are arranged in descending order of preference and the preference of the relating to the geometry in Fig. 1a. Thus the sub-populations having a higher preference for right-hand paths from left to right. Thus the sub-populations having a higher preference for right paths are on the left and the sub-populations having a lower preference for right-hand paths are on the pauls are on the left and the sate population on the right-side have the strongest preference for right-hand and the clearly, right-handed people driving on the right-side have the strongest preference for right-hand and the contract of t and the left-handed people driving on the left-side have the lowest preference for right-hand paths (and highest preference for left-hand paths). The preference for right-hand paths in the first six sub-popular from the left is statistically significant at the 0.001 confidence limit. The preference for left-hand paths the last two sub-populations is also statistically significant at the 0.001 confidence limit.

The right-handed sub-population has a strong preference for right-handed paths at 64 %. The preference right-hand paths increases to 75 % in the RHRD sub-population. This suggests that the preference for no hand paths is amplified if one is right-handed and from a country driving on the right side of the re compared to when one is simply right-handed. The left-handed sub-population has little preference right-handed paths at 29 %. The preference for right-hand paths further decreases to 23 % for the LHI sub-population. This suggests that the preference for left-hand paths is amplified if one is left-handed from a country driving on the left side of the road compared to when one is simply left-handed.

The RHRD sub-population has a 15 % greater preference for right-hand paths than the RHLD is population. Thus if one is right-handed and driving on the left side of the road then the preference form hand paths while high is not as high as it is when one is right-handed and driving on the right-side of road. The LHLD sub-population exhibits a 25 % greater preference for left-hand paths than the LHRD population. This suggests that if one is left-handed and driving on the right-side of the road there is a small preference for left-hand paths, and if one is left-handed and driving on the left side of the road there is strong preference for left paths. The LHRD sub-population has a 51 % preference for left-handed path close to a 50-50 preference for right- and left-hand paths. The small preference for left-handed paths this sub-population may be attributed to the small number of participants in this category, only 54, with next smallest category having 102 participants (LHLD). It is expected that if the number of participants the LHRD category were increased, a stronger preference for left-handed paths would emerge for his population. However, according to Cochran [12], the expected and observed frequencies in this population are sufficient to make statistically significant conclusions.

Considering that the RHLD sub-population has a strong preference for right-hand paths and the LHRD population has a slight preference for left-hand paths, one can deduce that handedness of people stronger factor than the driving side in influencing the right/left-hand path choice. The same deducing also be made comparing the v<sup>2</sup> value of also be made comparing the  $\chi^2$  values for the handedness and driving side analyses. The  $\chi^2$  value influence of handedness 60.69 is greater than the  $\chi^2$ influence of handedness, 60.69, is greater than the  $\chi^2$  value for the influence of the driving side, 24311 supports the conclusion that handedness (a constitution of the driving side). supports the conclusion that handedness (a genetic factor) is a more influential factor than the driving supports the conclusion that handedness (a genetic factor) is a more influential factor than the hander (a cultural factor) in affecting path choice. Furthermore, if the driving side is the same as the hand these factors reinforce each other however, if they are opposite, they work in opposition.

In Questions 2 (Fig. 1b) and 3 (Fig. 1c), the length of the first leg is introduced as a path choice is Question 2 the right-hand path is the shortest leg with the length of the first leg is introduced as a path is the length of the first leg is introduced as a path is the length of the first leg is introduced as a path is the length of the first leg is introduced as a path choice is Question 2 the right-hand path is the shortest leg while in Question 3 the right-hand path is the shortest leg while in Question 3 the right-hand path is the percentage of each sub population. Figure 4 shows the percentage of each sub-population that selected the right-hand paths in Quantum and 3.

It is interesting to note that in Question which are the first sin and in Question which are the first six columns handers, whand nath regardless handers, which hand path regardless of wheth the right-man professions of left-handed per population preference for the left-hand is is the LHRD sub-population when this is the LHRD sub-population when the same is a may be too small ample size may be too small to make m regardless of the length of the first leg su negatives a more influential factor than the



Fig. 4. The percentage of each su

However, for some of the populatio handedness of the path. Consider th columns of the left of Fig. 4, when the Fig. 3) it is noted that fewer people se for example, consider the RHRD sub strongest with 75% of the sub-por ub-population, selecting the SLF or realting in the proportion of the sub-

is noted from Questions 1 and 2 th pexed to select the right-hand path is small group, selecting the path v by have selected the left-hand pa character for the SLF than the righ bestion 3 will be less than 75 %. It cted the SLF in preference to the or important than the handedness

thermore, 66 % of the RHRD su ion 2) while 56 % of the sub s that selecting the SLF is a RD sal-population, more people be LLF path.

lar rends are found for the sul then of Fig. 4. When the left-ha 1% Light-hand preference (%) the first leg of the path is sh effective for selecting the le he left-hand path in Qu

nt/left-hand paining and left-side of has a strong mft and o note that even up arred the right-hand.

ion

significant influence considered. Figure 3 sh question of the questionary ending order of pretentions of the preference for right-hand paths are on the preference for right-hand paths (and in the first six sub-population eference for left-hand paths (and dence limit.)

aths at 64 %. The preference for right g on the right side of the roal ulation has little preference for ecreases to 23 % for the LHLD plified if one is left-handed and simply left-handed.

and paths than the RHLD subpad then the preference for rightid driving on the right-side of the
t-hand paths than the LHRD subt-side of the road there is a small
ne left side of the road there is a
preference for left-handed paths
ference for left-handed paths
in this category, only 54, with the
at if the number of participants in
paths would emerge for this subbserved frequencies in this sub-

tht-hand paths and the LHRD set that handedness of people is a handedness of people is a handedness. The  $\chi^2$  value for the driving side, 24.31. The uential factor than the driving set ide is the same as the handedness k in opposition.

troduced as a path choice factor, e right-hand path is the longest the right-hand paths in Question.

to note that in Questions 2 and 3, the sub-populations containing a majority of rightpresenting to note that in Questions 2 and 3, the sub-populations containing a majority of rightpresenting to note that in Questions 2 and 3, the sub-populations containing a majority of rightpresenting to note that in Questions 2 and 3, the sub-populations containing a majority of rightpresenting to note that in Questions 2 and 3, the sub-population tree are the first two columns as significant preference for the subpresenting to note that in Questions 2 and 3, the sub-population tree first two columns as significant preference for the subpreference for the left-hand path regardless of whether it is the SLF/LLF path. The exception
preference for the left-hand path regardless of whether it is the SLF/LLF path. The exception
preference for the left-hand path regardless of the LHRD sub-population who prefer the right-hand path – however, as suggested earlier the
preference for the left-hand path regardless of the length of the first leg suggests that for the majority of the population the handedness of the
preference for the left-hand path regardless of the length of the first leg suggests that for the majority of the population the handedness of the
preference for the left-hand path regardless of the length of the first leg suggests that for the majority of the population the handedness of the
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preference for the left-hand path regardless of the length of the first leg in affecting path choice.

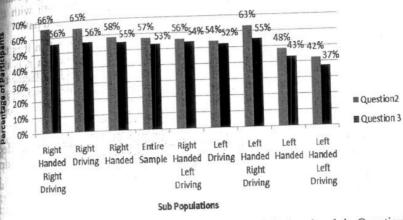


Fig. 4. The percentage of each sub-population choosing the right-hand path in Questions 2 and 3.

However, for some of the population, selecting the SLF or the LLF will be more important than the bindedness of the path. Consider the sub-populations that prefer the right-hand path i.e. the first six columns of the left of Fig. 4, when the right-hand path preference is compared to that of Question 1 (see Fig. 3) it is noted that fewer people select the right-hand path when the first leg of the path is short or long. For example, consider the RHRD sub-population for which the preference for selecting the right-hand path is strongest with 75 % of the sub-population preferring the right-hand path in Question 1. For some of this sub-population, selecting the SLF or the LLF will be more important than selecting the right-hand path resulting in the proportion of the sub-population falling below 75 % in Questions 2 and 3.

this noted from Questions 1 and 2 that 9 % (75–66 %) of the RHRD sub-population that would have been expected to select the right-hand path have selected the LLF path (i.e. the left-hand path) in preference. For this small group, selecting the path with the LLF is more important than the handedness of the path and so they have selected the left-hand path. Similarly, as some of this sub-population will have a stronger reference for the SLF than the right-hand path, the percentage of people selecting the right-hand path in Question 3 will be less than 75 %. It is also noted that 19 % (75–56 %) of the RHRD sub-population have received the SLF in preference to the right-hand path. For this group, selecting the path with the SLF is some important than the handedness of the path and so they have selected the left path.

Furthermore, 66 % of the RHRD sub-population have selected the SLF path when it is the right-hand path (Question 2) while 56 % of the sub-population have selected the LLF when it is the right-hand path. This subgests that selecting the SLF is a more dominant secondary factor than selecting the LLF. Within the sub-population, more people prefer the right-handed path when it is also the SLF path than when it substituted by the LLF path.

similar trends are found for the sub-populations that prefer the left-hand path i.e. the last two columns on the right of Fig. 4. When the left-hand path preference is compared to that of Question 1 (derived by taking right-hand preference (%) shown in Fig. 3) it is noted that fewer people select the left-hand path then the first leg of the path is short or long. For example, consider the LHLD sub-population for which the preference for selecting the left-hand path is strongest with 77 % (100–23 %) of the sub-population beforing the left-hand path in Question 1. For some of this sub-population, selecting the SLF or the LLF

will be more important than selecting the left-hand path resulting in the proportion of the sub-popul falling below 77 % in Questions 2 and 3.

It is noted that from the 77 % who chose the left-hand path in Question 1 only 63 % (100–37 %) chosen the left-hand and SLF path in Question 3. Hence 14 % (77–63 %) of the LHLD sub-population could normally have been expected to select the left-hand path have selected the LLF path (right-hand in preference. For this group, selecting the path with the LLF is more important than the handedness of path and so they have selected the right-hand path. Similarly, as some of this sub-population will be stronger preference for the SLF than the left-hand path, the percentage of people selecting the left-path in Question 3 will be less than 77 %. It is noted that 19 % of the LHLD sub-population have seen the SLF in preference to the left-hand path. For this group, selecting the path with the SLF is a timportant than the handedness of the path and so they have selected the right-hand path.

Furthermore, 63 % of the LHLD sub-population have selected the SLF path when it is the left-hand path (Question 3) while 58 % of the sub-population have selected the LLF path when it is the left-hand path (Question 2). This suggests that selecting the SLF is a more dominant secondary factor than selecting the LLF. Within the LHLD sub-population, more people prefer the left-handed path when it is also the sub-populations and the path than when it is the LLF path. The same trend is also found across the other sub-populations and the entire sample.

From the results of Questions 1–3 we conclude that for the majority of people, the handedness (a general factor) is the important factor in influencing a person's path choice. The handedness howers influenced in turn by the driving side (a cultural factor) – if the driving side is the same as the handedness important factor reinforce each other while if they are opposite, they work in opposition. The next may important factor influencing path selection is the length of the first leg of the path. The preference for SU paths is greater than the preference for LLF paths. This result is interesting as it contradicts the conclusion of urban wayfinding research which suggests that the preference for LLF is greater than that for the SU of urban wayfinding research which suggests that the preference for LLF or the LLF will be the majority of the population, selecting the SLF or the LLF will be the majority of the population of the population, selecting the SLF being more dominant to selecting the LLF.

On completing the Question 2 and 3 path selection tasks, participants were asked to comment on why be selected a particular path (see Fig. 5). This was an open question with no prompts provided. Each of the comments have been analyzed and generalized into certain common factors. For example the following comment was made by a participant, "... this was my first reaction, I tend to turn to my right ..." This was inferred to mean that the participant had a preference for right-handed paths. A comment made by another participant was, "Initial path looks to be shorter". This was inferred to mean that the participant preference for the SLF path. From Fig. 5 it is noted that the SLF criterion is identified as being not important to most people than the LLF path.

It is somewhat surprising that the SLF criterion has been mentioned by more people than the right-hande path criterion. However, among the group who claim to have selected paths based on instinct, 64 is selected the right-handed path (and 45 the left-handed path). If these are added to the right-hand path selection, then the right-hand path selection dominates. Furthermore, 18 % and 23 % of the participants who answered Questions 2 and 3 respectively did not provide a reason for their path choice. Here such least half of these participants will have selected the right-hand path, but it is not clear if they selected the right-hand path selection based on the results from handed paths or SLF paths exert the most influence on path selection based on the results from question.

In addition, right-handed paths have been mentioned by more participants than left-handed paths which consistent with the path selection tasks. The number of participants who claim that they made a path selection is very small, representing only 2 % of the responses to Questions 2 and 3. Finds, number of participants who suggested that they made a path selection based on the most direct round only 7 % of the responses to Questions 2 and 3. While it is not clear what the participants means of the results suggest that consciously selecting a path on the basis of its directness appears a low influence on path selection.

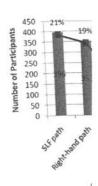
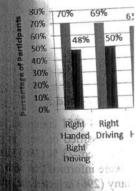


Fig. 5. Participant pa

Questions 4 and 5: Removing Directness

Question 4 (Fig. 1d) and Question 5 (Foregotion that the LLF path is no longer starting point, both the LLF and SLF path in the exit. Furthermore, the travel distances, the SLF path has acquired a designation of the right path in Questions 4 and handed path which is also the SLF path which is also the LLF path (Question 5 handed path (which is also the SLF path populations, even those who are expect populations on the right side of Fig. 6.



The percentage of each ich is counter to expecta thanded path (which who are expected to har majority of people in (

were simply the cas your 2 and 3, it can he LLF paths. How d 5 than in Question d-hand path in prefer ne proportion of the

tion 1 only 63 % (1) %) of the LHLD sub ected the LLF path ( mportant than the h e of this sub-popular ige of people selection LHLD sub-population has ing the path with the SL e right-hand path.

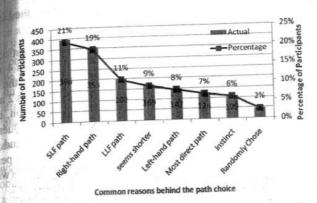
LF path when it is the left. \_F path when it is the left. nt secondary factor than selection -handed path when it is also the st oss the other sub-populations and the

of people, the hancedness (a gene 1 choice. The handedness however ing side is the same as the handed y work in opposition. The next me eg of the path. The preference for SIE resting as it contradicts the conclusion or LLF is greater than that for the SIF the SLF or the LLF will be the most ing the SLF being more dominant ha

its were asked to comment on why the vith no prompts provided. Each of the non factors. For example the following , I tend to turn to my right ...". This us ded paths. A comment made by another rred to mean that the participant had LF criterion is identified as being more

ed by more people than the right-hard selected paths based on instinct, 64 is these are added to the right-hand per nore, 18 % and 23 % of the participal eason for their path choice. Here again eath, but it is not clear if they selected e SLF. Thus it is not clear whether reselection based on the results from

articipants than left-handed paths ants who claim that they made a f oonses to Questions 2 and 3. Finally lection based on the most direct route t clear what the participants meant 1 the basis of its directness appears



5. Participant path selection comments for Questions 2 and 3.

as 4 and 5: Removing Directness from Path Selection

Question 4 (Fig. 1d) and Question 5 (Fig. 1e) investigate the same factors as Question 2 and 3 with the described that the LLF path is no longer the most direct path. By positioning the exit directly opposite the g point, both the LLF and SLF path are considered equally direct as both paths have the same bearing the exit. Furthermore, the travel distance associated with each path option is still equal as in the other As a result of removing the path directness from consideration while maintaining equal total travel frances, the SLF path has acquired a sharp angle turn. The percentage of each sub-population selecting the right-hand path in Questions 4 and 5 is shown in Fig. 6. As was found in Questions 2 and 3, the rightknded path which is also the SLF path (Question 4) is preferred by more people than the right-hand path which is also the LLF path (Question 5). Furthermore, the majority of people in Question 4 prefer the rightkinded path (which is also the SLF path) however, unlike in Question 2, this trend extends to all of the subpopulations, even those who are expected to have a preference for left-handed paths i.e. the last three subpopulations on the right side of Fig. 6.

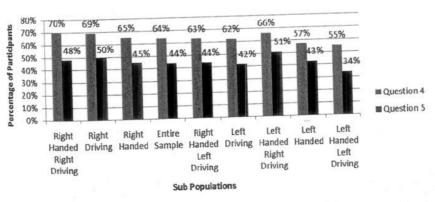


Fig. 6. The percentage of each sub-population choosing the right-hand path in Question 4 and 5.

A result which is counter to expectations is that the majority of people in virtually all the sub-populations the left-handed path (which is also the SLF paths) in Question 5. This even includes those subequations who are expected to have a preference for right-handed paths. This rejection of the right-hand by the majority of people in Question 5 may be a result of the strong preference for the SLF path wever, if this were simply the case, a similar trend would have been expected in Question 3.

Questions 2 and 3, it can again be concluded that the majority of people prefer the SLF paths pared to the LLF paths. However, the preference for SLF paths appears to be more significant in to the LLF paths. However, the preference for SLF paths appears of people have and 5 than in Questions 2 and 3, so much so that in Question 5, the majority of people have elected the left-hand path in preference to the right-hand path. There are two possible explanations for the increased trend in the preferences for the SLF path over the LLF path. Either the LLF path has becomes

In an attempt to resolve this question, consider the nature of the paths in Questions 2 and 3 and 6 Questions 4 and 5. There are two key differences between the paths in Questions 4 and 5 and those in 3. The first is that the initial leg of each path in Questions 4 and 5 is such that the bearing of each the exit is identical. Thus each path appears equally direct, whereas in Questions 2 and 3, the LLF pa the exit is identical. Thus each pain appears equally direct, which is the more direct path. By removing the path directness aspect from consideration, between 3 % and more people across all the sub-populations have selected the SLF path in Question 4 compared Question 2. If this reasoning is correct, this would suggest that for between 3 % and 13 % of the populations selecting the most direct path will be the most important factor in influencing a person's path choice this group of people, when the most direct path option is removed, the LLF path (which corresponds most direct path) is no longer considered attractive and so the SLF path is selected.

The second difference is that in Questions 4 and 5, the SLF path has a sharp angle turn. Thus an alter explanation for the increased popularity of the SLF path is that for between 3 % and 13 % of population, selecting a path with a sharp angle turn is the most important factor in influencing a per path choice. While both these explanations are plausible, neither is particularly convincing. By considering the path that was selected it is not possible to convincingly resolve the issue as to why the path appears to be more attractive in Questions 4 and 5 compared to Questions 2 and 3. However the reof the open questions following Questions 4 and 5 provide some insight into the rationale use participants in selecting their preferred path (see Fig. 7).

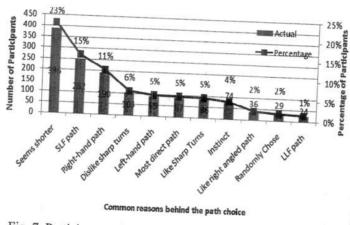


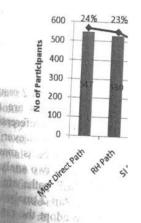
Fig. 7. Participant path selection comments for Questions 4 and 5.

A total of 1671 comments were provided by the participants to Questions 4 (851 comments) and 51 comments). Of these, 19 % (315) provided answers that could not be classified or were in groups consisted of less than 20 responses or were unclear. Of the comments received, 23 % (386) identified they selected what they thought was the shorter path, even though they were informed that both puths the same length. Furthermore, of these people, almost three times as many (296) selected the path of t sharp angle turn, i.e. the path with the SLF. This explains why there was an increase in the num people who selected the SLF path in Questions 4 and 5 i.e. a large number of people selected the SLF because they thought this path also had the shorter total length. The reasons suggested productions of the path also had the shorter total length. concerning the most direct path and the sharp angle, while plausible clearly do not correlate reasons provided by the participants for their path selection. This demonstrates that interpreting why have selected a particular path based only on the paths selected can result in incorrect conclusions. drawn. Furthermore, 6 % (103) of the participants have indicated that they selected their parts because they disliked paths involving sharp angle turns while 5 % (86) selected their path by liked paths involving sharp angles. In addition, 5 % (87) claimed that they selected their path was the most direct area than 1 direct area. was the most direct, even though both paths had the same heading relative to the exit. 'most direct' is open to interpretation and may not mean the same thing as defined earlier

ne comments also support the observ influencing path choice and that rig oussions 2 and 3, the SLF path appear goup that selected their path based on be group that selected the right-hander gree level of influence on path selectic mater due to a substantial number of duter due to the sharp angled corner.

## Discussion of Part 2 Results

On completion of the wayfinding tasks their wayfinding decisions. Unlike the o were asked to provide a reason for their more than one factor could be selected. ] 9% of the participants completed thi elected 2.0 criteria. The wayfinding crit being on the left and the least importal Direct' was selected by 24 % (547) of t election. This is considered surprising ; mentioned by 7 % of the participants in thown in Questions 4 and 5, both paths h equally direct. Within the context of this the same understanding of the term 'mo things to different people. However, the for paths which appear to them to be the the meaning of the term 'most direct' is co acluded from further consideration.



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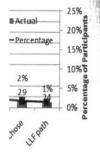
Fig. 8. Participant identified fac

cluding the responses identifying the 'mc edion tasks, notably selecting a right-ha that for most people than the SLF path two times more influential than the LLI more influential than the left-h s between preference for left/right suggested by the findings of the a preference for 'clockwise' or ' cant also, as only 8 % of the returns i anticipants had reasons for their path s

h. Either the LLP

aths in Questions in Questions 4 and is such that the bear in Questions 2 and 3 consideration, between F path in Question 4 co tween 3 % and 13 % of the nfluencing a person's path he LLF path (which correspond ath is selected

a sharp angle turn. Thus an after for between 3 % and 13 % of portant factor in influencing a per is particularly convincing. By gly resolve the issue as to why the SI Questions 2 and 3. However the re ne insight into the rationale used



#### Questions 4 and 5.

estions 4 (851 comments) and 5 (82) t be classified or were in groups that ts received, 23 % (386) identified than ey were informed that both paths were many (296) selected the path with the ere was an increase in the number of umber of people selected the SLF pad 1. The reasons suggested previous ible clearly do not correlate with the nonstrates that interpreting why people 1 result in incorrect conclusions being hat they selected their particular particula (86) selected their path because the hat they selected their path because relative to the exit. Clearly, the term ng as defined earlier in this paper.

also support the observation that the SLF criterion is more influential than the LLF criterion that right-handed paths are more influential than left-handed paths. As with 13 the SLF path appears to be more influential than the right-handed paths. However, of the their path based on instinct, 43 selected the right-hand path. If these are then added to selected the right-handed path, then the SLF and right-handed paths have approximately the selected and selection. Furthermore, the number of people who selected the SLF path is of influence of people selecting this path because they thought the entire path was The to the sharp angled corner.

## ion of Part 2 Results

completion of the wayfinding tasks, participants were asked to identify the factors which influenced decisions. Unlike the open questions following each wayfinding task in which participants asked to provide a reason for their path choice, they were given a list of factors to choose from and that one factor could be selected. Presented in Fig. 8 are the results from this question. In total (1150) of the participants completed this section, making 2309 selections. On average, each participant ded 2.0 criteria. The wayfinding criteria are arranged in descending order with the most popular criteria on the left and the least important criteria being on the right. It is noted that the criterion 'Most of the participants and so is the criterion which most influenced path then. This is considered surprising as it did not figure highly in Questions 2 to 5, indeed it was only entend by 7 % of the participants in Questions 2 and 3 and 5 % in Questions 4 and 5. Furthermore, as down in Questions 4 and 5, both paths had the same initial bearing on the exit and so could be considered ally direct. Within the context of this survey, it is suggested that not all the participants had a clear or te same understanding of the term 'most direct'. The term can clearly be interpreted to mean different tings to different people. However, the result clearly indicates that participants have a strong preference which appear to them to be the most direct, although it is not clear how they define this term. As reaning of the term 'most direct' is considered to be ambiguous within the context of this analysis, it is acluded from further consideration.

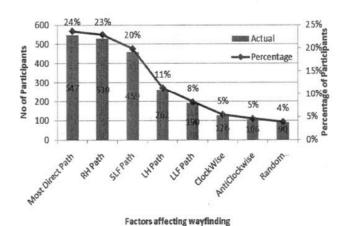


Fig. 8. Participant identified factors which influenced their path selection decisions.

ing the responses identifying the 'most direct' path, the main results support the findings of the path tasks, notably selecting a right-handed path (23 %) appears to be a marginally more important for most people than the SLF path criterion (20 %). Furthermore, the SLF path criterion is more times more influential than the LLF path criterion and the right-handed path criterion is more than more influential than the left-handed path criterion. It is noted that the magnitude of the ces between preference for left/right and SLF/LLF paths in this part of the survey is significantly than suggested by the findings of the wayfinding tasks. Also, as approximately 5 % of the responses a preference for 'clockwise' or 'anticlockwise' paths, these criteria are not considered to be ant. Also, as only 8 % of the returns indicate a random path selection, this suggests that the majority Participants had reasons for their path selection.

## RELATIVE IMPORTANCE OF THE WAYFINDING CRITERIA

The results presented in Fig. 8 show the relative importance of the main wayfinding criteria as identification. the participants on completing the wayfinding tasks. The most influential criteria, in order of interest in the participants on completing the wayfinding tasks. are selecting; right-handed paths (23 %), SLF paths (20 %), left-handed paths (11 %) and LLF path These rankings are based on the opinion of the participants and do not necessarily correlate w actual path selection. To determine the relative importance of the path selection criteria, the resu Questions 2 and 3 are further investigated. The results from Questions 4 and 5 are being left out analysis due to uncontrolled factors such as perceived total path length and multiple factors like/dislike of sharp angle turns impacting the path selection. It is to be noted that these factors examined in the second survey described earlier. The relative importance of the four path selections is determined as follows: if a participant selected right-hand paths in both Questions 2 and 3 the clearly prefer right-hand paths over all other criteria (i.e. left-hand paths, SLF, LLF); if a participants the left-hand paths in both Questions 2 and 3, then they clearly prefer left-hand paths over all other than the left-hand path if a participant selects the SLF paths in both Questions 2 and 3, then they clearly prefer SLF paths: a participant selects the LLF paths in both Questions 2 and 3, then they clearly prefer the LLF path participants who have answered both Question 2 and 3 must fall into one of these four preference categories. These results for this analysis for various sub-populations are presented in Table 1.

Table 1. Summary of path preference criteria based on wayfinding tasks in Questions 2 and 3.

Sample population	RH path preference (%)	SLF path preference (%)	LLF path preference (%)	LH path preference (%)
Entire sample	31	29	23	17
RH	30	28	23	20
LH	20	28	23	29
RD	33	32	23	12
LD	30	28	23	20
RHRD	33	33	23	11
	35	25	23	18
LHRD	32	28	23	18
RHLD	15	29	23	33
LHLD	13	2)		

If we compare the results for the entire sample in Table 1 with those from the Part 2 results (see Fig. 8) note that there is broad agreement in the trends namely; right-handed paths are significantly preferential than left-handed paths and right-handed paths are marginally more preferential than SLF paths are more preferential than LLF paths however, the results from the wayfinding tasks in Questions 2 and 3 suggest that the difference is marginal where the difference derived from the Part 2 results is significant. The results from the two analyses contradicted other in that, based on the results derived from Questions 2 and 3, LLF paths are significantly preferential than left-handed paths (see Table 1) whereas, based on the Part 2 analysis (see Fig. 8). It is paths are marginally more significant than LLF paths. Here we adopt the rankings based as actual wayfinding tasks as being representative of human behavior within buildings as these way results of actual wayfinding tasks as opposed to opinions.

The ranking of the path preference criteria based on the entire sample presented in Table 1 provides are for ranking path preference in evacuation models. The results are significantly different from generated by Golledge's urban wayfinding study [5,6] in that the results from this study suggest paths are more preferential than LLF paths. These differences may be due to Golledge's results been on an urban environment or due to the small and selective sample used in his study. This result different to that of Conroy [7] for similar reasons. Furthermore, the suggestion by Conroy directness is a significant path selection criterion [7] is not supported by the results of the wayfinding in Questions 2 to 5 and when participants were asked to suggest why they selected their participants were asked to suggest why they selected their participants path finding criteria from a list. Neither of these studies included the concept of these terminant of path selection. This study has shown it to be the most important factor. These terminant of path selection. This study has shown it to be the most important factor. These terminant of path selection.

similar to those of Scharine and McB and their sample was much smaller.

the results for the entire sample are population as a whole. It is acknowle the same type of behavior as sugge complex and wayfinding decision r diving decision making, some of wh which these influential factors work 1 working together while in other group way by the influential factors that de multis! However, from a modeling p rileria that can be applied to a popul presented in Table 1 shows that ther for important sub-populations. For e that drive on the left side of the ro sample population made up of people each of these populations can be furt people each of which display signific cultural differences may influence ou

It is suggested that in situations wher mixed population, the path prefere application is primarily catering for side driving path preference is used drive on the right e.g. a USA applicatives country specific can be furth while it may not be known which international average of 13 % of the an effect these differences in sub-ports currently being examined by introduced into the building EXODUS

#### CONCLUSION

This work has identified factors whi credation conditions. The results are countries. The survey involved par condor layouts. It was found that th interia used in normal circulation ar tractic factor) and the side of the portant influential factors in path sor with the driving side modifyin; ndedness, these factors reinforce es important to consider the hande Intering to predict wayfinding beh the criterion was found to be more n wayfinding studies and is thought a selective sample used in the urb path selection criterion ba considering the responses to the od 6 be: 31 % prefer right-hand o be: 1% prefer right. ayfinding algorithms. How relation will exhibit the same typ

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ain wayfinding crite iential criteria, in or ded paths (11 %) and lo not necessarily o oath selection criteria ions 4 and 5 are bei 1 length and multiple is to be noted that the rtance of the four path sel s in both Questions 2 and paths, SLF, LLF); if a partic er left-hand paths over all o 1 they clearly prefer SLF par n they clearly prefer the Lit fall into one of these four as are presented in Table 1.

inding tasks in Questions 2 and 3

LLF path eference (%)	LH path preference (%)	
23	17	
23	20	
23	29	
23	12	
23	20	
23	11	
23	18	
23	18	
23	33	
40	7.000	

ight-handed paths are significantly arginally more preferential than SLF han LLF paths however, the results dense at the difference is marginal where sults from the two analyses contradicts and 3, LLF paths are significantly and on the Part 2 analysis (see Fig. 8). Here we adopt the rankings based to havior within buildings as these was

sample presented in Table 1 provide as sults are significantly different from the results from this study suggest may be due to Golledge's results being more, the suggestion by Conroy ported by the results of the wayfinding sest why they selected their particular when the participants were asked included the concept of handedness the most important factor. These results are significantly as the concept of the suggestion of

Scharine and McBeath [9] however, their study did not include the SLF and LLF factors of Scharine smaller.

sample was much smaller. for the entire sample are intended to represent an average result which can be applied to the for the entire Sample of the preference distribution for the applied to the applied to the applied to the applied to the preference distribution for a suggested by the preference distribution for the preference distributio whole. It is acknowledged that not every individual within a given population will exhibit of behavior as suggested by the preference distribution for the entire sample. People are not type of behavior as suggested by the preference distribution for the entire sample. People are ne type of behavior as a second of the protection of the entire sample. People are wayfinding decision making is multi-faceted with a number of different influential factors and wayfinding some of which reinforce each other while others. and waymum, some of which reinforce each other while others oppose each other. The nature in decision making, some some states of the individual, in some groups the influential factors work may also be dependent on the nature of the individual, in some groups these influential the other groups working in opposition. Not everyone will be influenced in the same in the same with the same wayfinding behavior — unfortunately these are not universal with influential factors that determine wayfinding behavior — unfortunately these are not universal However, from a modeling perspective it is desirable to have a global ranking of the wayfinding However, from a supplied to a population as a whole. Unfortunately, the ranking of path preference criteria Table 1 shows that there are significant differences in the nature of the ranking distributions portant sub-populations. For example, a sample population made up of individuals from countries drive on the left side of the road will display a significantly different wayfinding preference to a population made up of people from countries that drive on the right-side of the road. Furthermore, and of these populations can be further broken down into sub-populations of left-handed and right-handed each of which display significantly different wayfinding preferences. Thus it is seen that genetic and altral differences may influence our wayfinding preferences and thus our ability to evacuate efficiently.

the suggested that in situations where the nature of the population is not clear or there will be a significant mixed population, the path preference ranking for the entire sample is used. If it is known that an epilication is primarily catering for individuals who drive on the left e.g. a UK application, then the left driving path preference is used whereas if the application is primarily catering for individuals who drive on the right e.g. a USA application, then the right-side driving path preference is used. Furthermore, the country specific can be further broken down into left-handed and right-handed sub-populations. While it may not be known which individual within the population is left-handed or right-handed, the mixed average of 13 % of the population being left-handed can be applied. It is not clear how large meffect these differences in sub-population path preference criteria will have on evacuation analysis. This surrently being examined by introducing these factors into the recently developed wayfinding algorithm and the building EXODUS evacuation model [4].

#### CONCLUSION

hs work has identified factors which influence wayfinding decisions in building evacuation and normal trulation conditions. The results are based on an international survey involving 1166 participants from 36 The survey involved participants completing path selection tasks based on five simplified and layouts. It was found that there was no significant statistical difference between the path selection ria used in normal circulation and evacuation. A main result from this study is that the handedness (a netic factor) and the side of the road that the participants normally drive on (a cultural factor) are ortant influential factors in path selection. The handedness is considered to be the main influencing tor with the driving side modifying the impact of handedness. Thus, if the driving side is the same as the dedness, these factors reinforce each other however, if they are opposite, they work in opposition. Thus important to consider the handedness of an individual and the country from where they come when pring to predict wayfinding behavior. These results are considered statistically significant. The length he first leg of the path also had a considerable influence on an individual's path choice. The shortest leg criterion was found to be more influential than the longest leg first criterion. This contradicts earlier wayfinding studies and is thought to be due to both the differences in the environments and the small delective sample used in the urban studies. Furthermore, the path directness does not appear to be a path selection criterion based on the results of the wayfinding tasks.

considering the responses to the wayfinding tasks, the participant's preference for right-handed, left-aded, SLF or LLF paths was determined. The preferences for these paths for the entire sample were and to be: 31 % prefer right-handed paths, 29 % prefer SLF paths, 23 % prefer LLF paths and 17 % of left-handed paths. This distribution provides a means for ranking path preference within evacuation wayfinding algorithms. However, it is acknowledged that not every individual within a given wayfinding will exhibit the same type of behavior as suggested by the average preference distribution for

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the entire sample. Furthermore, there are significant differences in the wayfinding preferences of influences in the wayfinding preferences in the wayfinding preferences of influences in the wayfinding preferences in sub-populations as genetic e.g. handedness, and cultural e.g. driving side, differences influence ways. suo-populations as generic e.g. handedness, and the factors influencing wayfinding was further references. Thus, the preference distribution for the factors influencing wayfinding was further references. preferences. Thus, the preference distribution difference and driving side. It is not clear how large an effect these sub-population difference that the preference and driving side. It is not clear how large an effect these sub-population difference that the preference and driving side. path preference criteria will have on evacuation analysis. This is currently being examined by introd path preference criteria will have on evacuation analysis introduced into the building EXODUS evacuation and the state of model. Finally, when reviewing these findings it must be noted that the study is a map based questi and so relies on the ability of participants to imagine themselves in the described situation. It is not a the participants would behave in a similar manner in a real emergency evacuation situation.

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