Passenger Familiarity and Intuitive Navigation within Airport Environments

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Passengers navigating through airports can experience confusion or become lost, resulting in dissatisfaction, missed flights and flight delays. Passengers moving through airports are required to make many navigation decisions, for example to find the correct check-in desk or find the correct boarding gate. Prior experience of using the airports is likely to enable intuitive navigation, however limited research on this topic currently exists.

In this paper we investigate passenger navigation by observing 30 participants at one international airport as they moved from check-in to a departure gate. The results indicate that passengers do spend time navigating intuitively through the airport, and that there is a positive correlation between intuitive navigation and airport familiarity. It was also found that participants with lower airport familiarity spend a greater percentage of overall navigation time searching and assessing/acquiring information than high familiarity participants. These findings provide evidence that passengers with higher airport familiarity have a greater understanding of the process, have a better understanding of what information to look for and use this familiarity to navigate intuitively. Findings from this research will have design implications for both current, and future airport terminals and other large spaces that people navigate through.

Key words: Intuitive interaction, wayfinding, navigation, airport, terminal design

1. Introduction

A number of researchers have identified that passengers can have difficulty navigating through airport terminals [13, 25], which can result in a less than optimal airport experience. For passengers there are three main opportunities to use airport terminals when (i) departing to a destination, (ii) arriving at a destination, and (iii) when transferring flights. According to Horonjeff [18] passengers, whether they are departing, arriving or transferring, should be able to navigate directly and efficiently throughout the airport terminal. Passengers who have difficulty finding their way may have a more stressful experience, or arrive at the boarding gate later than required, potentially missing or delaying the flight. Caves and Pickard [7] state that one of the primary concerns affecting passenger acceptance at a terminal is wayfinding. This paper will use the term navigation in preference to wayfinding as Butler, as cited in Thi Pham [27], noted how "Many practitioners describe wayfinding design in terms of the navigation of physical space with a strong focus on signage." A number of authors such as Fewings [13], Churchill, Dada, de Barros and Wirasinghe [8], Lynch [21] and Passini [24] use the term wayfinding rather than navigation, however the terms are often used interchangeably, for example: Downs and Stea [10].

1.1 Navigation within airports

There are a range of activities passengers can navigate to within the airport. Kraal, Popovic and Kirk [20] found that the activities passengers undertake in the airport can be divided into two categories; (i) processing and (ii) discretionary. Processing activities are defined as "those which are directly related to conforming to the legal and regulatory requirements that must be followed to get on a plane" [20]. In Australian airports there are at least four processing activities that passengers are required to navigate to: (i) check-in, (ii) security, (iii) customs, and (iv) boarding the plane (Figure 1). There are also discretionary activities that only some passengers will do, such as retail shopping, using viewing areas or seating. Between international airports, there can be variation in the order of activities required, for example passing through security screening first before checking-in, or passing through security screening at the boarding gate.

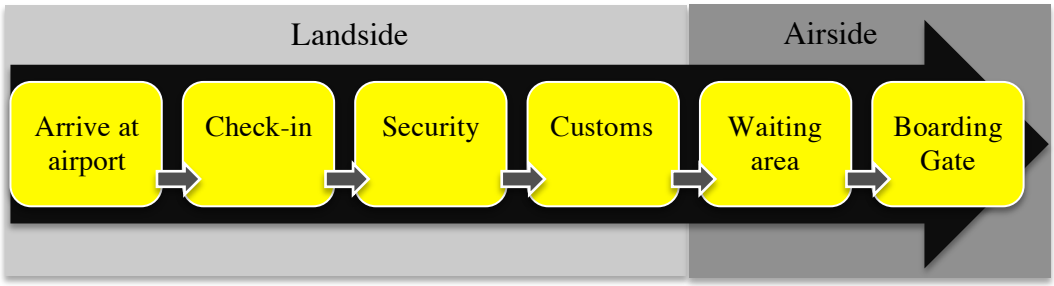


Figure 1. Processing activities of departing passengers

1.2 Navigation Difficulties

Potential causes of navigation difficulty in airports could include the building design, internal layout, internal design, number of decision points, length of the corridors, number of level changes, length of the chosen path and signage [8, 13]. A number of researchers, including Tam and Lam [25], Braaksma & Cook [6] and Correia, Wirasinghe & de Barros [9] have investigated passenger navigation within airports, often using passenger surveys to collect data. In a survey of airport passengers, Churchill et al. [8] found that most people identified signage as the main element they used to find their way through the terminal, while others responded that they had used nothing at all. This could be because signage is one of the few elements people are consciously aware of that they use to navigate and they are not consciously aware of the non-signage elements they are using. Several researchers believe that the most crucial or influential aspects that affect navigation are building configuration or layout [2, 13-15]. Currently, there is a lack of observational research that has focused on passenger navigation within airports. The question that motivates the research is: What elements do people use to navigate through the airport and does signage play such an important role?

1.3 Navigation Elements

The ability to navigate through the environment is often taken for granted. However it is often a highly complex process, with human elements (including cognitive and physical abilities) and environmental elements interacting throughout the journey. From the work of a number of authors, including Lynch [21], Passini [24] and Fewing [13] navigation can be defined as the movement of people through the environment, utilising perceived

environmental elements and human cognition to reach an intended destination. A modified model of navigation is proposed, consisting of three components, (i) the navigator (one person whose navigation experience is the focus), (ii) the environment (the space and objects that surround the navigator), and (iii) other people (in the immediate environment, or who can be contacted outside the immediate environment). In the airport context, there is the passenger (the navigator), who moves through the airport environment, which contain building structures (for example check-in desks and security screening structures) and spaces (for example pathways or entrances between check-in and security screening areas). A passenger may navigate individually through the airport, or with travelling companions. In addition, the passenger will navigate through the airport with other passengers present, as well as airport and airline staff.

1.4 Intuitive Navigation

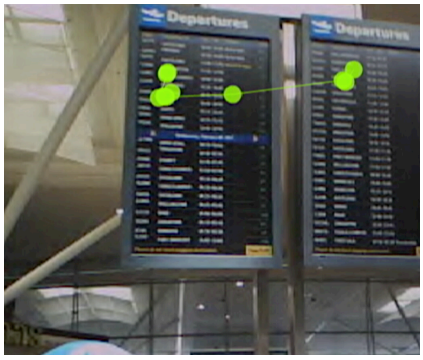
To help understand why people may experience difficulty navigating, the theory of intuitive interaction can be transferred to the airport setting. Intuitive interaction with products is fast, semi conscious and often correct [4, 5] and is linked with familiarity with the product/s or similar systems [4]. The link between familiarity with technology and intuitive interaction has been well established [4, 5, 19, 23]. Making use of features familiar from the user's previous experience has been found to reduce the amount of learning required as many features are already understood [4].

Navigating within a building, familiarity with the building in question can lead to improved navigation performance [17]. In the context of the airport environment, a passenger with high levels of prior airport experience is likely to be able to make navigation decisions intuitively, due to having knowledge of the process, being able to identify which elements in the environment to use, and require little time to identify where to go or what to do. This would require less conscious effort than a passenger with little previous airport experience, who may have little knowledge of the process, have difficulty identifying which elements to use and spend more time identifying where to go and what to do.

Considering how passengers navigate within airports, previous research [13, 25] has found that people can experience difficulty. While signage may play an important role in the navigation process, there are a number of other environmental elements as well that aid intuitive navigation. This paper will explore the research question: Is there a link between intuitive navigation and familiarity with airport environments?

2. Methodology

To understand how passengers navigate through airport terminals, observational research was conducted at Brisbane International Airport (Australia) over a 9 month period between March and November 2012. In total 30 participants navigated through departures to a boarding gate wearing the Tobii eye tracking glasses [26] (Figure 2), providing video and audio recording. In addition, participants completed an Airport Environment Familiarity (AEF) questionnaire. The eye tracking glasses provided both video footage of the navigation process from the participants viewpoint, as well as where the participants eye focussed in scene (Figure 2). Think-aloud protocol was used to capture what participants were looking for or looking at while navigating [12].



Figures 2. Tobii Glasses eye tracking system (left) and footage showing eye tracking overlay (right)

2.1 Participants

The age of participants ranged from 19 to 67 years, and an equal number of each gender was recruited (15 males, 15 females). Participants were recruited through social media, print and online media, word of mouth. Initially passengers catching a real flight (travelling individually and did not need to wear glasses in the terminal) were sought for recruitment, however due to slow recruitment, participants were recruited to simulate navigating through the airport. Of the 30 participants recruited, 27 were participants who simulated catching a real flight, and 3 were actual passengers who caught a real flight. Participants ranged from those who had never flown internationally before and had never been through the airport before, to participants who fly internationally out of the airport every 1 to 3 months.

2.2 Procedure

Real Flight participants (RF participants) were met in the departure drop off zone, and were fitted with the glasses before entering the terminal. Simulated Flight participants (SF participants) were met at a prearranged date and time, were told to act as if they had baggage to check and reminded to fill out an outgoing passenger card. On the day, the participant was met, given information about the flight they would be required to 'catch' and was fitted with the Tobii eye tracking glasses. Participants were asked to navigate through the departures area, completing necessary processing activities, as well as going to any discretionary activities they would like to. To limit the number of variables, each participant navigated through the terminal as an individual navigator. The researcher followed each participant, standing about one metre behind them. This close distance enable the researcher to prompt verbal protocol, as well as to comply with airport security requirements.

After navigating to their correct check-in desk SF participants were given a simulated boarding pass with time they were required to be at the boarding gate. On the simulated boarding pass, the boarding gate number was not given. This detail was omitted to identify how participants used the environment to navigate. RF participants used the flight information they had previously acquired and the boarding pass they received at check-in. In total, 48% (14/30) of participants received an outgoing passenger card (for customs) at check-in, while 52% (16/30) did not receive a card. Simulated Flight participants were not required to stand in line and wait at check-in. With reduced processing time, SF participants were given roughly 1 hour before being required at the boarding gate. For actual passengers, they were asked to be at security within 50 minutes of the recording starting. The recording was

stopped when the participants had to pass through the security screening process.

For both SF and RF passengers, the glasses were removed just before going though the metal detector in security, and were placed back on after customs due to restrictions in video recording the customs area. SF participants did not have to pass through the custom control area (as only passengers leaving the country enter this point), and were instead taken by the researcher through an alternative path to enter the airside of the terminal. While Real Flight participants passed through the custom control area, the battery was changed, and the participants were instructed to be at the boarding gate within another 50 minutes. The participant then was free to navigate through airside of the terminal until the required boarding time of the flight. The observation was completed when the participant arrived at the boarding gate, had finished navigating through the airport and was now waiting to board the plane. After the recording was stopped, the participant completed the Airport Environment Familiarity questionnaire and a short interview was audio recorded.

2.3 Determining Airport Environment Familiarity

To determine each participant's familiarity with airport environments, they were asked questions about their previous experience with the international airport in question, other international and domestic airports, as well as other transportation terminals (including rail, port and bus terminals). Questions used to determine a participant's Airport Environment Familiarity (AEF) score included: how often on average do you fly internationally, how often on average do you fly out from the international airport used today and when did you last fly out from the international airport used today? A score of 0 was given if the participant had never used the environment before and 6 given if the participant had used the environment recently or frequently. From the questionnaire, scores were given for each question and added together to provide an Airport Environment Familiarity score for each participant. For the AEF score, participants received a possible score between 0 and 84. A total of 11 questions were used to determine each participant's AEF score, with 3 questions given double weighting due to a high relevance to navigation within the airport environment. Each question was scored on a scale of 0 to 6. A copy of the questions can be provided on request by contacting the authors.

2.4 Coding

The video footage was coded in Noldus Observer [22]. A coding scheme was developed based on existing wayfinding literature, as well as visual search literature [1, 3, 11, 16, 28]. It has four broad categories of navigation states: Going/doing, Assessment/acquiring information, Search and Wander (Table 1). Each Going/doing and Assessment/acquiring information action was categorised as intuitive, partially intuitive or not intuitive. Search was categorised as focussed or unfocussed. The navigation state Wander was coded for when a participant entered retail or a surrounding area, and moved through actively engaged in examining the retail area. Coding was undertaken over a 4 month period, completed by one researcher.

Table 1: Categorising navigation states within airports

Navigation State	Description	Example	Sub classification	Example
Going/ doing	Identified point or area to navigate to and moving towards it	Visually identified check-in row to navigate to. Moving to correct check-in row	**Intuitive**	Moves to next point without verbalising, navigates confidently to next step correctly
			Partially Intuitive	Not certain that point is correct point to navigate to
			Not Intuitive	Not certain or logical reasoning used
Assessment/ acquiring information	Fixated on sign, object or area, extracting information from a source	Looking at sign for information. Locate flight number and find corresponding row number	**Intuitive**	Acquires information fast, with minimal verbalisation
			Partially Intuitive	Takes time to locate information, or decide how to use information
			Not Intuitive	Cannot find useful information from sign or takes significant time to find information
Search	Searching for a place or sign, information or clue as to what to do or how to use the area	Search for sign to locate which check-in desk to use	**Focussed**	Looks at limited number of points in area. Focuses on likely areas for information.
			Unfocussed	Looks at range of seemingly random points, searches across a range of points in the surrounding area
Wander (discretionary focus)	Move through retail area, primary engaged in retail	Moving through duty free, stopping to examine products	**Goal focussed**	Expressed interest in looking at certain products or displays
			Not goal focussed	Did not express interest in particular items, moves through area, visually scanning items

3. Results

Participants navigated to check-in, through landside to the security area, through security (navigation through customs was not observed due to government restrictions), and through airside to the boarding gate. All participants made it to the correct boarding gate in time for their flight, however differences were found in how participants navigated. This paper focuses primarily on navigation in relation to moving between and through the processing stages (i.e. check-in, security and boarding).

3.1 Variation in overall navigation states

Differences were found in the percentage of overall time each participant spent in Assessment/acquiring information, Search and Going/doing states. A significant positive correlation ($r=.597$, $p<.01$) was found between Airport Environment Familiarity scores (AEF) score and percentage of overall time spent Going/doing (Figure 3). The mean time spent in the Going/doing state was 77% of overall navigation time. While some participants spent a high percentage of their overall navigation time in Going/doing state, all participants spent time in at least one other navigation state.

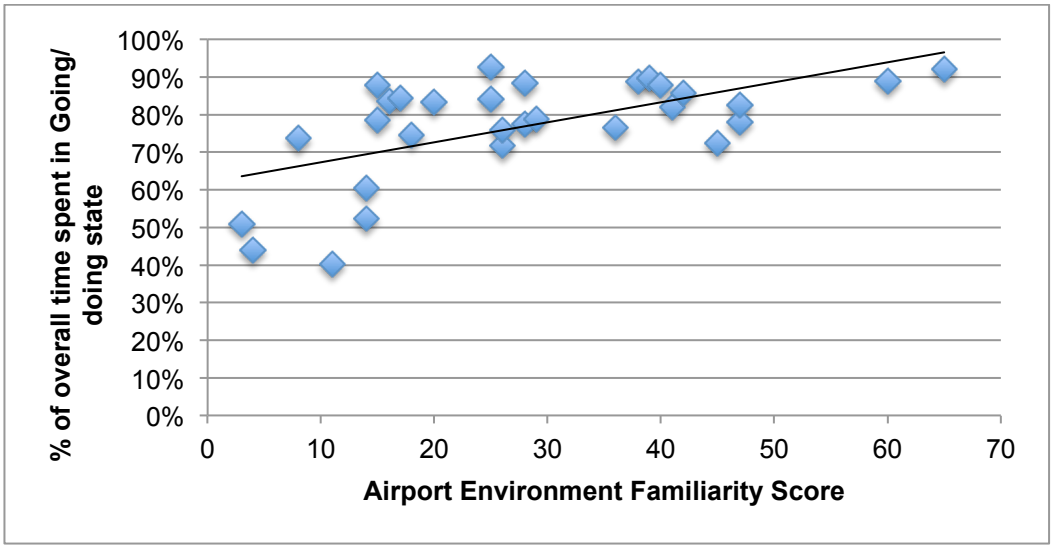


Figure 3. Percentage of overall navigation time spent in Going/doing state.

A significant negative correlation (r=-.458, p<.05) was found between AEF score and percentage of overall time spent in an Assessment/acquire information state (Figure 4). After Going/doing the second highest percentage of overall mean time (17%) was spent in the Assessment/acquire information state.

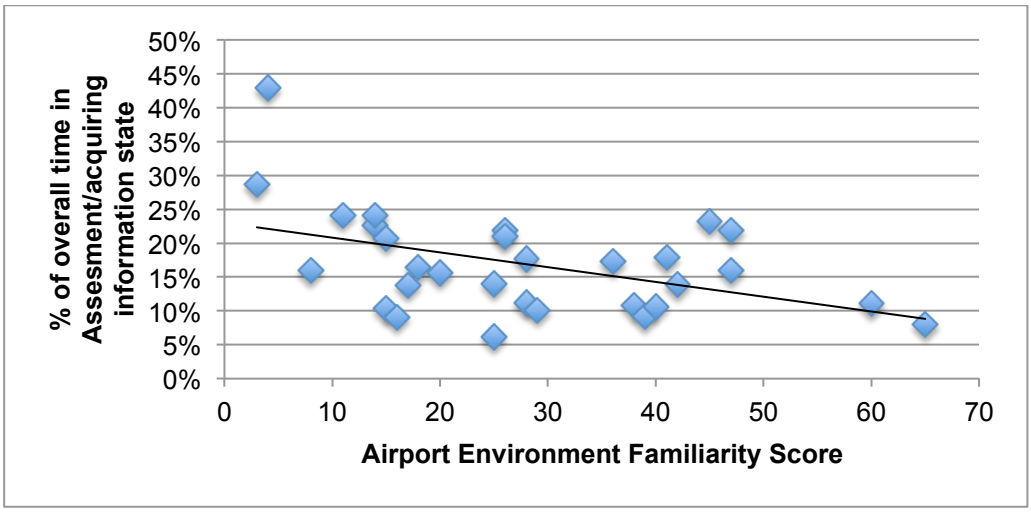


Figure 4. Percentage of overall navigation time spent in Assessment/acquire information state.

A significant negative correlation (r= -.586, p<.01) was found between AEF and percentage of overall time spent in the Search state (Figure 5). Participants in the Search state searched for a range of information, including what to do next and where to go. Most participants spent the least amount of overall navigation time in the search state, with 6% of overall mean time spent in this state.

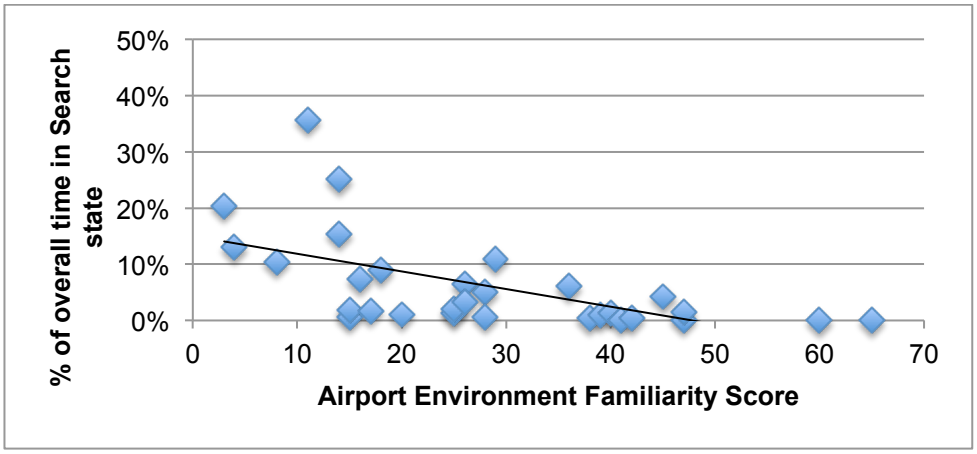


Figure 5. Percentage of overall navigation time spent in Search state.

These findings (percentage of overall navigation time spent Going/doing, Assessment/acquiring information and in the Search state) indicate that at a broad level, there are differences in how passengers navigate depending on their level of Airport Environment Familiarity. The following section will examine these navigation states in further detail.

3.2 Variation within navigation states

Examining each navigation state, it is possible to look at how intuitively passengers performed Going/doing, Assessment/acquiring information, and whether the Search was focussed or unfocussed. Starting with Going/doing, a positive correlation ($r = .534$, $p < .01$) was found between the percentage of Going/doing performed intuitively and Airport Environment Familiarity (AEF) (Figure 6).

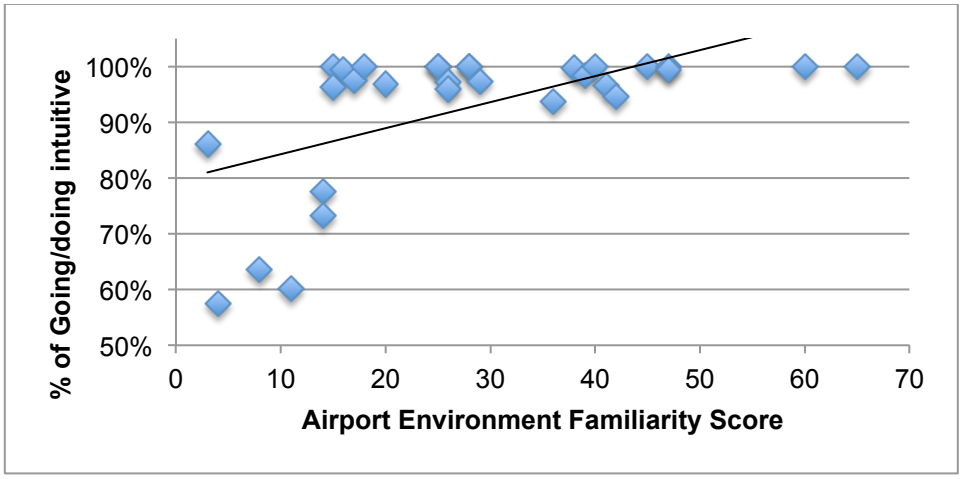


Figure 6. Percentage of Going/Doing time spent navigating intuitively.

A significant positive correlation ($r = .775$, $p < .01$) was also found between the percentage of Assessment/acquiring information preformed intuitively and AEF (Figure 7).

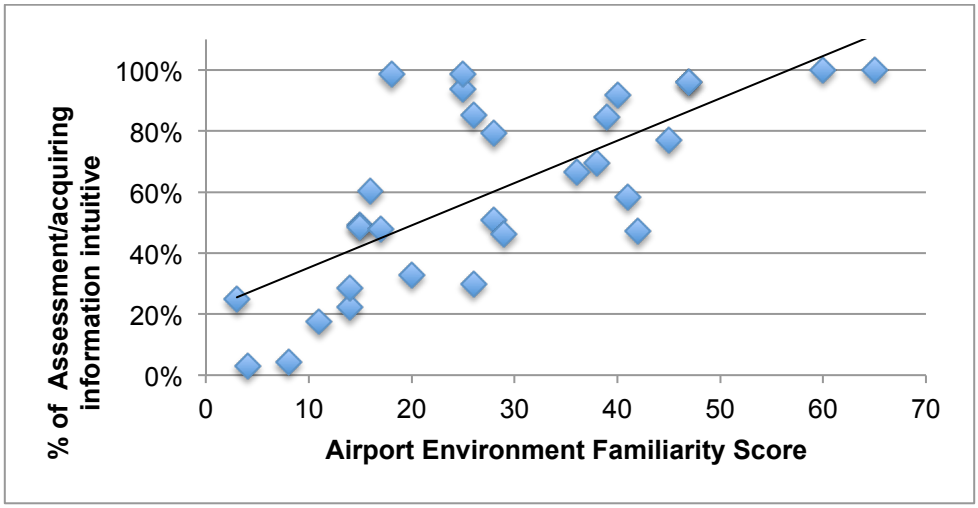


Figure 7. Percentage of Assessment/acquire information time done intuitively.

A significant negative correlation ($r = -.631$, $p < .01$) was found between the percentage of Search that was unfocussed and AEF (Figure 8). A number of participants with a high AEF spent no time in searching in an unfocussed manner, either searching in a focussed manner or not having to search for information at all.

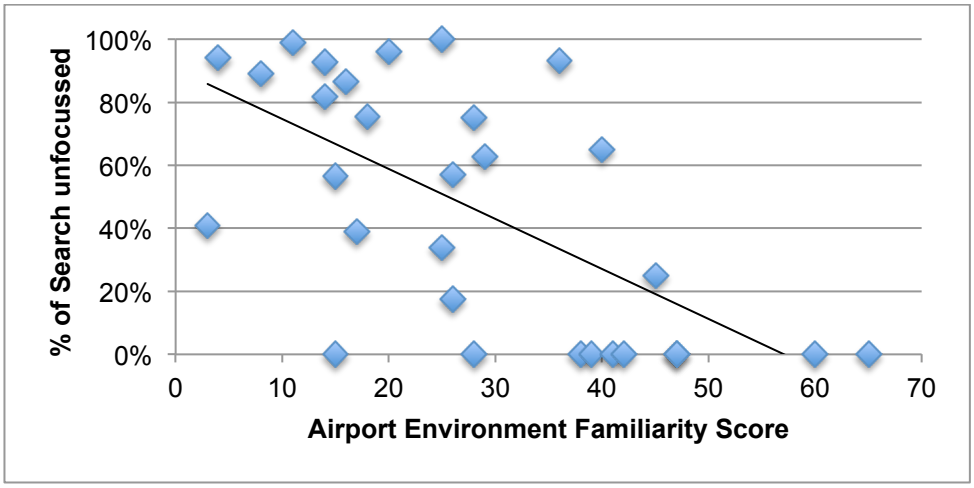


Figure 8. Percentage of Search time spent unfocussed

Overall, participants with higher AEF were found to spend significantly more time navigating intuitively (Going/doing and Assessment/acquiring information) and spend less time in the Search state. These findings will be explored further in the following section.

4. Discussion

This research has examined passenger navigation within airport terminals through the theory of intuitive navigation. Results indicate that while navigating through airports, people can make fast decisions, semi-consciously, or intuitively as defined by Blackler [4]. It was also found that there is a link between Airport Environment Familiarity (AEF) and intuitive navigation which is confirmed on two levels, (i) by examining the

percentage of overall time spent in the 3 navigation states (Going/doing, Assessment/acquire information and Search), and (ii) whether the percentage of time in each state that was intuitive, or unfocussed in the Search state. These findings are in line with previous work by researchers such as Blackler [4], O'Brien, Rogers and Fisk [23], and Hurtienne and Blessing [19], who have all confirmed the link between Technological Familiarity and intuitive interaction.

Considering the three navigation states, most participants spent the majority of time Going/doing, some of the time Assessing/acquiring information and the least amount of navigation time in the Search state. Participants with low AEF spent a greater percentage of overall navigation time searching for information or navigation cues, and spent more time searching in an unfocussed manner. This indicates that in the airport environment, low AEF passengers may not know where to go or what to do. On average, High AEF participants spent more time in the Going/doing state, and did so intuitively. With passengers using the terminal ranging from first time passengers through to frequent flyers, the challenge is to provide an intuitive experience for all passengers. With a reduction in the amount of time spent searching for information, there is the potential to reduce or remove navigation difficulties that some passengers encounter. Ideally, passengers would spend minimal time in the Searching and Assessment/acquire information states, and more time simply going to the next step.

While previous research has indicated the importance on signage and building layout on navigation [2, 8, 13], this research has found that prior airport experience is a critical factor. Those with a high familiarity with the environment are more likely to know what to do and where to go. This provides evidence that when considering how people navigate, there is a need to consider not only the surrounding environment, but also the navigator and the amount of prior experience they have.

5. Conclusions

An innovative methodology has been developed and applied to passenger navigation within airport terminals. This research builds on previous research that indicated passengers can experience difficulty navigating through airports by identifying how Airport Environment Familiarity (AEF) is linked to passenger navigation within the airport terminal. The results indicate that passengers do spend time navigating intuitively through the airport, and that there is a positive correlation between intuitive navigation and AEF. It was also found that passengers with lower AEF spend a greater percentage of time Searching and Assessing/acquiring information. These findings provide evidence that passengers with higher AEF have a greater understanding of the process, understand better what information to look for and are more able to use that information. Airports need to consider how the airport environment works in relation to passengers with low AEF. Not only are these findings of use for both current and future airports but also other environments that people have to navigate, such as other transportation terminals, shopping centres, hospitals and other environments. With the link between intuitive navigation and Airport Environment Familiarity established, future research can examine what environmental elements enable intuitive navigation, and what navigation elements passengers with low Airport Environment Familiarity struggle with.

6. Acknowledgements

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7. Citations

[1] Arthur, P., Passini, R. (1992) *Wayfinding: people, signs, and architecture*. New York: McGraw-Hill Book Co.

[2] Baskaya, A., Wilson, C., Özcan, Y. Z. (2004) *Wayfinding in an Unfamiliar Environment: Different Spatial Settings of Two Polyclinics*. Environment and Behavior; vol. 36, no. 6: pp 839-67.

[3] Beaumont, P. B., Gray, J., Moore, G., Robinson, B., (1984) *Orientation and wayfinding in the Tauranga Departmental Building*. Environmental Design Research Association Proceedings; 1984

[4] Blackler, A. L. (2008) *Intuitive interaction with complex artefacts : empirically-based research*: VDM Verlag.

[5] Blackler, A. L., Popovic, V., Mahar, D. P. (2010) *Investigating users' intuitive interaction with complex artefacts*. Applied Ergonomics; vol. 41 no. 1: pp 72-92.

[6] Braaksma, J. P., Cook, J. W. (1980) *Human orientation in transportation terminals*. Transportation Engineering Journal; vol. 106, no. 2: pp 189-203.

[7] Caves, R. E., Pickard, C. D. (2001) *The satisfaction of human needs in airport passenger terminals*. Transport; vol. 147, no. 1: pp 9-15.

[8] Churchill, A., Dada, E., de Barros, A. G., Wirasinghe, S. C. (2008) *Quantifying and validating measures of airport terminal wayfinding*. Journal of Air Transport Management; vol. 14, no. 3: pp 151-8.

[9] Correia, A. R., Wirasinghe, S. C., de Barros, A. G. (2008) *A global index for level of service evaluation at airport passenger terminals*. Transportation Research Part E-Logistics and Transportation Review; vol. 44, no. 4: pp 607-20.

[10] Downs, R. M., Stea, D. (1977) *Maps in Minds: Reflections on cognitive mapping*. United States of America: Harper & Row

[11] Duchowski, A. T. (2007) *Eye tracking methodology: Theory and Practice*. London: Springer.

[12] Ericsson, K. A. (2006) *Protocol analysis and expert thought: Concurrent verbalizations of thinking during experts' performance on representative task*. . In: K. A. Ericsson, N. Charness, P. Feltovich, Hoffman. RR, editors. Cambridge handbook of expertise and expert performance. Cambridge, UK: Cambridge University Press; pp 223-42.

[13] Fewings, R. (2001) *Wayfinding and Airport Terminal Design*. The Journal of Navigation; vol. 54, no. 2: pp 177-84.

[14] Gross, M. D., Zimring, C. (1992).*Predicting Wayfinding Behaviour in Buildings : A Schema-Based Approach*. . In: Kalay YE, editor. Evaluating and Predicting Design Performance NY: John Wiley; pp 367-77.

[15] Haq, S., Girotto, S. (2003) *Ability and intelligibility: Wayfinding and environmental cognition in the designed environment*. 4th International Space Syntax Symposium.

[16] Hayhoe, M. M., Droll, J., Mennie, N. (2007) *Learning where to look*. In: Van Gompel RPG, Fischer MH, Murray WS, Hill RL, editors. Eye Movements: A Window on Mind and Brain. San Diego: Elsevier Science

[17] Hölscher, C., Brösamle, M. (2007) *Capturing Indoor Wayfinding Strategies and Differences in Spatial Knowledge with Space Syntax*. 6th International Space Syntax Symposium.

[18] Horonjeff, R. (2010) *Planning and design of airports*. New York: McGraw-Hill.

[19] Hurtienne, J., Blessing, L. (2007) *Design for Intuitive Use - Testing image schema theory for user interface design*. 16th International Conference on Engineering Design; Paris.

[20] Kraal, B. J., Popovic, V., Kirk, P. J. (2009) *Passengers in the airport : Artefacts and Activities*. Proceedings of OZCHI 2009; Melbourne Victoria349-52.

[21] Lynch, K. (1960) *The image of the city*. Cambridge [Mass.]: MIT Press.

[22] Noldus. (2011) *The Observer XT*. [cited 2011 14 September]; Available from: http://www.noldus.com/human-behavior-research/products/1/the-observer-xt.

[23] O'Brien, M. A., Rogers, W. A., Fisk, A. D. (2008) *Developing a Framework for Intuitive Human-Computer Interaction*. Proceedings of the Human Factors and Ergonomics Society Annual Meeting. September 1, 2008; vol. 52, no. 20: pp 1645-9.

[24] Passini, R. (1984) *Wayfinding in architecture*. New York: Van Nostrand Reinhold.

[25] Tam, M. L., Lam, W. H. K. (2004) *Determination of service levels for passenger orientation in Hong Kong International Airport*. Journal of Air Transport Management; vol. 10, no. 3: pp 181-9.

[26] Technology, T. (2010) *Tobii Glasses Eye Tracker*. Tobii Technology AB; [updated 1/5/2012]; Available from: http://www.tobii.com/Global/Analysis/Downloads/Product_Descriptions/Tobii_Glasses_Product_Description.pdf?epslanguage=en.

[27] Thi Pham, L. *Q&A: Finn Butler on wayfinding design*. Smartplanet [serial on the Internet]. 2012: Available from: http://www.smartplanet.com/blog/global-observer/q-a-finn-butler-on-wayfinding-design/5234.

[28] Wiener, J. M., Büchner, S. J., Hölscher, C. (2009) *Taxonomy of Human Wayfinding Tasks: A Knowledge-Based Approach*. Spatial Cognition & Computation; vol. 9, no. 2: pp 152-65.