Licensed London Taxi Drivers: How They Navigate And What We Can Learn From Them.

Eva-Maria Griesbauer, UCL, explores how London taxi drivers get from A to B.

Licensed London taxi drivers are unique navigators. So far, there is no other city in the world, where taxi drivers are required to be able to plan routes between any two places without using GPS devices or physical maps in an area that contains a similarly large street network as London, UK.

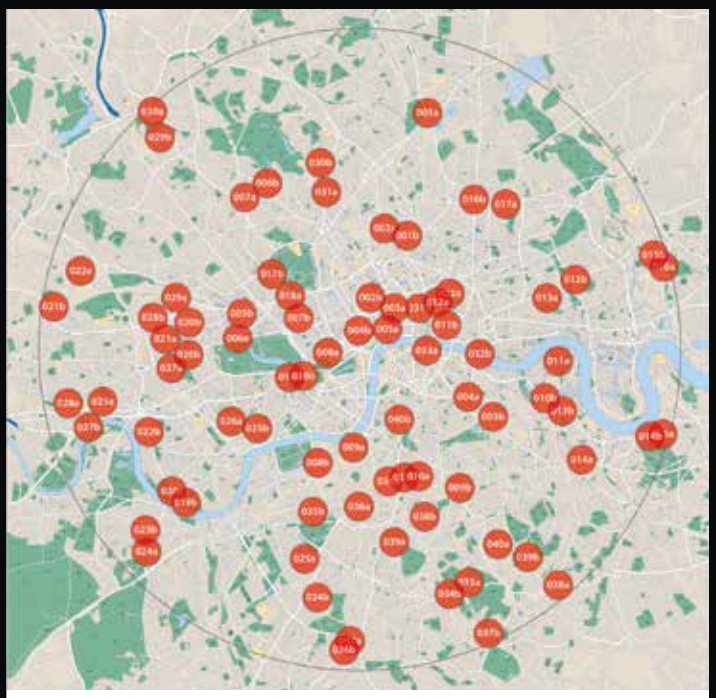
Within a six-mile radius around Charing Cross, black cab drivers – in order to earn their green badge – are required to be able to identify the street of any potential place a customer might want to be picked up from as well as any place they might be interested in going to. They need to be able to give an exact, consecutive verbal recall of all travelled streets that form a route along the direct line between these locations, including directions for turns and roundabouts. This so-called Knowledge of London encompasses almost 60 000 streets and 100 000 points of interest related to different sectors such as tourism, leisure, sports, housing, health, education and administration [1, 2]. One might ask: How can taxi drivers learn this vast amount of information and what can we learn from them using it?

About two decades ago, 320 origin-destination pairs – the most famous one being the first from Manor House Station to Gibson Square – were selected to create 'runs' (as taxi drivers call the routes) and build the basic framework to train students in knowledge schools to become taxi drivers. For each run, students not only identify and learn the most direct route between the two points in both directions (which might differ due to oneway systems and turning restrictions), but they also learn important points of interest and the streets that join them in the ¼ mile radius around each origin and destination. This collection of runs is now known as the Blue Book, and it covers London systematically in four layers of 80 runs each, creating a network of routes that becomes denser the further the students progress.

In order to memorise these runs, students use memory techniques (e.g. acronyms to recall groups of streets), practice in pairs or small groups with call-over partners to repeat or challenge each other with new origin-destination pairs, and constantly travel the routes on mopeds, taking notes of points of interest along the way to memorise what the streets and areas look like [13].

From a scientific point of view, learning the knowledge and using it for active navigation attracts attention because it has an impact on brain structure. In the late 90s, the hippocampus was identified as the part of the brain that enables taxi drivers to remember and use this information to flexibly plan routes [4]. Studies also showed that the hippocampus changes its structure with the posterior part having a higher grey matter density in black cab drivers [5].

London runs Credit: Knowledge Point School Limited



RUNS 001-040

001a Manor House UG Station, N4	to	001b Gibson Square, N1
002a Thornhill Square, N1	to	002b Queen Square, WC1
003a Chancery Lane UG Station, WC1	to	003b Rolls Road, SE1
004a Pages Walk, SE1	to	004b St Martins Theatre, WC2
005a Australian High Commission, WC2	to	005b Paddington Rail Station, W2
006a Lancaster Gate, W2	to	006b Royal Free Hospital Arrivals, NW3
007a Fitzjohns Avenue, NW3	to	007b Fitzhardinge Street, W1
008a Ritz Hotel, W1	to	008b Battersea Park Station, SW8
009a Ponton Road, SW8	to	009b Camberwell Grove, SE5
010a Knatchbull Road, SE5	to	010b Surrey Quays RAIL Station, SE16
011a Timber Pond Road, SE16	to	011b Grocers Hall Court, EC2
012a Barbican, EC2	to	012b Mile End UG Station, E3
013a Beaumont Square, E1	to	013b Cannon Wharf Business Centre (dem.), SE8
014a New Cross Rail & UG Station, SE14	to	014b National Maritime Museum, SE10
015a Maze Hill Rail Station SE10	to	015b Abbey Road, E15
016a West Ham Rail & UG Station, E15	to	016b Dalston Kingsland Rail Station, E8
017a Graham Road, E8	to	017b Hanover Gate Regents Park, NW1
018a Baker Street UG Station, NW1	to	018b Halkin Street, SW1
019a Lowndes Square, SW1	to	019b Hurlingham Club, SW6
020a Fulham High Street, SW6	to	020b Powis Square, W11
021a Walmer Road, W11	to	021b Wales Farm Road, W3
022a Old Oak Lane, NW10	to	022b Charing Cross Hospital, W6
023a Ravenscourt Park, W6	to	023b Gwendolen Avenue, SW15
024a Manor Fields, SW15	to	024b Bedford Hill, SW12
025a Nightingale Lane, SW12	to	025b Carlyle Square, SW3
026a The Boltons, SW10	to	026b Campden Hill Square, W8
027a Woodsford Square, W14	to	027b Chiswick Mall, W4
028a Turnham Green UG Station, W4	to	028b Oxford Gardens, W10
029a Golborne Road, W10	to	029b Pennine DriVe, NW2
030a Marble Drive, NW2	to	030b Chetwynd Road, NW5
031a Kentish Town RAIL & UG Station, NW5	to	031b West Smithfield, EC1
032a Armoury House, EC1	to	032b Tower Bridge, SE1
033a Sumner Street, SE1	to	033b Mostyn Road, SW9
034a Stockwell Park Road, SW9	to	034b West Dulwich Rail Station, SE21
035a Frank Dixon Way, SE21	to	035b Cedars Road, SW4
036a Clapham North UG Station, SW4	to	036b Mitcham Lane, SW16
037a Ambleside Avenue, SW16	to	037b Sydenham Hill, SE26
038a Stanstead Road, SE23	to	038b Milkwood Road, SE24
039a Brixton Water Lane, SW2	to	039b Forest Hill Road, SE22
040a Barry Road, SE22	to	040b Kennington Cross, SE11

Current research is now focusing on how this knowledge is structured and retrieved from memory to plan routes quickly. Let's imagine a taxi driver planning a route across the six-mile radius from Manor House Station in the north east to Putney Station in the south west. Would this black cab driver consider all possible routes through a street network containing 60 000 streets to select the one they are intending to take? Even though this is a valid approach and often used in computational modelling, this appears very inefficient and would require excess effort for the brain to do. Still, taxi drivers are capable of solving this task quickly and thus more efficiently than such models would suggest. So, there must be a way for the brain to efficiently select which streets to consider and which to ignore for each route, without taking all streets into account.

A hierarchical model [6] suggests that the brain restricts the number of options by planning on two levels, a global level and a local level. On the global level (in this case, all of London) the brain segregates the environment (i.e. London) into areas (e.g. Soho, Mayfair, etc.) and decides which of these areas to consider as relevant and which to eliminate from the route planning process as irrelevant. On a local level, actual route choices can be made within each area individually as the area is entered. This ensures the brain can limit the information that is needed and it is able to hold relevant information in chunks until the next stretch of the route is planned.

London consists of many smaller, quite well-known areas, such as Soho or the City of London that could theoretically segregate the environment into consciously perceived areas that our brain might use for route planning tasks. For Soho, an online search will show quite distinct boundaries that align with main roads, such as Oxford St, Regent St, Shaftesbury Av, and Charing Cross Rd, which might also be perceived by humans as boundaries that separate Soho distinctly from any other surrounding area. Any place that is within this area can therefore be considered as part of Soho, and any place across the roads listed above would not be. For taxi drivers this means, when being asked to drop off a passenger in Soho, they would know exactly and unambiguously which street counts as being in Soho and which would not be. However, this is not the case for all areas in London. The City of London, for instance has historically developed municipal boundaries that are even marked by dragons, but contain many minor streets and form a complex outline. Would black cab drivers also be able to identify these boundaries?

Recently I carried out a study at UCL with licensed London taxi drivers to understand if certain streets are really perceived as boundaries and how these affect route planning (still awaiting publication). According to this study that asked taxi drivers to draw the boundaries for a list of areas of London in a map, there is some overlap of their perception of boundary roads and street network measures that reflect the importance of a road (i.e. how important they are to connect any two places with each other). The boundaries identified in this study also helped understand route planning data in an experiment that I conducted, which required taxi drivers to plan routes and recall the sequence of streets that would have to be travelled as they do during their training. Audio recordings allow us to transcribe the runs and analyse response times in relation to the effect of geographical information (e.g. path distance) and street network measures, such as the consciously perceived boundaries.

In a new study, our research team is now planning to scan licensed London taxi drivers to understand how their brain activity changes during these tasks in relation to boundaries. With these findings it might be possible to predict human navigation more generally for Rome, Paris, Singapore or any other city in the world, based on known factors of the street network, such as common boundaries. This might help optimise traffic flow or the planning of new cities and improve navigation instructions.

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