

You The Language of Distance Perception: Cultural and
Linguistic Implications in Distance Expression

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Statement of Declaration

I have read and understood The University of Edinburgh guidelines on Plagiarism and declare that this written dissertation is all my own work except where I indicate otherwise by proper use of quotes and references.

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Abstract

Do speakers that use different kinds of language representations to describe the same concept come to perceive and conceptualize the world in different ways? Particularly, what role does culture play in creating and defining our conceptualization of the physical and abstract domains of the human experience, in domains such as space, time and distance, and does it in fact determine the language is used to describe those conceptualizations? This study examined the effects of culture on influencing the language used to describe concepts of distance and whether the language used shapes how distances are perceived among different cultures. Following in a line of research aimed at the question of whether the linguistic representations used to represent concepts actually define how those concepts are perceived, especially within the natural world, the current study examines the specific parameter of culture in (1) dictating the type of language used to express the same physical space, and within a cultural group (2) manipulating and defining individual perceptions of space as it applies to the cognition of distance reasoning and expression. In two experiments, a survey and a navigation decision task examined several elements of culture and the impact it has in designating the type of language choices that are made, and found that culture does in fact influence the type of language that is chosen to describe distances. Furthermore it was found that the language used to describe distances reflects a cognitive perspective that influences reasoning in a navigation task.

Table of Contents

Statement of Declaration	ii
Acknowledgements	ii
Abstract	iii
Introduction.....	1
Cultural Influences on Cognition.....	2
Distance Cognition	8
The Current Study.....	9
Methods	12
Experiments	12
Experiment 1	14
Experiment 2.....	15
Results	17
Experiment 1	17
Experiment 2.....	22
Discussion	25
Experiment 1	25
Experiment 2.....	27
Summary of Overall Findings	28
General Discussion.....	29
Conclusions.....	32
References.....	33
Appendices.....	36
Appendix A. Priming Stimuli	36
Appendix B. Experiment 2 Stimuli	37
Appendix C. Sample Survey for Experiments 1 & 2	43

Introduction

Descriptions of distance are used in everyday situations to orient ourselves and to provide a tool for navigation in the world around us. People giving directions use varying kinds of measurements to indicate duration or use it as a tactic for navigation (“*You’ll want to go three blocks down and turn right, if you walk for five minutes, you can’t miss it*”). Descriptions of distances often play a role in conversation and stories to convey experiences (“*We walked for miles*”). People need to be able to measure distances to in order to form plans for travelling. Concepts of distance are used to break up the perceptual realm of landscape and environment. Both time based and spatial based terms are used intermittently to make the concept of distances salient in a given situation (“*it took 15 minutes*” or “*it’s about five miles away*”). Is there, however, a distinct preference amongst population groups for which kind of term is used, and does this dictate the kinds of considerations that are made in navigational decisions? Furthermore, time and space seem to represent categorically different concepts; when used to describe distance do they present a different understanding of the space and different navigational tactics? The current study seeks to examine the cultural factors, that influence the kinds of ways in which people choose to describe distances, and whether the different language descriptors used to represent the concept of distance impact how people actually perceive and think about distance.

The extent of the cognitive impact of linguistic representations on our perception of the world around us has inspired a growth of interest and debate in several fields, from neuroscience, psychology, and cognitive science to linguistics, anthropology and philosophy. Furthermore, research interests have expanded to account for cognitive diversity amongst populations and between individuals as a growing number of studies have begun focusing on the impact of culture in shaping natural cognitive processes and its role structuring human cognition. In this same vein, studies on linguistic relativism examine the influence of language in shaping the terms of human perceptions and whether these perceptions differ between language groups. The theory put forth by linguistic relativism, in its weakest form, posits that language, to a degree, influences the conceptualization of the entities it seeks to represent and shapes cognition of those entities (Casasanto, 2008). In compiling evidence from across these disciplines, a more complete image of the factors that impact, influence, and shape human cognition emerges, as researchers question how significant of a role language actually plays in defining our conceptualization of the human experience and whether cultural and linguistic differences give way to individual variations in fundamental cognitive processes across populations— an idea made particularly salient by the

extent of cultural and linguistic diversity existent in the world (Haun, Rapold, Janzen, & Levinson, 2010). The extensive linguistic and cultural diversity (Evans and Levinson (2009) cite 6,000 to 8,000 languages in the world), may not only indicate the possibility for variance between populations in the terms used for labelling distances (*e.g. meters, miles; minutes*), but in the inherent perceptions of the distances they represent in terms of spatial reasoning and navigation in the environment.

The following sections discuss evidence of the cultural and linguistic impact on spatial cognition and the diverse frames of reference that are used by different populations to orient and navigate through the environment as well as examine the concepts of time. In addition, this paper will examine the cross modality of those temporal and spatial representations in general distance cognition and reasoning, touching on evidence from theories of embodied cognition. General distance cognition will be presented, followed by the current study, which explores two experiments about cultural influence on language choices and distance perceptions.

Cultural Influences on Cognition

This study examines whether there is a cognitive impact of culture on the kind of linguistic representations that are used to describe distances and whether this directly effects how distances are perceived. Evidence from the various fields of neuroscience, cognitive science, psychology, and linguistics suggests that a cultural influence exists in shaping individual cognitive perspectives, and – from an examination of cultural diversity and differences in various cognitive processes– indicates that culture creates cognitive diversity (Evans & Levinson, 2009). The ways that the collective experience of sharing a culture impacts individual cognitive structures and perceptions will be discussed below.

First, the ways in which experience structures the brain and cognition should be examined. It has been found that experience –in music, literacy, numerical problem solving (Frank, Everett, Fedorenko, & Gibson, 2008; Tang, et al., 2006), navigation (Maguire, et al., 2000; Maguire, Woollett, & Spiers, 2006)– and motor resonance can train the brain to process things in a certain way and can impact the level of development, and areas of activation for individual neural structures (For a review of cultural impacts on neural structuring, see Kitayama & Park, 2010; Kitayama & Uskul, 2011; Wilson, 2010). Two studies by Maguire and colleagues (2000, 2006) found that London cabbies, who must have extensive navigational knowledge stored for immediate use, had an enlarged posterior hippocampus compared to controls, which correlated to years of experience, and a lessened ability to acquire new spatial information, illustrating an effect of navigational experience shaping neural cognitive structures.

Culture provides a framework of experience itself, and can have an impact on neurological structure, with the same behaviours reflecting differing neural activations in processing (Kitayama & Uskul, 2011). For example, a functional Magnetic Resonance Imaging (fMRI) of abacus users, typically a tool used by Eastern cultures, reveals activation in the motor cortex while running mental math problems that is not present in the Western counterparts. Culture can also affect what we attend to in a given situation. Kitayama and Uskul (2011) report findings of differences in the patterns of neurological activations in Japanese and American participants told to describe a picture, finding that Japanese participants were more attentive to the context of the image and the Americans more attentive to the subjects of the image. Cultures are often categorized as collectivist or independent, which reflect a general difference in the behavioural practices and perceptions between the East Asian cultural practices of a collectivist society (the Japanese participants), and the Western cultural practices and perceptions of an independent society (the American participants). These differences in items attended to by particular cultural groups may have a causal role in the way that distances are perceived. These studies demonstrate an influence of social experience and that, across cultures, experience itself plays a very big role in cognitive and neural structuring. This may shape the visual cues that are accessed when assessing a distance for navigation providing a possible explanation for differences in distance perception and expression.

The relationship between culture and language and their impact on cognition can be bi-directional and interactive. While cultural practices, methods of communication and perspectives may structure language, language itself, in representing those cultural perspectives and concepts, can shape how something is thought of, making concepts more tenable and providing for higher efficiency of cognitive processing on tasks, in such a way that flexibility to another perspective isn't always supported. For example, some language groups do not have concepts, generally thought to be universal, represented within their language, and demonstrate an inability to cope with or process those concepts efficiently. In the case of the Pirahã, a relatively isolated tribe in the Amazon, an inability to accurately reproduce numerical matching from memory in a basic counting task were reflected by a general absence of language representing numerical concepts, limiting their ability to cognitively organise them efficiently (Everett, 2009; Frank, et al., 2008). Whether it is possible for language to shape differing perspectives of a single concept has driven research in a number of directions, and whether the language that is used to represent concepts can have a tenable influence on how those concepts are processed– and can impact cognitive efficiency in processing– has long been under debate (Casasanto, 2008; Evans & Levinson, 2009; Levinson & Evans, 2010) as a growing number of studies – in numbers (Frank, et al., 2008;

Miura, Okamoto, Chungsoon, Steere, & Fayoi, 1993), colours (Regier, Kay, & Khetarpal, 2009; Roberson, Hanley, & Pak, 2009; Winawer, et al., 2007), time (Boroditsky, Fuhrman, & McCormick, 2011; Boroditsky & Gaby, 2010; Casasanto & Boroditsky, 2008; Fuhrman & Boroditsky, 2010), and space (Burenhult & Levinson, 2008; Levinson, Kita, Haun, & Bjorn, 2002; Li, Abarbanell, Gleitman, & Papafragou, 2011; Majid, Bowerman, Kita, Haun, & Levinson, 2004)– have begun to focus on a larger sample of language populations. Particularly relevant to the current study, how language serves to shape differing perspectives of a single concept in the areas of spatial and temporal reasoning will be examined next in more detail.

With the framework provided by culture and individual experience serving as the ‘design’ behind our perspectives of the world, coupled with the role of language to represent concepts and make them accessible, cognitive processes and differences in those cognitive processes can be explored. If underlying structures of cognition and neural pathways are affected by experience, then the language used to represent the nature of the perspective will reflect that. This emerges in the frames of reference that are used in spatial reasoning. Furthermore, if shared cultural experiences actually train specific neural structures, then how the same scene, environment, and situation is evaluated will be different where the experience is different. The following section will address the literature on cross-linguistic differences in spatial reasoning and the different frames of reference that are used and will attempt to identify the potential factors that create these differences as well as identify the cognitive impact spatial reasoning differences among cultures may pose on distance perception.

Spatial Reasoning. Evidence from cross-cultural studies have not only found differences in the language used to represent the experience of the spatial domain, but have also found that the tactics employed in spatial reasoning have an impact on the processes of spatial cognition. Space conceptually represents a physical and perceptual entity, which must be processed effectively for successful orientation and navigation within the environment. However, questions of what dictates and influences the human conceptualizations of the spatial realm, and indeed allows for coordination and successful movement within our environment, has sent researchers to examine whether language plays a role in shaping those concepts. Differences in the conceptual organization of space across language groups creates an interesting question into what causes differences in cognitive processing and that they may do so as a result of the language that is used to represent perceptual space. While initially hotly contested amongst researchers– and still very much an area of interest– evidence for a correlation of linguistic representations and spatial reasoning methods, and for cross-linguistic diversity in these spatial cognition processes, has become more prevalent (Haun, et al., 2010; Levinson, Kita, Haun, &

Bjorn, 2002; Li, Abarbanell, Gleitman, & Papafragou, 2011; Majid, Bowerman, Kita, Haun, & Levinson, 2004; Wilson, 2010). Findings indicate that language can be an indicator of a certain perspective and manner of conceptual understanding- particularly in the realm of spatial reasoning- and that the concepts represented by language may then go on to influence the terms and style in which an individual considers the perceptual realm (Burenhult & Levinson, 2008). The correlation between the conceptual understanding and perspectives and the language used to represent them allows for a rich and accessible area in which to examine cognitive diversity.

Categorical divisions in the types of spatial language and frames of reference that are used amongst various language groups display the variations in interpretation of space and the environment. These frames of reference will be discussed in detail in the next section.

Frames of Reference. Spatial reasoning guides navigation and coordination within the environment, however, across populations, people do not use one size fits all method of thinking about their surroundings. Spatial orientation methods have been found to differ across languages groups, reflected in the language used to code their environment. Frames of reference are the categorization of the kinds of linguistic representations that are used to reflect kinds of perspectives of orientation within the environment (Majid, et al., 2004). While many Western cultures rely on a body oriented perspective (*“the pencil is on the left side of the table”*) which codes spatial information in terms of an egocentric perspective in navigation, a great many of other culture groups make little or no use of this kind of spatial orientation perspective. In fact a large number rely on either allocentric or absolute, geocentric methods of spatial orientation and navigation. The allocentric coordination system codes orientation based on the objects that are being discussed (*“The pencil is to John’s left,”* or *“The tree is to the right of the house”*). Absolute methods of orientation rely on physical layout of the environment, using points of the compass (*“The pencil is at the north of the table”* or in some cases the actual features of the environment (*“The pencil is uphill of the table”*), a geocentric perspective, to orient and coordinate navigation (Li, et al., 2011; Majid, et al., 2004).

Many cultures make use of an absolute method of orientation and demonstrate the same constant awareness of their coordination systems as those using body oriented systems, even when displaced from their natural environment. In many cases cultures making use of absolute coordinate systems do not have terms for *“left”* and *“right”* or have a very limited understanding of the concepts they represent. Interestingly the language used for absolute coordination is not homogenous amongst culture groups, and often evolves based on a prominent environmental feature, as in the Tenejapan Mayans who live on a hill and orient themselves in terms of *“uphill”* and *“downhill,”* even when placed in a different environment (Everett, 2008; Li, et al., 2011).

The Pirahã, living in the Amazon jungle, orient themselves based on the location and directional flow of the river, turning “upriver” or “downriver,” even when in a location far from the river (Everett, 2008). Evidence shows that the form of spatial reasoning methods employed within one’s culture may have a cognitive commitment. The employed perspective of spatial reasoning is learned implicitly: as a child learns coordination of “left” and “right” within a Western culture, a five year old in the Pormpuraaw village can spontaneously identify any of the cardinal directions with a great degree of accuracy. However, a Pormpuraaw villager may have no concept or representation for “left” and “right”, and the spontaneous and accurate identification of any of the cardinal direction is not replicable by adults in Western cultures, indicating that the kinds of spatial reasoning employed may involve cognitive commitment (Boroditsky & Gaby, 2010).

The elements of spatial cognition employed by an individual to coordinate navigation and orientation within their environment are reliant on the perceptual interpretations that are engaged and evidence suggests that the ability for movement between interpretations may not be flexible. In a recent study, Haun et al. (2011) demonstrated that participants from two cultural groups (Dutch and Namibian) who differed in their dominant spatial reasoning methods were unable to move naturally to a non-predominant spatial reasoning strategy, and further found that attempts to do so impaired their performance in a spatial memory task. Their findings indicate that the linguistic representations that are used may reflect a correlated cognitive understanding in the way that the domain of space is coded— beyond the level of mere preferences, but into actual reasoning competence.

While the cultures that encode spatial coordination using the egocentric perspective may be unable to navigate as efficiently using an absolute geocentric perspective, and visa versa, across cultures, the type of coordination system in use is naturally coded and accessible by its users. How these perspectives shape spatial cognition, and actually define processes of navigation poses an interesting question. Evidence suggests that the language used to reflect the type of coordinate system used by a specific cultural group shapes how space is interpreted, and indeed that this perspective translates to other areas of navigation, and may even permeate into other realms of perceptual reasoning.

Temporal language and Reasoning. A growing number of studies suggest that temporal understanding, an abstractly perceived entity, coincides with the kind of spatial reasoning and type of frame of reference employed by a cultural group. Time is often represented metaphorically by spatial language (“*time moved forward*,” or described as “*long*” and “*short*”) and represents a conceptually rich platform by which diverse cognitive tactics amongst

populations can be examined (Boroditsky, Fuhrman, & McCormick, 2011; Boroditsky & Gaby, 2010; Casasanto & Boroditsky, 2008; Fuhrman & Boroditsky, 2010). Casasanto, Boroditsky, and colleagues suggest that temporal concepts are mapped metaphorically onto space and, often, in the same way as the type of spatial reason method employed. Casasanto and Boroditsky (2008) posit that this is as a result of a recycling of concepts from a more perceptually concrete realm of space to understand the more conceptually abstract realm of time, which is for all intents and purposes, intangible. How this emerges has been observed through the language that is used to represent concepts which is rooted in spatial concepts (e.g. “*We raced to the 4 o’clock deadline*”). Boroditsky, Fuhrman and McCormick (2011) observe “people in different cultures or groups have been shown to differ in whether they think of time as stationary or moving, as limited or open-ended, as horizontal or vertical, as oriented from left-to-right, right-to-left, front-to-back, back-to-front, east-to-west, and so on,” (Boroditsky, et al., 2011, p. 123). Differences in perspectives of time and one’s relation to it (is it *ego-moving*, following our trajectory, or *time-moving*, coming towards us) emerge in terms of spatial structuring, and may indicate an interrelated conceptual structuring that is accessed and shared in distance perception (Boroditsky, 2000).

Boroditsky and Gaby (2010) demonstrated that the Pormpuraaw, an aboriginal tribe, map temporal concepts in terms of an absolute frame of reference employed in their spatial reasoning, a process that is both spontaneous and automatic. The Pormpuraaw subjects took the direction they were facing (“north”, “east”, “south”, “west”) into account and the directionality of time was conceptually organized according to that direction, rather than using a consistent “left to right” ordering of time common in Western cultures (Boroditsky & Gaby, 2010). Some language groups represent time horizontally (English moves left to right, Hebrew from right to left) and in some cases vertically (Chinese) (Boroditsky, et al., 2011; Margolies & Crawford, 2008). Núñez and Sweetser (2006) demonstrate that not all groups homogeneously represent directionality of the temporal concepts of the PAST and the FUTURE. A large number of populations present the temporal concept of the PAST as *behind* them and the FUTURE as *in front* of them. Aymara speakers—which are spread across areas of Bolivia, Peru and Chile—represent those concepts in an opposite pattern, with the PAST *in front* of them, where it is visible, and the FUTURE *behind* them, where it is not (Núñez & Sweetser, 2006). Differences in the organisation of space and time are reflected in the language used to convey perceptions.

The convergence of temporal concept and spatial concepts, and cross-cultural variations in the representation of those concepts introduces an interesting perspective into the workings of the cognitive processing of concepts. This recycling of conceptual organisation between time and

spatial representations maybe a result of the engagement of the perceptual motor system in the brain, known as embodied cognition, making concepts salient and accessible by running simulations of the actions and the movements represented by language (Casasanto & Boroditsky, 2008; for more indepth look at embodied cognition see Fischer & Zwaan, 2008; Gallese & Lakoff, 2005; Zwaan & Taylor, 2006). In the next section the factors that may influence the conceptual development of the various frames of reference and spatial cognition will be discussed.

The Landscape Backdrop. Burenhult and Levinson (2008) discuss the importance of landscape and environment in shaping the different cognitive perspectives, viewing landscape as something that “furnishes us with large, (almost) immoveable entities and surfaces, with spatial and temporal constancy and three-dimensional complexity on a large scale” and which serves as the “backdrop for action,” from which unique navigational techniques have risen up (Burenhult & Levinson, 2008, p. 136). The landscape simultaneously provides our physical surround, which the body must access for survival and navigate within, and a conceptual backdrop that the mind must be able to interpret for specialized purposes: conceptually, landscape and environment simultaneously act as concrete and abstract entities which are categorized and manipulated for use (concrete: “*We climbed the hill to the castle*”; abstract: “*He lived across the ocean*”) to make them accessible and salient. However, evidence suggests that conceptually, landscape categorizations may not even be the same in all languages (Burenhult & Levinson, 2008).

Distance Cognition

Distance itself represents an interesting concept of study for psychology and cognitive science. Moving from point A to point B introduces a slew of processes which include navigation, orientation, conceptual understanding of the energy required to travel and so forth. Distance cognition involves a dual process of dealing with the concrete physicality of the actual environment that one must navigate and move through, expending energy as well as dealing with higher-level abstractions used to interpret the space that the physical distance might represent (Burenhult & Levinson, 2008; Henderson & Wakslak, 2010).

Perception of landscape and environment, shaped by cultural experience, may have a particular influence on shaping cognitive and linguistic organisation of distances. With different language groups demonstrating different kinds of spatial reasoning and tactics for orientation in the environment, differences in the conceptual organization of the spatial realm may have a deep-rooted impact on distance perceptions. Further categorical differences between the temporal and

spatial types of measurement, which in many ways seems to overlap (as in the Pormpuraaw aboriginal tribe that makes use of absolute orientation system in both spatial and temporal representations) may even impact the salience of distance perceptions (Boroditsky & Gaby, 2010). The recycling of temporal and spatial representations (discussed above) may indicate a cross-modal experience of distance, which maybe related to the salience of the environment in a navigational situation, contextually dependent on the effect of energy that will be expended to cover those distances or the cultural influence of the terms things are considered.

The Current Study

The aims of the current study were to examine whether differences observed in the kind of language that is used to describe distances affected individual perceptions of those differences, and to examine whether cultural and environmental factors influence which way an individual processes and perceives distance. Cognition of distance introduces a rich area of interest as people can engage seemingly categorically different elements, space and time, to use in its interpretation. Navigational and orientation tactics vary from culture to culture, evident from the frames of references they use and from the language that is used to reflect varied cognitive perspectives. If people are not homogenous in how they represent their environment conceptually or in how they reason about the spatial realm, how distances are perceived could differ culturally as well.

Two experiments were designed to look at this question of distance perception and examine, beyond just mere lexical choice (kilometre versus mile), the role of culture in shaping the type of representation (time (*hours, minutes, seconds*) versus space (*kilometres, miles, feet*)) chosen to describe this perspective of space. The first experiment was designed in order to explore how distances are actually described, and examined a variety of factors to determine what kinds of things influence language choices and whether those choices are mediated by culture. The second experiment examined whether the linguistic preference used for distance description had a conceptual correlation and influence on navigational choices in a route decision task. Both experiments also contained two priming conditions to examine whether these perceptions could be conceptually influenced.

Experiment 1. The first experiment of the current study examined six hypotheses in order to determine which factors effect the terms in which distance is perceived. Primary to the current study, the first hypothesis posited that the country of origin influences the units (time or space) used to express distance. The effect of culture in structuring neural and cognitive

processes, and perceptual interpretation in the realms of spatial reasoning, navigation and temporal understanding, among others, has been well documented; that distance perception and description contains both spatial and temporal something makes cultural effect important to examine.

The second hypothesis examined whether priming of temporal (clock) or spatial (a map) images would influence the units used to express distance. Priming has been found to effect cognitive operations at a pre-semantic level (Tulving & Schacter, 1990). It could be expected that salient priming objects such as a map or a clock, could generate more time or space based language representations and thought processes. It is expected that the priming image in the clock condition will produce more time based-responses than the control and map conditions. It is also expected that the map condition will produce more distance-based responses than either the control and clock condition.

It has been found that differences in performance in spatial tasks differs between males and females (Contreras, Rubio, Pena, Colom, & Santacreu, 2007). Contreras et al. (2007) found navigational tactics differ in spatial orientation tasks, with males on the whole outperforming females. In this study, the effect of gender in influencing the units used to express distance will be examined to determine if gender plays a role in shaping distance perception. The fourth hypothesis to be examined by the current study is that the most typical mode of transportation (driving, walking, public transportation) of the individual will influence the units used to express distance, indicating how everyday experiences might shape the way distances are perceived.

In the fifth hypothesis, the type of social environment (rural, small town, urban) of the participant was examined. Considering the diversity in how the environment is categorized, synergistically resulting from actual environment (living in the city versus living in the wilderness), necessity or cultural practices (the needs of a businessman over those of a hunter-gatherer), how the environment is represented amongst culture groups varies (Burenhult & Levinson, 2008). These representations, however, are generally consistent amongst members of an individual group, which then allows for a shared 'conceptual map' of the environment, leading to translatable comprehension in communication and navigation. This is important because the way the environment is categorised emerges in the shared linguistic ontology used by a particular group to makes interpretations salient. Shared preferences for certain perceptual representations make measurements of space, and distances more cohesive. It is expected that the types of environment will have an influence on whether spatial or temporal terms are used to express distance.

Lastly, for the sixth hypothesis, the language group to which the participant belongs to

will be examined for an effect on the way in which distances are perceived, with the expectation that members of the same language groups will be inclined to express distance in similar terms. In the next section, experiment 2 will be introduced.

Experiment 2. For the second experiment, the degree to which a person's language is temporally based or spatially based is related to their sensitivity to temporally and spatially intensive considerations in their navigation decisions were examined. Evidence from spatial reasoning studies indicates that the language used to represent orientation and navigation styles reflects a particular cognitive interpretation used in navigation (Haun, et al., 2010; Levinson, et al., 2002; Majid, et al., 2004). It is expected that the language used to describe distances will reflect cognitive differences in how the same distances are perceived amongst various cultures and will impact the kinds of navigation decisions that are made. The same five variables of culture (country of origin), gender, transportation method, environment, and language group from the first experiment were examined, but to discover whether there is an effect on the degree to which people are sensitive to time versus distance in their navigation decisions. It is expected that these variables will have an impact on the kinds of navigation decisions that will be made.

To address these hypotheses, a study was conducted using a survey of a broad number of cultures to determine the effects of each factor on the degree to which people represent space as either time or distance and the degree to which this affects their decision-making.

Methods

Experiments

Participants. International participants were recruited online via Mechanical Turk, a data collection service that provides access to a global pool of participants, through the Internet hosting site www.Amazon.com. Participants were recruited for both experiments 1 and 2 and were paid for their participation in both experiments at the rate of \$0.50 in accordance with Mechanical Turk rates (which range from \$0.05 to \$10.00). Data from 390 total participants were recorded. The same participants were used in experiments 1 and 2. However, the sample sizes varied between the two experiments¹. Participant profiles for experiments 1 and 2 will be discussed below.

Stimuli. The stimuli for the priming conditions of both experiments 1 and 2 were images of a clock and a map of Scotland, which were found through an Internet image search (see Appendix A). The clock image was selected to use as a priming image with the aim that it would implicitly prime the concept of time, which is very often represented by a clock. The map of Scotland was selected to use as the spatial priming image, to convey a sense of spatial distance, with careful consideration of the topography it illustrated, and contained no city names. In each priming condition, each stimulus appeared at the top of each page of the study. A control condition showed no priming image.

Experiment 1. Stimuli consisted of a survey, which asked for some demographic information; country of origin, age, sex, most frequent form of transportation (including, bicycle, walking, bus, car, subway/ underground, and train), type of environment (Mostly rural, A small town, a small city, and a large city), first language, and other languages spoken. An open-ended general distance estimation question (“*How far from where you live now is the nearest supermarket?*”) was included in the survey.

Experiment 2. Stimuli consisted of a series of ten maps designed specifically for this study with two routes from a starting point to an ending destination, labelled in blue and pink (available in appendix B). Each of the stimuli was designed for participants to make a choice between a shorter but time consuming route through traffic and a distance-intensive route. The time consuming route was always more direct; however, it always went through an area of heavy

¹373 participants completed the first page of the initial survey, however 24 did not go on to complete experiment 2. Additionally, 17 participants took the experiment multiple times. The duplicate responses were removed from both experiments 1 and 2, and only their first run was included.

traffic, indicated on the map by a red line. The distance intensive route was always much longer and very indirect. The routes were marked “A” and “B” and were uniformly a blue dotted line and a pink dashed line, respectively, across stimuli. Route directness was counterbalanced between the two responses across the stimuli, so that the A or B response was not a consistent indicator of directness or indirectness of the route, limiting response replication. The directions of all routes from the starting point to the ending point were indicated consistently with arrows. A yellow coloured diamond icon with the label “Start” beside it always indicated the starting point of the route. A black circle with the label “End” beside it always indicated the end point of the route. A map key identifying and labelling the routes and traffic accompanied each of the stimuli.

A sample of the map stimuli is presented in Figure 1, (for the full set of map stimuli, please see Appendix B.) All maps were prefaced with instructions and a question as follows: “*The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes. Which route would you choose?*”

All survey stimuli and map stimuli were given to participants in English. A sample version of the survey used for experiments 1 and 2 can be viewed in Appendix C.

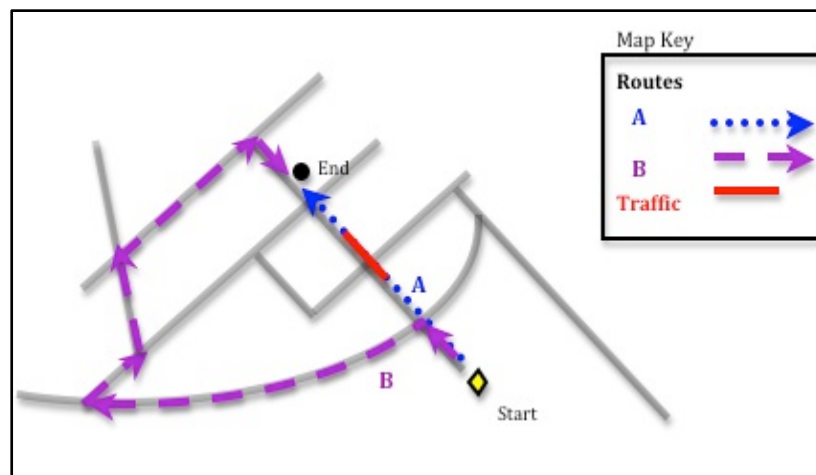


Figure 1. Sample of Experiment 2 Stimuli. The map indicates two routes A and B, marked by a blue dotted line and a purple dashed line, respectively. Traffic, labelled in the Map Key, is located in the map above on Route A and is indicated by a red coloured line, The direction of all routes are marked in the map with an arrow.

Procedure. This study obtained ethical approval from the Psychology Research Ethics Committee at the University of Edinburgh. Participation in this study was voluntary, and all

participants gave consent by checking a button on the first page of the survey. The online survey software and questionnaire tool Survey Monkey provided the platform for this study.

Experiments 1 and 2 were given in succession and presented as one study. All participants received instructions and were directed to the study through a direct link on Mechanical Turk. Participants were informed by instructions at the start of the study that the study would have two parts; a short survey which would collect some demographic information, followed by a task in which participants would be presented with images and a question to which they would respond with either “A” or “B”.

Due to limitations of the Survey Monkey design platform, one of three conditions, either (1) the Control condition; (2) the Clock condition; or (3) the Map condition, was randomly assigned to participants by their birth month (January- April, May-August, September-December). Participants selected their birth month range at the start of the study and were automatically directed to one of the conditions. The assignment of priming conditions was rotated between birth months consistently throughout the study to minimize any possible effect of birth month and to make assignment of priming conditions random. The priming condition that each participant received was consistent between experiments 1 and 2. Priming stimuli did not change between experiments.

Experiment 2. For each of the priming conditions, the order of the presentation of the 10 map stimuli were counterbalanced and assigned by odd or even birth day, which participants self selected at the end of experiment 1. Randomisation of the counterbalancing condition of the map stimuli was simulated by the rotation of which response, odd day or even day, went to each ordering of the stimuli. The rotation of counterbalancing between the two responses was done uniformly in all priming conditions throughout the course of the experiment, in order to minimize any possible effect of odd or even birthday.

Data collection was conducted over six rounds, in which all conditions were rotated for randomization. Participants were self-paced, and began the experiment after selecting their birth month.

Experiment 1

The purpose of the first experiment was to determine the method by which people describe distance. In particular, this study focused on determining the responses of participants with regard to an open-ended general distance estimation question (how far away is a particular location), with the aim of identifying their natural responses as using either a specifically time based (*i.e.* minutes) or spatial based (*i.e.* meters) term. Further questions focused on determining

whether certain cultural factors, including (a) country of origin, (b) type of environment (rural, small town, small city or large city), (c) gender, or (d) typical means of transportation formed a trend on how individuals responded. This experiment collected basic demographic information in a survey form (shown in appendix A), used to determine whether specific responses of distance measurement and description are culturally mediated. In addition, three conditions were applied: two priming conditions in which either an image of a map of Scotland or an image of a clock prefaced the survey; and a control condition, which featured no images.

Participants. Experiment 1 consisted of 373 participants, 177 women and 196 men (mean age= 32.41 years, SD= 11.64). Participants reported a wide range of nationalities. In experiment 1, the participant majority consisted of approximately 149 individuals from the United States of America, 134 from India, 11 from the UK. The remaining 79 participants reported 42 other nationalities, and two failed to report nationality. Of these participants, 209 reported English as their first language. The population majority of Indian participants reported three first languages: 40 reported Tamil, 26 reported Malayalam, and 21 reported Hindi. The remaining 20% of participants reported a further 33 different languages as their first language. 28% of participants reported they were monolingual, approximately 32% reported some knowledge of two languages, and 39% of participants reported knowing three languages or more. Language proficiency was not included as a factor in this study.

One hundred and twenty-one participants received the control condition (1), 129 received the clock condition (2), and 123 participants received the map condition (3).

Analyses. Responses to the distance estimation question were blind coded as either time (*T*) based or spatially (*S*) based. Spatial responses were then coded with a (1) and temporal responses with a (2). Priming Conditions were also assigned numerical values: Control (1), Clock (2), and Map (3). Multiple chi square tests were run to examine whether the frequency of a time based versus distance-based response was affected by priming condition, country of origin, transportation, environment, age or sex to determine statistical significance of responses.

Experiment 2

Experiment 2 focused on distance perceptions in decision based task. This study tested whether the choice of language representation used for expressing distances in measurements of time or space terms is related to the choice they would make when faced with either a time consuming or distance consuming route while travelling. Responses to the general distance estimation question from experiment 1 (“*How far from where you live now is the nearest supermarket?*”) were used as a measure of participants’ natural language choice. Participant

responses to the 10 map stimuli presented in experiment 2 was used to determine the degree to which individual choices on a navigation task were based around time considerations or distance consideration.

Further, Experiment 2 also tested for an impact of cultural influence on participants' natural bias for perceptions of distance in either temporal or spatial terms. The study aimed to discover the responses of participants when they have been forced to make a decision regarding preference for a route that is either time consuming or spatially intensive, and from the country of origin question in experiment 1 determine if there are any cultural trends. It was also expected that primary method of transportation and environment were also examined as factors impacting participant responses to the route decision task.

Participants. The sample for experiment 2 consisted of 349 participants, 164 women and 185 men (mean age=32.10 years, SD=11.45). Nationalities of participants in experiment 2 consisted of approximately 132 from the United States of America, 130 individuals from India, and 10 from the United Kingdom. The remaining 77 participants reported nationalities from 42 various countries around the world, and two failed to report nationality. Of these participants, 189 reported English as their first language. Of the Indian participants, 39 reported Tamil, 26 reported Malayalam, and 19 reported Hindi. The remaining 21% reported a further 33 different languages as their first language. 26% of participants reported they were monolingual, approximately 33% reported some knowledge of two languages, and 40% reported knowledge of three languages or more. Again, language proficiency was not included as a factor in this study.

One hundred and eleven participants received the control condition (1), 121 received the clock condition (2), and 117 participants received the map condition (3).

Analyses. The dependent variable tested in experiment 2 were participant responses to the route selection task. Responses to the 10 map stimuli were coded; choices for the longer time routes received a coding of zero (0), longer distance routes received a coding of one (1), the total sum was calculated in the range of a minimum score of zero and maximum score of ten. ANOVA was conducted to determine the factors that effected the number of distance based choices made, with natural language responses (use of temporal or spatial terms) from experiment 1, priming condition, country, primary method of transportation, environment, and gender serving as the independent variables.

Results

Experiment 1

The results of the first experiment are presented in this section. A total of 373 responses were blind coded for the open-ended general distance estimation question, however 24 of these responses were thrown out; two participants responded to the distance estimation question using both temporal and spatial descriptions, and a total of 22 used no units, were nonspecific (“near by”) or were unrelated. The results of experiment 1 are presented below.

The results of the chi-square tests involving the interactions of priming condition, country of origin, sex, language, primary method of transportation, and environment with the type of response (time-based or distance-based) elicited from the general distance estimation question are presented in this section.

Summary of Responses. The results of the open-ended distance question are shown in Table 1. Overall 10.3% of the 349 respondents provided a time-based response. Results indicate a much higher preference for spatial language descriptions over temporal language descriptions of distance.

Table 1. *Summary of Responses to the Open- Ended Distance Estimation Question*

(Participants $N=349$)

Response Type	Time Based	Distance Based
(%) Response	10.3 %	89.7 %
Total Responses	36	313

Priming Condition. Table 2 presents the number of time-based and distance-based responses across each of the three priming conditions. A chi-square test revealed that there was not a significant difference in the frequency of time-based responses across each of the three priming conditions ($\chi^2 = 0.686$ $df = 2$, $p = 0.710$). The results indicate a small, but not significant, trend for a higher frequency of time-based responses in the control and clock priming conditions than in the map condition, and for a slight trend towards a higher frequency of distance-based responses in the map priming condition than in the clock and control conditions.

Table 2. *Frequency of Time-Based and Distance-Based Responses by Priming Condition*(Participants $N=349$)

Condition	Time-Based Responses (%)		Distance-Based Responses (%)		Total
Control	14	(12.0 %)	102	(87.9 %)	116
Clock	12	(10.1 %)	107	(89.9 %)	119
Map	10	(8.8 %)	104	(91.2 %)	114
Total	36	(10.3 %)	313	(89.7 %)	349

Country of Origin. Table 3 shows the number of time-based and distance-based responses across the different countries of the respondents. A chi-square test was performed to compare the frequency of time-based responses between respondents from the United States, the United Kingdom, India, and other countries. A chi-square test revealed a significant difference ($\chi^2 = 12.247$, $df = 3$, $p = 0.007$) in the frequency of time-based responses based on country of origin. Participants listing India as their country of origin were more likely to use spatially oriented language to describe distances (about 95%), where as a higher percentage of participants listing country of origin as the United States, the United Kingdom and other countries used time-based responses to describe distances.

Table 3. *Frequency of Time-Based and Distance-Based Responses by Country*Participants ($N=347$)²

Country	Time-Based Responses (%)		Distance-Based Responses (%)		Total
USA	17	(12.4 %)	127	(87.6 %)	145
India	6	(5 %)	113	(95 %)	119
UK	4	(36.4 %)	7	(63.6 %)	11
Other	9	(12.3 %)	64	(87.7 %)	73
Total	36	(10.4 %)	311	(89.6 %)	347

² Two participants who did not list their country of origin were not included in this analysis.

Environmental Factors. The environmental impacts on the frequency of time-based and distance-based responses of participants are examined in Table 4 below. Responses were grouped into the categories of rural/ small town, small city, and large city. A chi-square test revealed no significant ($\chi^2 = 1.219$, $df = 2$, $p = 0.544$) interaction between response type and environment. A non-significant trend for fewer temporal responses by those listing rural and small town environments is revealed in the data, with the more time-based responses present in small and large city environments.

Table 4. *Frequency of Time-Based and Distance-Based Responses by Environment*

(Participants $N=349$)

Environment	Time-Based Responses (%)		Distance-Based Responses (%)		Total
Rural/ Small Town	9	(8.1 %)	102	(91.9 %)	111
Small City	13	(10.2 %)	114	(89.8 %)	127
Large City	14	(12.6 %)	97	(87.4 %)	111
Total	36	(10.3 %)	313	(89.7 %)	349

Primary Transportation. Table 5 illustrates the effects of the primary method of transportation on the frequency of time-based and distance-based responses. For analysis, transportation types were grouped into personal transportation (walking, cycling), personal motorized transportation (car, motorcycle), and public transportation (train, bus, subway/underground). A chi-square test revealed significance ($\chi^2 = 10.161$, $df = 2$, $p = 0.006$) in the interaction of transportation and types of response recorded. Participants using public transport systems gave more time-based responses than those using personal motorized methods of transport (car and motorcycle) or personal forms of transport (walking and cycling). The highest percentage (19.8%) of participants using temporal responses to describe distances occurred in the public transportation group.

Table 5. *Frequency of Time-Based and Distance-Based Responses by Transportation*(Participants $N=349$)

Transportation	Time-Based Responses (%)		Distance-Based Responses (%)		Total
Walking, Bicycle	5	(7.2 %)	64	(92.8 %)	69
Car, Motor Cycle	15	(7.5 %)	184	(92.5 %)	199
Train, Bus, Subway/Underground	16	(19.8 %)	66	(80.2 %)	81
Total	36	(10.3 %)	313	(89.7 %)	349

Gender Effects. A chi-square test revealed a significant effect ($\chi^2 = 10.258$, $df = 1$, $p = 0.001$) of gender on the frequency of time-based and distance-based responses, which are illustrated in Table 6 below. Gender differences were found in the type of response used; female participants using time-based responses represented 7.4% of the total responses as opposed to the 2.9% of males who used time-based responses.

Table 6. *Frequency of Time-Based and Distance-Based Responses by Gender*(Participants $N=349$)

Gender	Time-Based Responses (%)		Distance-Based Responses (%)		Total
Male	10	(5.4 %)	175	(94.6 %)	185
Female	26	(15.9 %)	138	(84.1 %)	164
Total	36	(10.3 %)	313	(89.7 %)	349

First Language. In addition, an analysis was conducted examining the interaction between frequency of time-based and distance-based response and the first language of speaker. Table 7 shows the frequency of response type of participants with English as their first language ($n=196$) with all other speakers. A chi-square test reveals a significant difference ($\chi^2 = 5.787$, $df = 1$, $p = 0.016$) in frequency of time-based responses for those with English as their first language, as compared to others, indicating that English speakers are far more likely to use a time-based response to estimate distance than speakers of other languages. Also interesting is that in the six languages, other than English, reflected by the Indian participants (Tamil, Malayalam, Hindi, Telugu, Gujarati, and Nepali), only two responses were in a time-based

measurement, indicating these languages may influence the preference for distance measurements in either spatial or temporal language.

Table 7. *Frequency of Time-Based and Distance-Based Responses by First Language*

(Participants $N=349$)

First Language	Time-Based Responses (%)		Distance-Based Responses (%)		Total
English	27	(13.8 %)	169	(86.2 %)	196
Other	9	(5.9 %)	174	(94.1 %)	153
Total	36	(10.3 %)	313	(89.7 %)	349

A general summary of participant language by response type is represented in Table 8, below. While there were no specific predictions for which languages might be more likely use time-based versus distance-based descriptions, the table does show that first-language English speakers appear to be more likely to use time-based responses than many of the other languages, with the exception of Portuguese, Filipino and German. Future research should examine these languages more closely, with larger sample sizes from those groups.

Table 8. *Summary of Time-Based and Distance-Based Responses by First Language*(Participants $N=349$)

First Language	Time-Based Responses (%)		Distance-Based Responses (%)		Total
English	27	(13.8 %)	169	(86.2 %)	196
Tamil	1	(2.9 %)	34	(97.1 %)	35
Malayalam	0	(0 %)	26	(100 %)	26
Hindi	0	(0 %)	18	(100 %)	18
Telugu	0	(0 %)	6	(100 %)	6
Gujarati	0	(0 %)	4	(100 %)	4
Portuguese	1	(20.0 %)	4	(80.0 %)	5
Filipino	2	(40.0 %)	3	(60.0 %)	5
Serbian	0	(0 %)	5	(100 %)	5
Russian	0	(0 %)	4	(100 %)	4
German	1	(25.0 %)	3	(75.0 %)	4
French	0	(0 %)	4	(100 %)	4
Spanish	0	(0 %)	3	(100 %)	3
Greek	0	(0 %)	3	(100 %)	3
Other	4	(12.9 %)	27	(87.1 %)	31
Total	36	(10.3 %)	313	(89.7 %)	349

Experiment 2

This section will present the results of experiment 2. The total number of responses to the navigation questions in Experiment 2 that chose the longer-distance (but shorter time) route was calculated; participant scores range from 0-10. Overall, the mean number of longer-distance (shorter time) responses was 4.99 (SD= 2.75).

One-way ANOVA tests were conducted testing the effect of priming condition, response type, and country of origin, environment, transportation, and gender on the number of longer-distance responses chosen.

Priming Condition. ANOVA results revealed that the priming condition was not a significant factor ($F(2, 346) = 1.377, p = 0.254$) in effecting the number of longer-distance responses in experiment 2.

Natural Language Response. The ANOVA test run on the interaction of longer-distance responses to the maps presented in experiment 2 with the type of natural language response used in experiment 1 revealed a significant effect ($F(1, 325) = 6.085, p = 0.014$) presented below in Figure 2. These results indicate a significant effect of natural language choice on navigation considerations; the use of a time-based response in the open-ended distance estimation question is significantly related to the degree to which participants consider time in their navigation activities. People who responded with a time-based measurement of distance were more likely to choose the longer distance, spatially intensive routes but shorter time routes

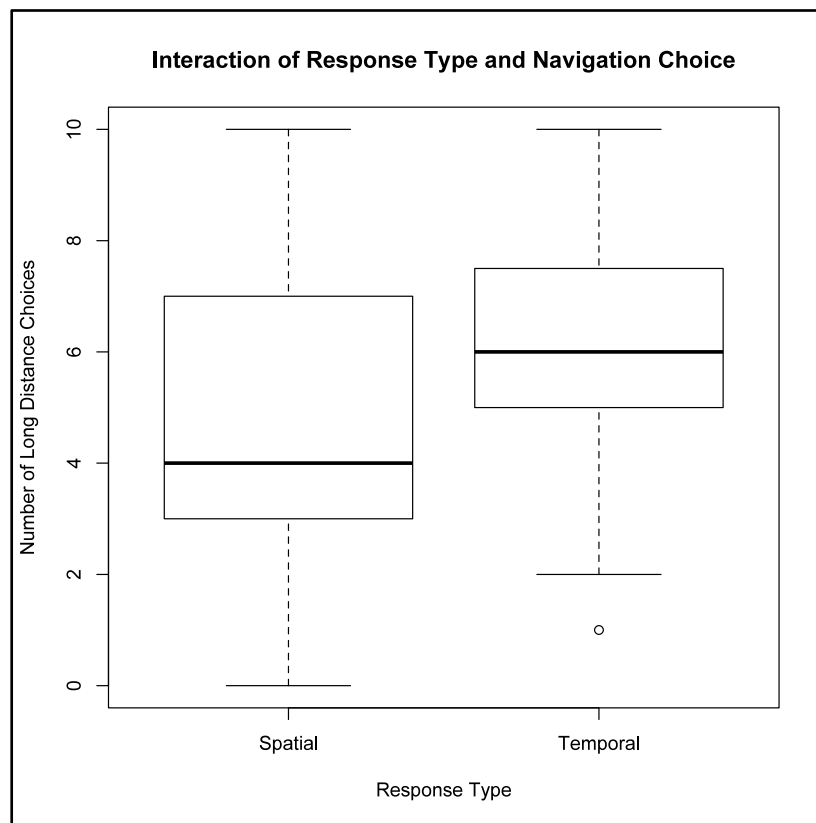


Figure 2. Mean of Navigation Responses by Spatial and Temporal Response. ANOVA revealed a significant interaction ($F(1, 325) = 6.085, *p = 0.014$) between the response type (time/ distance based) and the navigational choice of participants. Overall, people who used time-based responses in the natural language choice question were more likely to consider time factors the navigation task and chose the longer distance route more frequently. (Note. $*p < .05$, $**p < .01$, $***p < .001$).

than the shorter distance, but more time-intensive routes. Individuals who responded using a space-based measurement of distance were more likely to choose more of the time-intensive, but

shorter distance routes over the spatially intensive, but shorter time routes.

Other Factors. ANOVA results for the interaction between country of origin and the number of longer distance choices made in the map decision task revealed no significant ($F(3, 344) = 1.694, p = 0.168$) influence of country on the type of decision made. An ANOVA revealed that primary type of transportation had no significant effect ($F(2, 346) = 0.584, p = 0.558$) on the type of choice participants made on the map decision task. Type of environment was also found to have no significant effect ($F(3, 345) = 0.716, p = 0.543$) on the type of decision participants made in choosing a distance or time intensive route. The ANOVA results for the effect of gender on the number of longer distance routes chosen revealed no significant influence ($F(1, 347) = 3.2962, p = 0.070$), but showed a trend indicating women were more likely to choose the longer distance (shorter time) route option over the longer time route option than men.

Discussion

Experiment 1

Not all hypotheses were supported in the first experiment. However, experiment 1 reveals that there is a significant influence of cultural and life style factors on the terms in which people think about distance. Only 10.3% of total responses used a time-based response on the open-ended distance estimation question, which was somewhat lower than expected based on anecdotal observations in real world settings. This may have been due to the format of the questionnaire, or may reflect an accurate baseline on such behaviours in the studied populations. As predicted, a strong cultural trend was discovered in the data as to which type of response, time-based or distance-based, was selected, this data will be discussed below.

Country of Origin. Particularly interesting, the analysis of the data revealed a very significant influence of country of origin on the type of response used, thus supporting the first hypothesis. The highest percentage of time-based responses in this study came from the United States and the United Kingdom, as compared to India. However, the data revealed that participants in all groups made use of both kinds of responses when describing distances. Only five percent of Indian participants provided time-based responses to the open ended question, with an overwhelmingly 95% of responses using a distance-based response to convey their measurements. The cultural background of the participant indicated a strong preference for the terms in which distance was considered. The data indicates that whether a time-based or distance-based representation is used more often is dependent on country of origin. Moreover, there may be additional effects of within country sub-cultural and regional differences, however this is beyond the scope of the current study. Next, the data from the analysis of the effect of the priming condition (clock, or map) will be discussed.

Priming Condition. A significant effect of priming for response type based on the presented images of the clock and the map were not supported by the data. Thus the hypothesis that priming will affect the frequency of time-based versus spatial-based responses must be rejected in favour of the null hypothesis. In fact, the controls used slightly more time-based responses (12 %) than the clock priming condition (10.1 %), demonstrating that participants were not manipulated by the priming image to discuss distance in time-based terms. The data from the map condition reveals that while there were a slightly higher percentage of distance-based responses than in the other conditions, it was not statistically significant, with the map condition producing only 1.3 % more distance-based responses than the clock condition. This data indicates

that the type of response given by participants is a fairly robust indication of the terms in which they perceive distance, as they were not easily manipulated by the experimental conditions to use one form over the other. In addition, the six Indian participants who responded using a time based-response were spread evenly across each of the three priming conditions, revealing that priming condition played no effect in influencing the type of response given for this group. Context may play a role in the type of description that is accessed for use in a given situation, and which type of response is used may be flexible based on other factors, however this is beyond the scope of this study. Evidence for gender influences will be discussed next.

Gender. Gender revealed a significant influence on the type of response that was given in the distance estimation question, in line with hypothesis three. Females were much more likely to express distances in terms of time than men, with 15.9% of the total female participants using a time based response as opposed to 5.4 % of the total male participants. This indicates that there are gender- based differences in the type of distance representation strategies that are employed, which is consistent with literature on gender differences in spatial reasoning and navigation (Contreras, et al., 2007).

Primary Transportation. The analysis of the effect of the primary type of transportation on the type of distance description used by participants revealed a statistically significant effect, supporting hypothesis four. Those using public transport (trains, buses, subway/ underground) were far more likely to consider distances in terms of time than those driving a car or motorcycle, and far more so than those walking and cycling. This may be a result of several factors; reliance on public transportation requires a particular need for time keeping, and scheduling. Also, unlike driving a car or a motorcycle or walking and riding a bike, riding on public transportation is a much more passive form of transportation– you’re not controlling forward motion yourself– and thus may encourage distances to be considered as amount of time spent getting from point A to point B.

Environment. It was expected that the type of *social* environment (rural, urban) and in the urban context, the size of the city (large, small), of the participants would have a significant influence on how a participant responded to the distance estimation question. Analysis of the data, however, did not support this hypothesis. A non-significant trend was found in the number of time-based responses from the large city environment, which produced 4.5 % more temporal responses than the rural/ and small town category, however there was little difference in the numbers of time-based responses between the large city and small city categories (2.4 %). Thus hypothesis five must be rejected in favour of the null hypothesis. If there are regional differences, they may result from factors other than the socio-environmental landscape feature examined here.

First Language. A significant interaction between the first language of the participants and the type of response given was also indicated by the analysis of the data, particularly in the comparisons of English speakers with the other languages in the world. English speakers gave the highest number of time-based responses. This was true of participants from countries like the United States and the United Kingdom, where English is the predominant language. In addition, it should be noted that of the six Indian participants who used a time-based response, four indicated that English was their first language. The data indicates that English, more than other languages in this study, significantly uses both time-based and spatial-based representations of distance more often, which may indicate a duality that is not present in other language groups studied. In particular, the data indicate that a strong trend of both country and language emerges in distance representation, which in this study are somewhat confounded. Notably, the languages listed by Indian participants (Tamil, Malayalam, Hindi, Telugu, Gujarati and Nepali) represented only two of the six time-based responses, with the remaining four speaking English as their first language, indicating that country of origin and the way that distance is reflected in its languages may be correlated, but that language may be an overriding factor. However deconflicting these two factors is beyond the scope of this study, as further personal information about participants' experiences (such as current country, years living there) was not collected.

Experiment 2

The factors influencing the kind of navigation decision participants make when faced with a choice in two different routes were examined. Analysis revealed that factors that influenced language choice in the first experiment, such as country of origin, type of transportation and gender, were not influential on which type of route, time intensive or space intensive, participants chose in the second experiment. Furthermore, factors that were found to have no influence on the type of language choices that were used to describe distances in the first experiment, such as priming condition and environment, also had no significant influence on the navigational decisions made by participants in the second experiment. These results were contrary to the expected hypotheses that these factors (priming condition, country of origin, type of transportation, environment, and gender) would also influence which kind of navigation decisions were made regarding routes in the maps.

The results of the second experiment did reveal that the most significant factor influencing the type of navigation decisions that were made were significantly correlated with the type of response given to the open-ended distance estimations question from the first experiment. This reveals that the language, in temporal or spatial terms, used by people to describe distance

reflects a specific mental representation of space, which is also relevant when making navigation decisions in real world tasks. Whether they were inclined to specifically consider time or distance in their decisions was reflected in how they talked about space. Thus the language used by participants is significantly related to relevant cognitive tasks.

Summary of Overall Findings

In sum, the results of both experiments revealed that there are significant factors that influence distance language representations and the decisions we make during navigation. Country of origin, first language, typical mode of transportation and gender were all found to significantly effect how distance was described in an open-ended language query situation. The way that participants chose to describe distance in the first experiment was significantly correlated with the number of spatially intensive routes that were selected over temporally intensive routes in the navigation decision task. These results reveal both a cultural influence on the language terms in which distance is considered and a relation between those specific language representations and the perceptions and the cognitive processing of distances

General Discussion

While a large number of studies have focused on the question of how language influences the diverse interpretations and perceptions of spatial and temporal cognition, the nature of distance perception and the role of both temporal and spatial representations in defining and describing the concept of distance has received (*almost*) no attention. After extensive literature review, I found no previous psychological studies that examined the factors which impact of the kind of conceptual description that is assigned to express distance. While there have been several previous studies examining cultural differences in the spatial reasoning techniques (Burenhult & Levinson, 2008; Haun, et al., 2010; Levinson, et al., 2002; Li, et al., 2011; Majid, et al., 2004), and on the metaphorical mapping of time onto the spatial realm (Boroditsky, et al., 2011; Boroditsky & Gaby, 2010; Casasanto & Boroditsky, 2008; Fuhrman & Boroditsky, 2010; Núñez & Sweetser, 2006), no previous studies have examined the categorical and conceptually different realms of time and space as they are both used in distance reasoning.

The notion that time and space terms are conceptually interposable when describing distances was supported by the data, making the actual nature of distance perception an interesting realm for examination. The findings from the current study fit in with a growing body of literature that seeks to include a greater range of culturally and linguistically diverse groups as subjects (Evans & Levinson, 2009; Levinson & Evans, 2010).

In this study, the factors that may influence language choices when describing distances (experiment 1), and whether these choices resulted in a cognitive effect when processing two kinds of distance choices (experiment 2) were examined. The results of the experiment suggest that there is a correlation of the language choice, whether in terms of time or in terms of space, reflected in the considerations that are made when making decisions about two kinds of routes from the same starting point to finishing point. Furthermore, consistent cultural influences of nationality and language groups were found to significantly correlate to whether people preferred to describe distances in temporal measurements (*e.g. 5 minutes*) or spatial measurements (*e.g. 10 miles*). The results of this study did not support an effect of priming affecting type of concept of language representation used to describe distance, and determined that the preferences for kind of distance description was more solidly related to a cultural influence.

Individual culture groups showed strong trends in the language of distance expression that was selected, and whether both types of descriptions were supported. It was found that country of origin had a significant role in determining whether spatial language or temporal language was used to describe distances. Indian participants expressed distances almost

exclusively in spatial terms, while both British and American participants demonstrated use of both spatial and temporal terms to convey distances. Additionally, English speakers produced far more of both temporal-based and spatial-based descriptions to express distance than any of the other language groups included in the study, indicating that cross-linguistic differences exist in the particular kinds of descriptions that are employed across populations. The finding of cross-linguistic differences in the tendencies to use only spatial responses and the tendency to use both illustrates a difference not only in preferences across cultures, but perhaps differences in perspective. The evidence from this study only suggests that there is a correlation between the likelihood that you will use one kind of a descriptor of distance over the other and that culture may determine which is selected more predominantly and whether the two types of descriptors are interposable within the culture. The study itself was not aimed to ascertain whether using terms of time or space alters perceptions of distance between the two, i.e. whether they are actually interchangeable based on context, or if there is a staunchly cultural inclination towards only representing distances with one kind of response.

The notion that culture has a cognitive impact in shaping the nature of our perceptions, and the terms in which we talk about things emerges in the studies conducted on spatial reasoning and organisation of time across cultures. An aim of future studies should be to focus on whether there is in fact a perceptual difference in cognition of distance between temporal and spatial descriptions, and whether there are differences across cultures. Additionally, future studies should focus on the cultural impact on distance perceptions, accessing a wider population. This study was limited to a majority United States and Indian participants due to the nature of the online study. A wider range of nationality and language populations could provide insight in the workings of distance perception, and may even find indications that other alternative forms of distance expression exist.

In spatial cognition, the language of the frame of references that are used to represent the conceptual interpretation of space is a good indicator of how that concept is perceived (Majid, et al., 2004). Quite a lot of evidence for differences in spatial reasoning amongst different cultural groups has been found, showing that it is possible for the same concept to be processed in multiple ways. While the current study does not go in depth enough to claim that actual perceptual differences of distance exist as a result of whether time-based or space-based measurements are used to express the distance, evidence from the second experiment suggests that a trend exists between whether distance is expressed in spatial or temporal terms and the considerations that are made during navigation.

The idea of the landscape, from Burenhult and Levinson (2008) and how it defines the space

around us makes it a backdrop from which we are always receiving perceptual input (e.g. weather changes, noises, other people, buildings, landmarks, society). This is relevant because our environment is what we operate from, and could greatly influence the terms of our distance perceptions (e.g. does ‘*point A*’ to ‘*point B*’ involve a mountain that we have to get over, a stream we need to cross; is survival dependent on these things?). Furthermore the nature of the landscape may be salient to decision making. Although the data didn’t support a significant effect of the type of social environment (rural, small town, urban) or city size, the nature of the study— given that the study was administered in an online setting— may have reduced salience of the environment. A future study that examines distance perceptions of people from different environment types within that environment, and whether there are any changes in the types of distance measurements used when moved to a new environment. Furthermore future research should examine whether spatial estimations of distance emerge differently based on varied frame of referents that are used by different populations

How the interchangeable terms of distance expression affect, or just merely reflect, differences in the way in which distances are thought of may echo the perceptual link of spatial concepts that are found in temporal representations. The metaphorical mapping of temporal concepts onto spatial ones serves to make abstract ideas more concrete through the language used to represent them, and thus more tangible (Casasanto & Boroditsky, 2008). The coinciding perceptual and directly physical quality of distance reasoning and measurement is reflected in how it is expressed. Distance perception may recycle both kinds of concepts, space and time, and play on the conceptual and metaphorical link of time being understandable and accessible through spatial terms. The limited number of time-based responses found in experiment 1 indicates that, while time is a salient way to express distance, it is in less use than spatial terms. This indicates interesting implications of how the time- space conceptual metaphors are linked, and further, that expressing distance in temporal language results only as a result of that shared conceptual link. It may be that time emerges in the perception of distance only in so far as it is conceptually salient to spatial reasoning, and given that measurements of distances have a highly navigational quality to it, relying on a whole realm of visual capacities and spatial reasoning abilities, spatial descriptions may make distance perceptually salient, when represented by a shared measurement. The conceptual link between space and time, and the implications this link has for how they are used and represented within distance measurements and reasoning is an area for further research. The current study has found that the concept of distance, and how it is conceptualized, is varied and that there are strong cultural preferences for distance representations, and could provide

beneficial knowledge not only to the study of distance, but to the understanding of spatial cognition and general cognition across populations.

Conclusions

The findings of the current study indicate that there are differences in the way distances can be conceptually represented. The language of distance expression and measurement reflects the two conceptually different forms of spatial representation and temporal representation, indicating a crossing of concepts in this area of cognitive understanding. Furthermore, the finding of cross-cultural differences in the terms of distance expression, and a significant influence of those representations in considerations of distance navigation decisions, fits in with a body of research that has found cross-cultural and cross-linguistic cognitive diversity. The concept of distance and the underlying factors of distance perceptions– and interposable presence of temporal and spatial representations– provide a rich arena by which future research can examine elements of human cognition.

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Appendices

Appendix A. Priming Stimuli

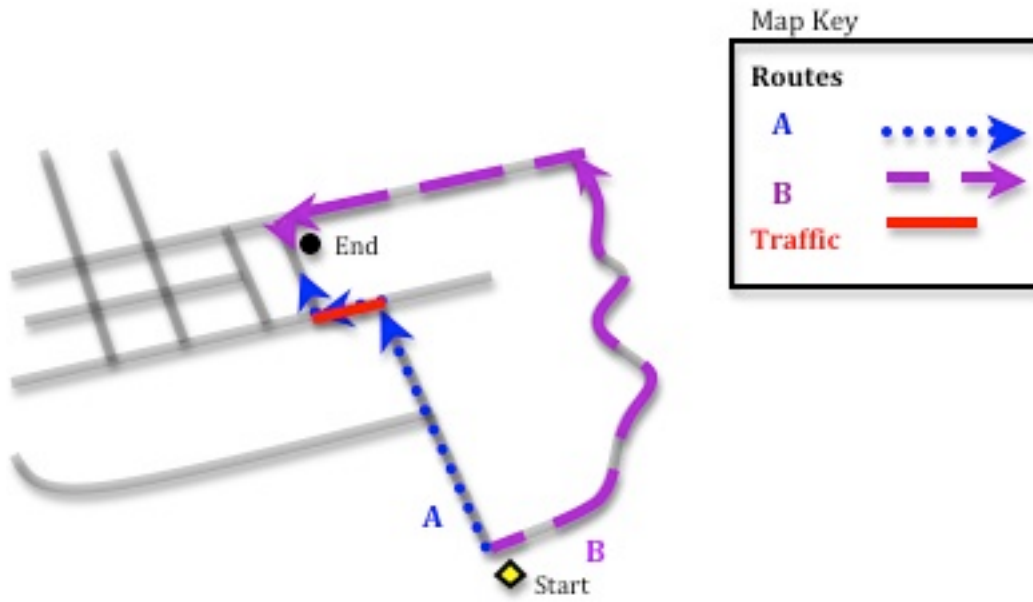
Clock Stimulus.

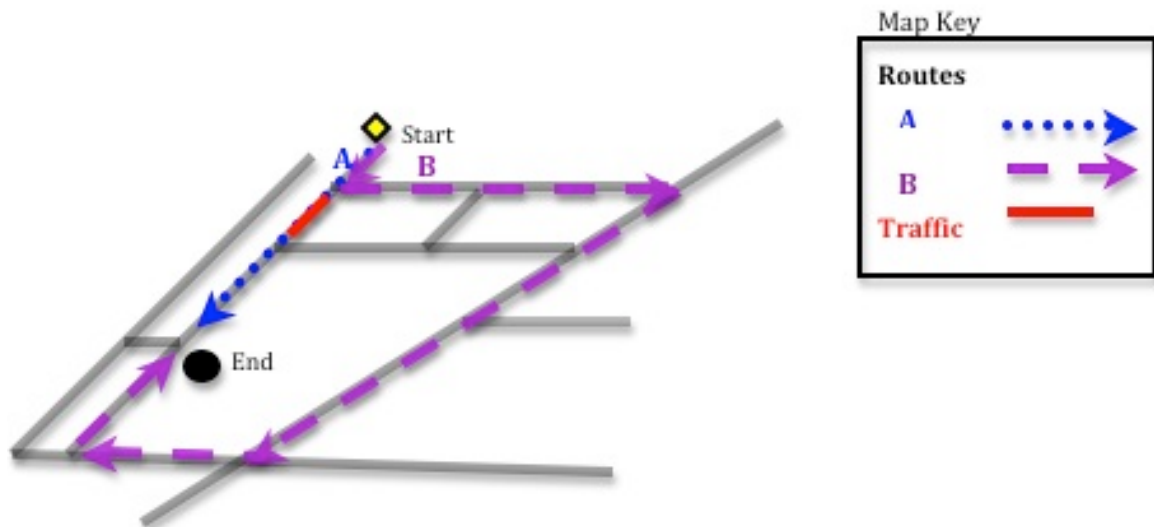
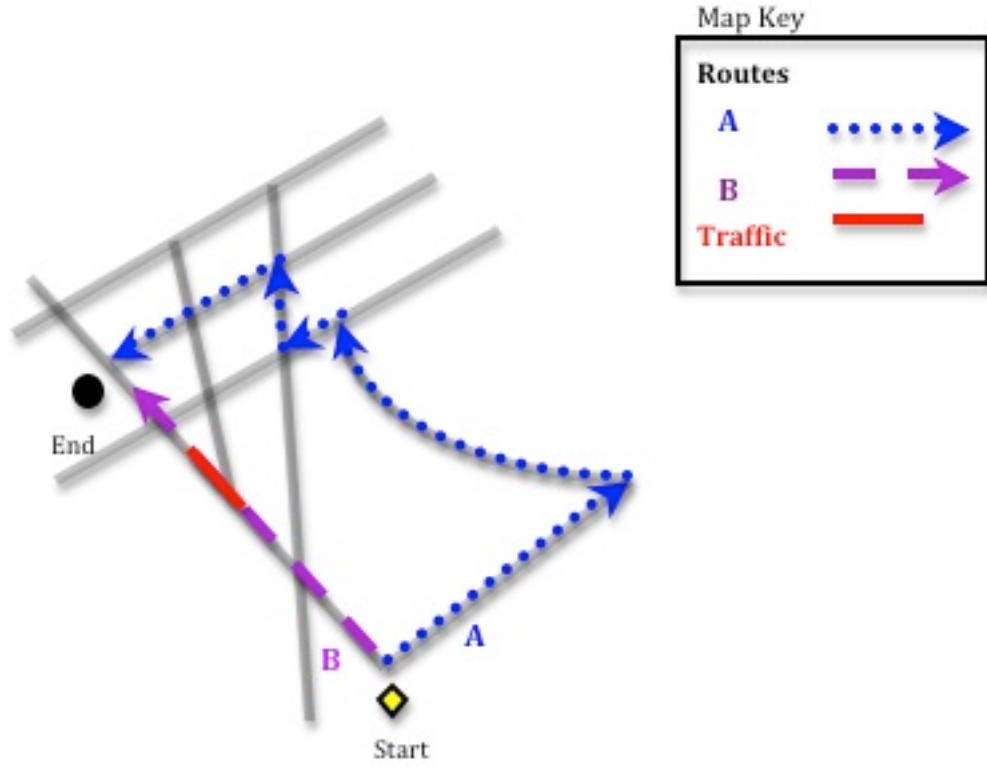


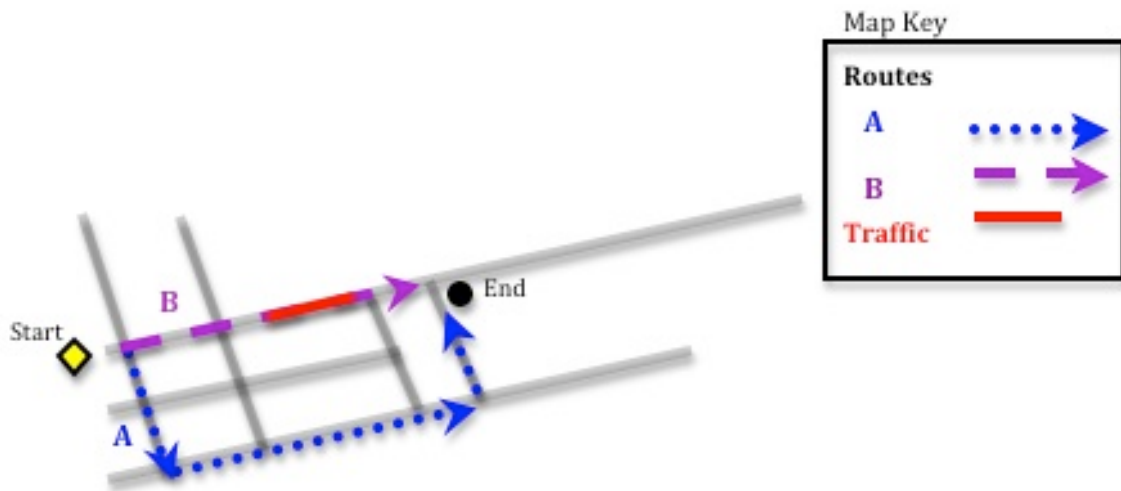
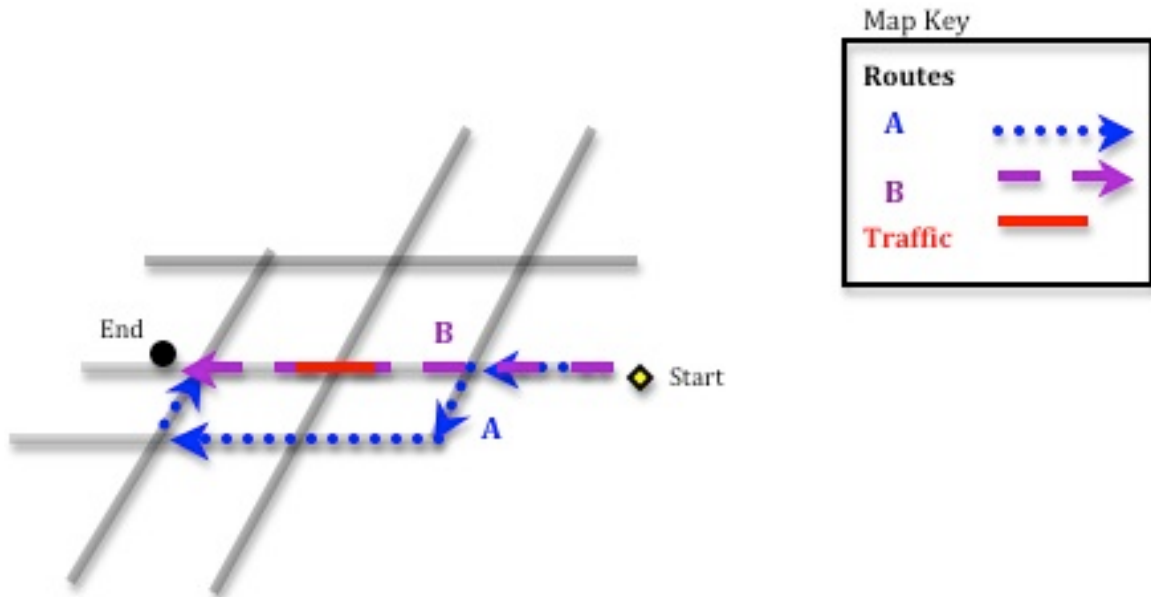
Map Stimulus.

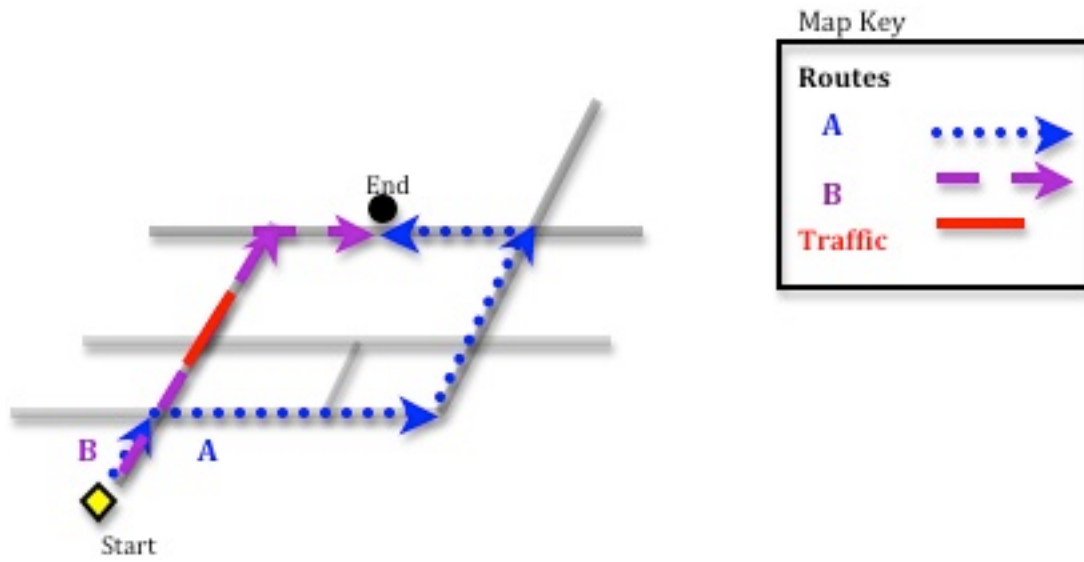
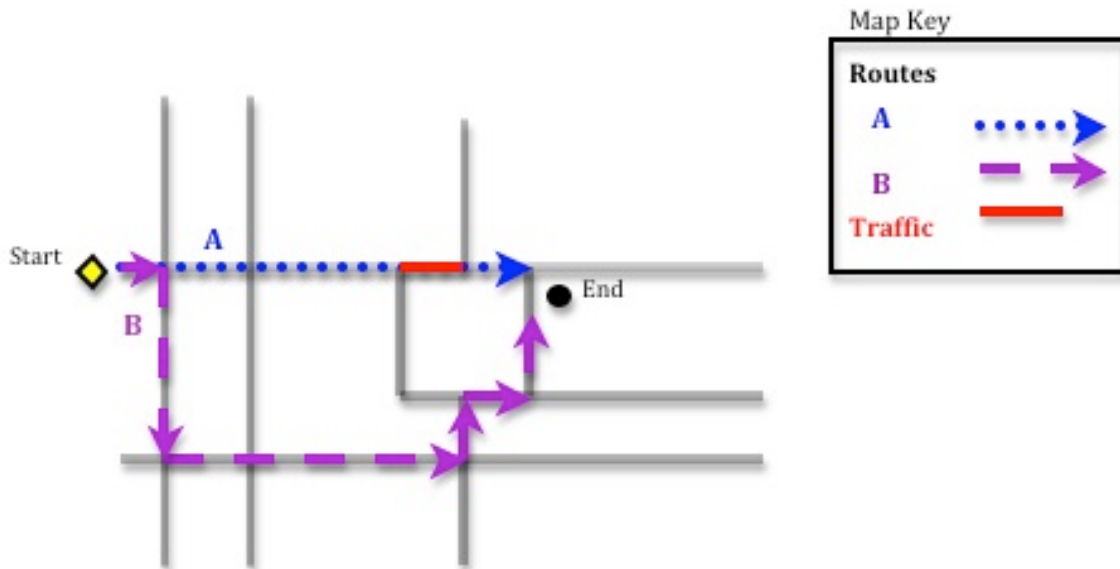


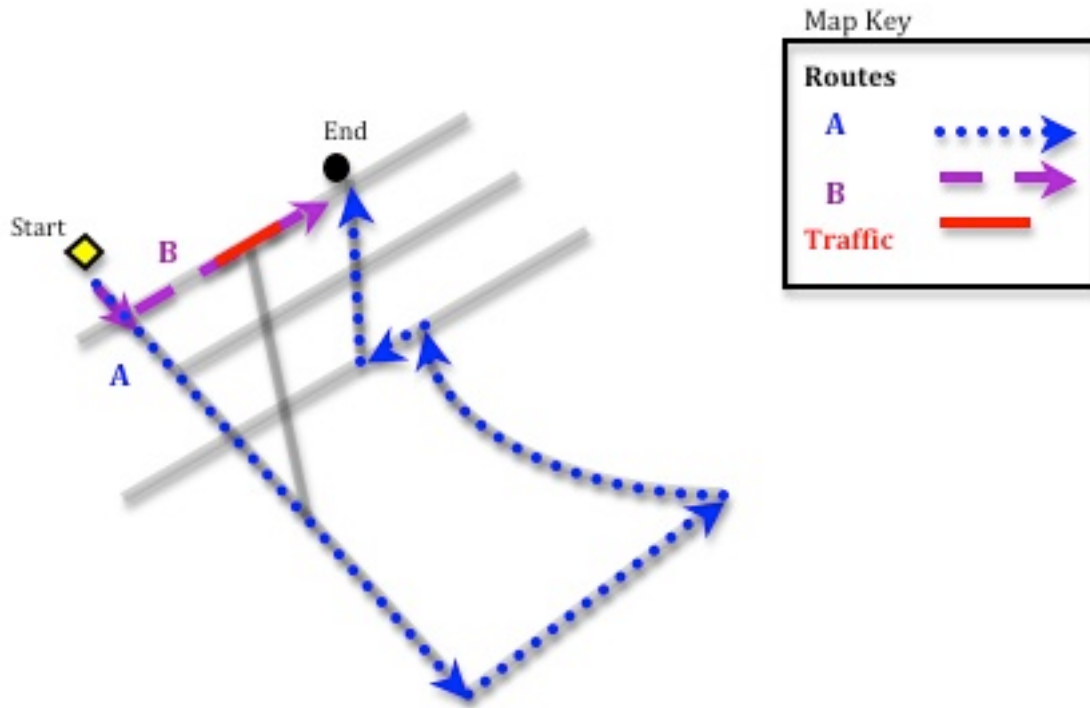
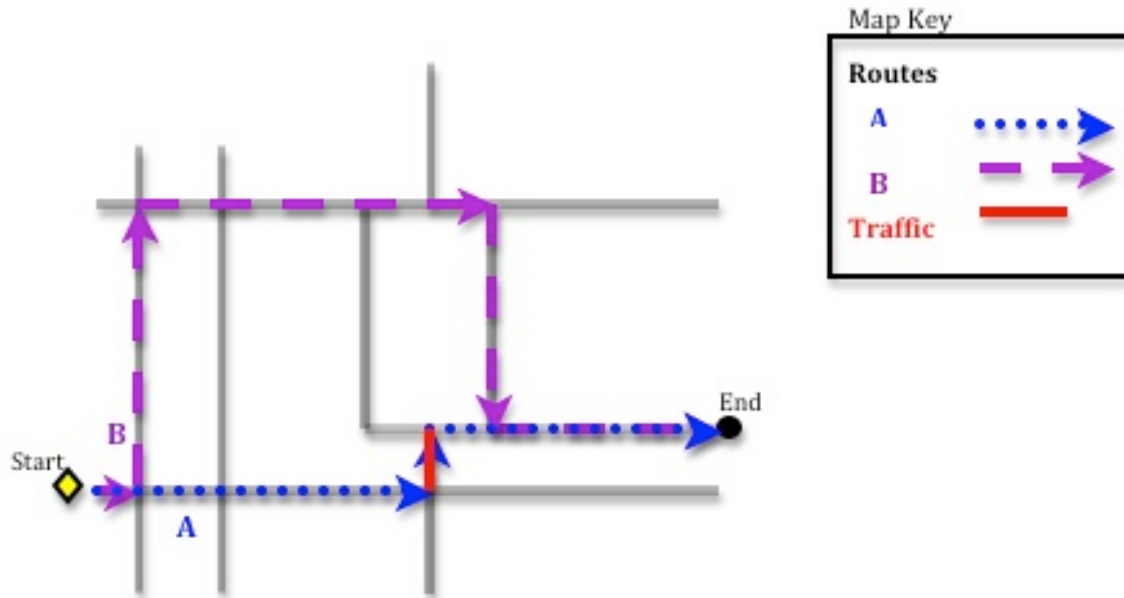
Appendix B. Experiment 2 Stimuli

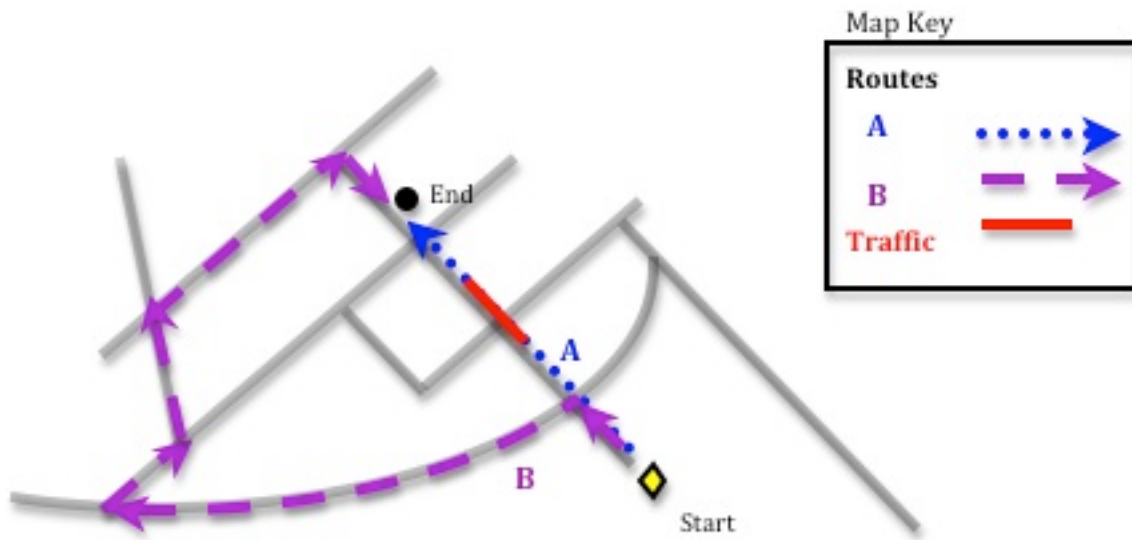












Appendix C. Sample Survey for Experiments 1 & 2

*** 1. Instructions**

This study contains two sections. In this study you will be asked to complete a short survey, which will ask for some demographic information. Please answer each question fully. This will be followed by a series of images which will each be accompanied by a question. You will be asked to make a decision about each image and should respond with either [A] or [B].

IMPORTANT

At the end of the survey, you will receive a unique completion code.

You MUST enter this completion code in TWO places to receive payment: on the survey, in the space directly BELOW the Completion Code AND on the HIT instruction page where you clicked the link to this survey.

Once you leave the page with the completion code on it you CANNOT go back so make sure to enter the SAME completion code in BOTH places before clicking continue.

Consent: Please indicate your consent to continue with this study. Your participation in this experiment is voluntary. You may withdraw from the experiment at any time and for any reason without penalty. All data will be treated with full confidentiality and, if published, will not be identifiable as your own.

If you do not wish to continue please exit the survey now.

By clicking the button below, you are giving your consent to participate in this experiment.

I consent

***2. In what month were you born?**

January- April

May-August

September- December

***3. What is your country of origin?**

Country:

4. What is your sex?** Female Male5. What is your age?**

5

6

***6. What is your first language?**

5

6

***7. What other languages do you speak? (in order of ability)**

5

6

8. What is your primary method of transportation?** Bicycle Bus Car Subway/ Underground Train Walking Other (please specify)9. Do you come from an environment that is:** Mostly rural A small town A small city A large city***10. How far from where you live now is the nearest supermarket?**

5

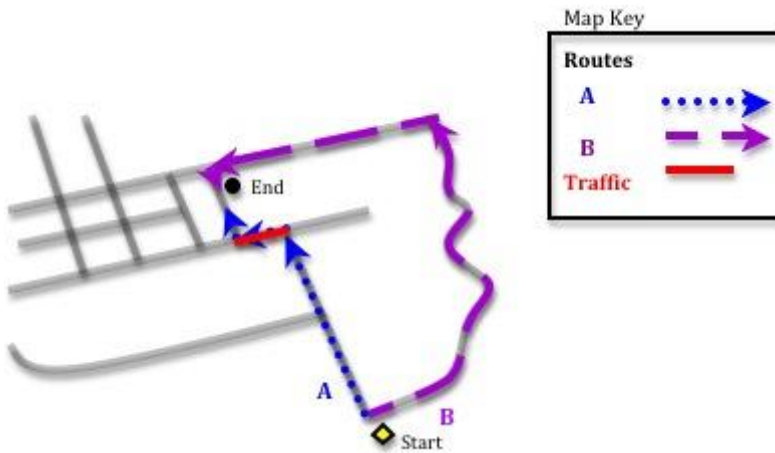
6

***11. On what day of the month were you born?**

Odd day

Even day

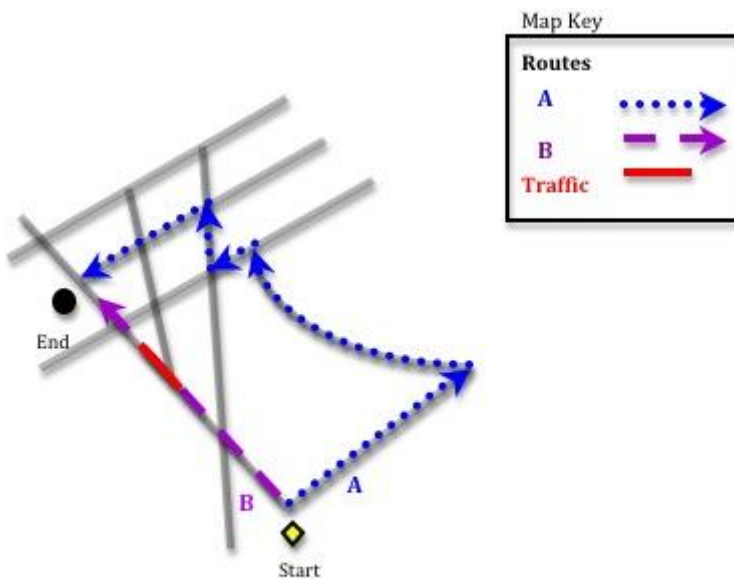
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***12. Which route would you choose?**

- A
- B

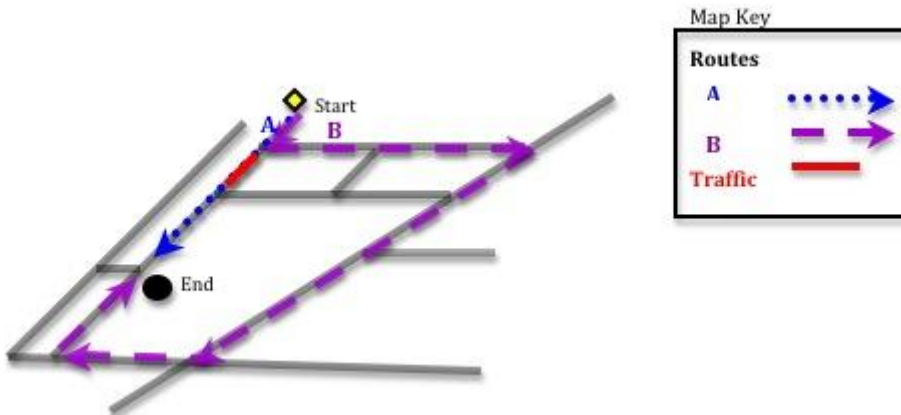
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***13. Which route would you choose?**

- A
- B

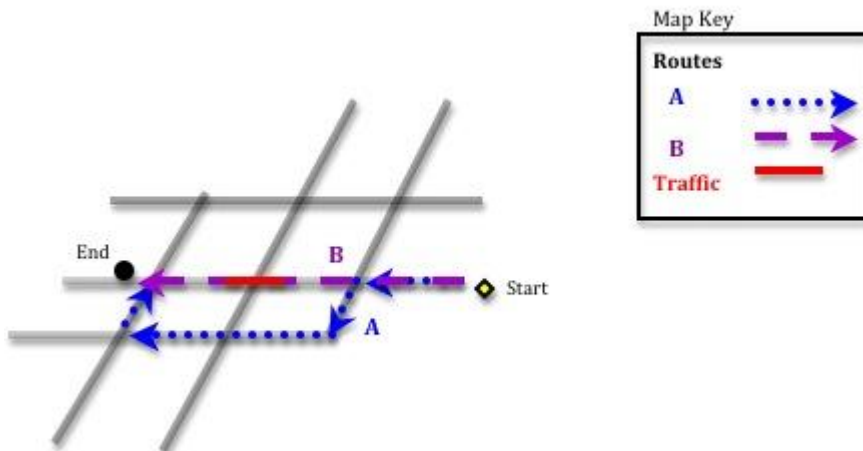
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***14. Which route would you choose?**

- A
- B

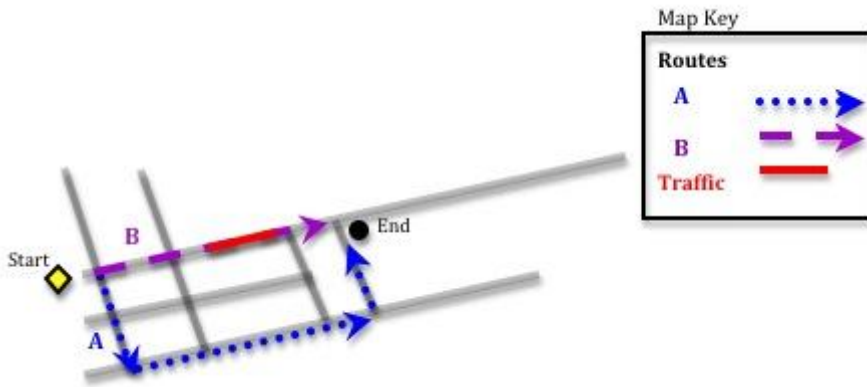
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***15. Which route would you choose?**

- A
- B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.

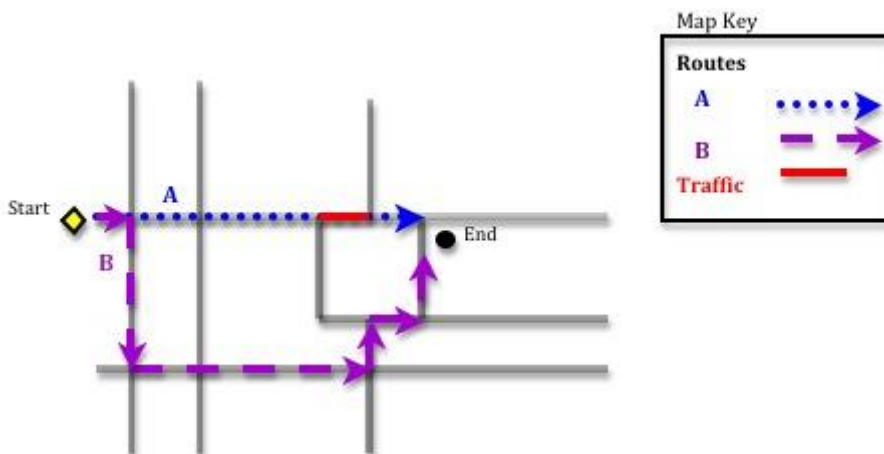


***16. Which route would you choose?**

A

B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.

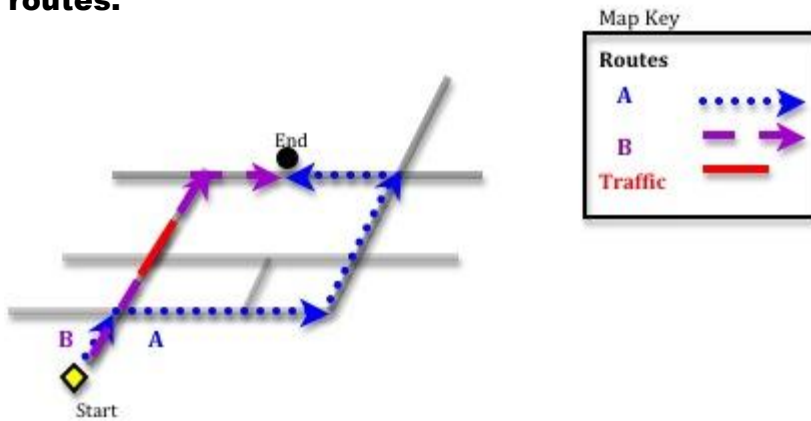


***17. Which route would you choose?**

A

B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.

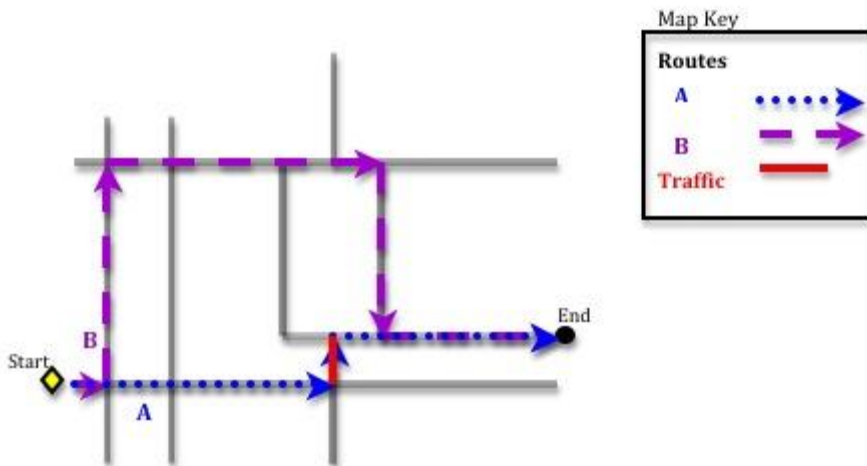


***18. Which route would you choose?**

A

B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.

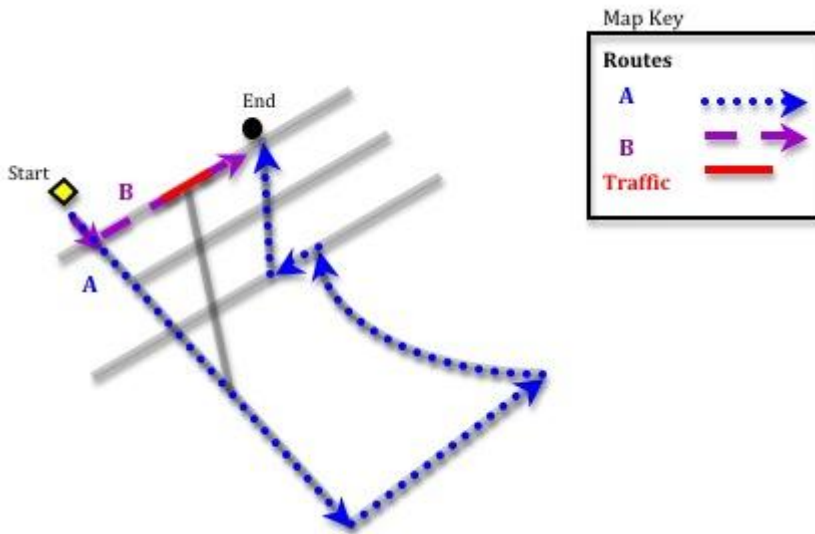


***19. Which route would you choose?**

A

B

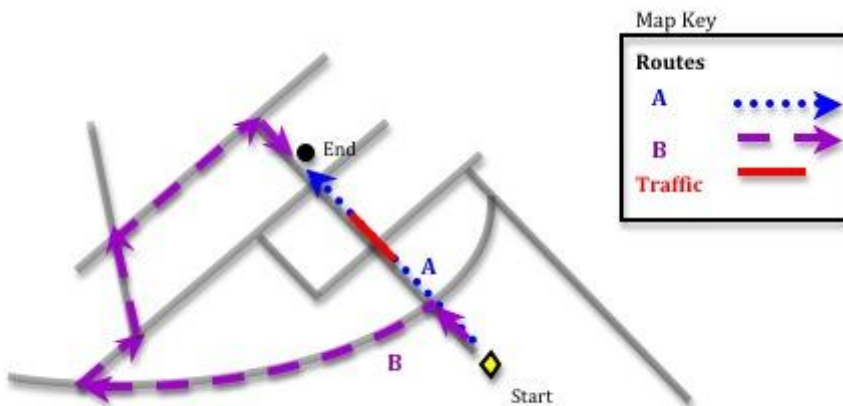
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***20. Which route would you choose?**

- A
- B

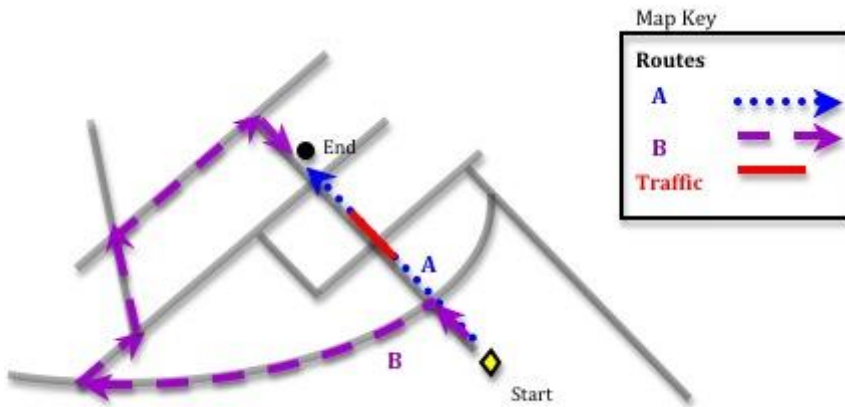
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***21. Which route would you choose?**

- A
- B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.

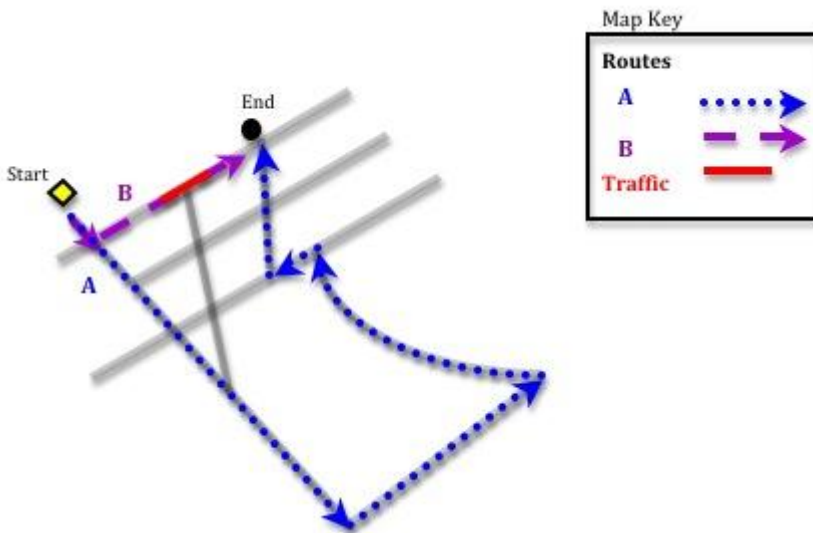


***22. Which route would you choose?**

A

B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.

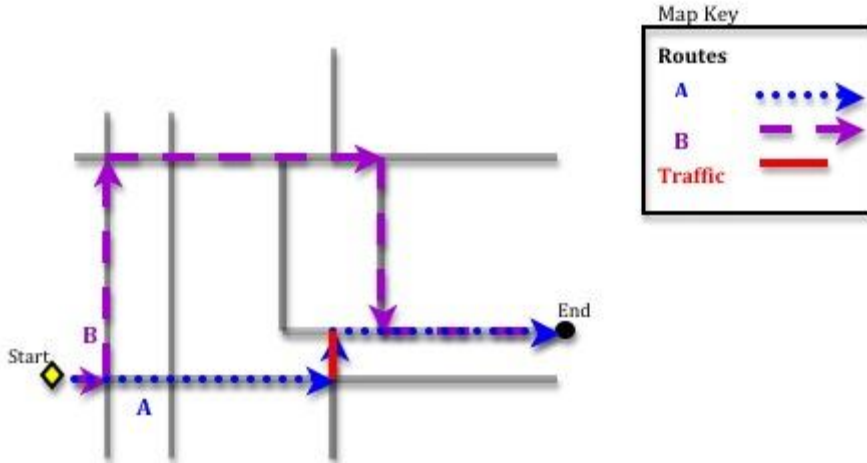


***23. Which route would you choose?**

A

B

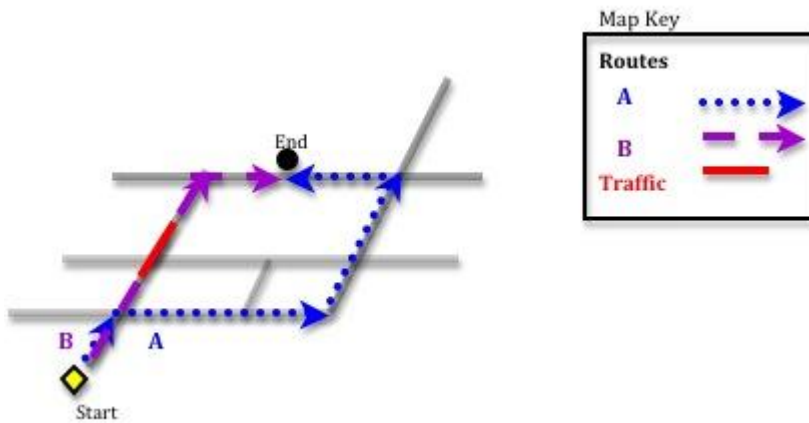
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***24. Which route would you choose?**

- A
- B

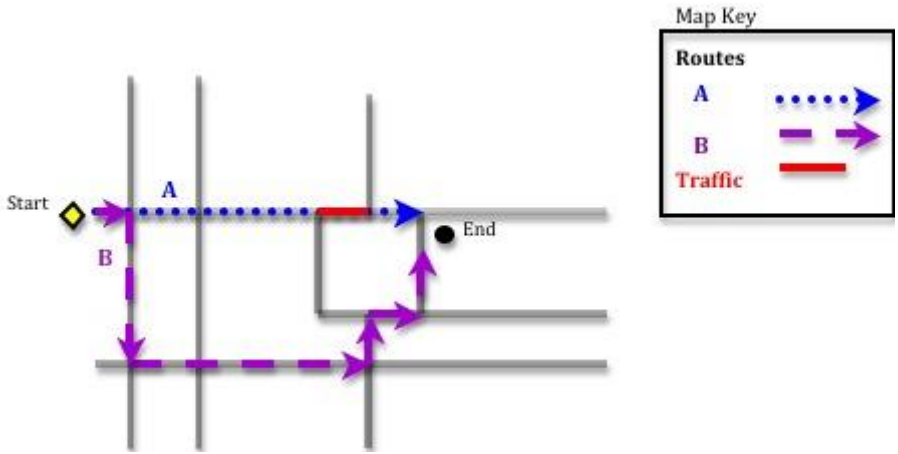
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***25. Which route would you choose?**

- A
- B

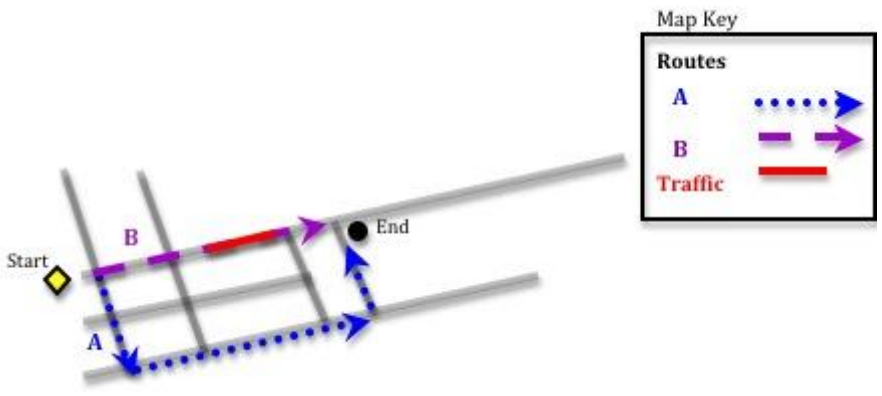
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***26. Which route would you choose?**

- A
- B

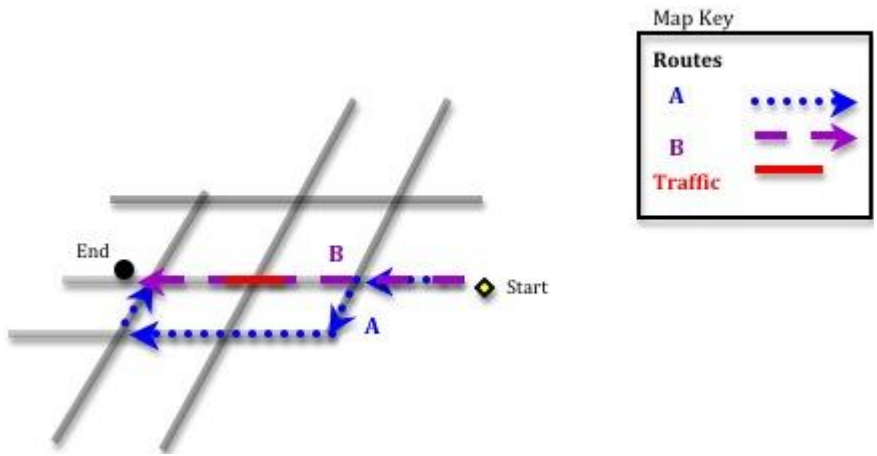
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***27. Which route would you choose?**

- A
- B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.

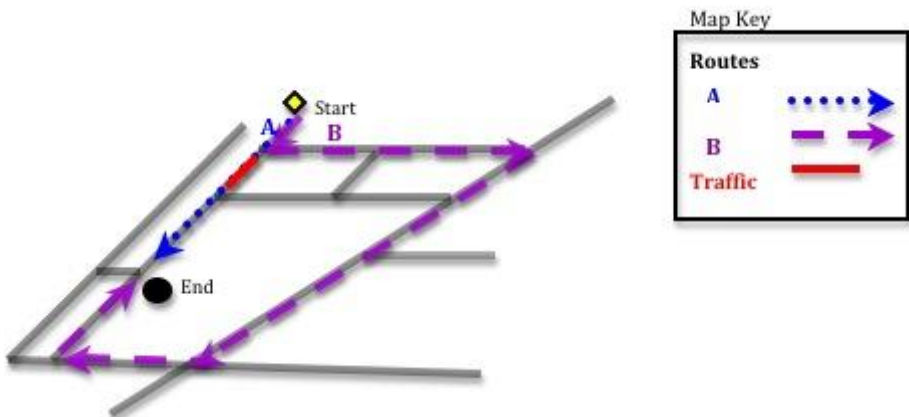


***28. Which route would you choose?**

A

B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.

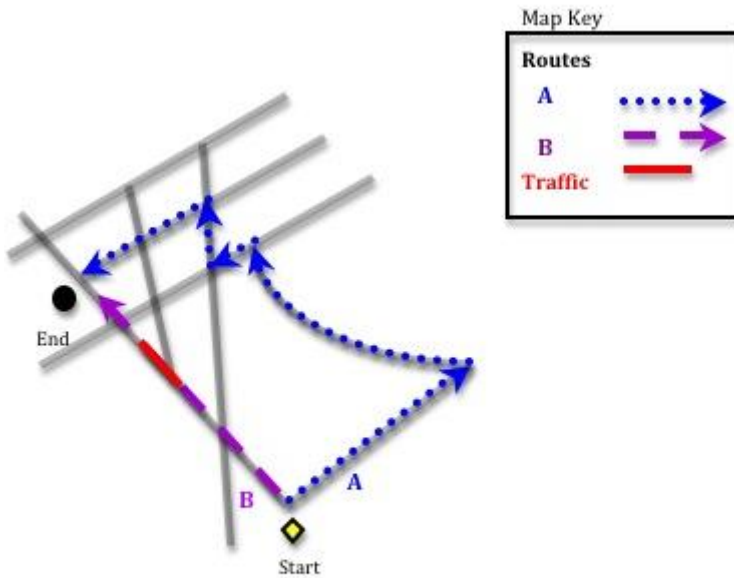


***29. Which route would you choose?**

A

B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.

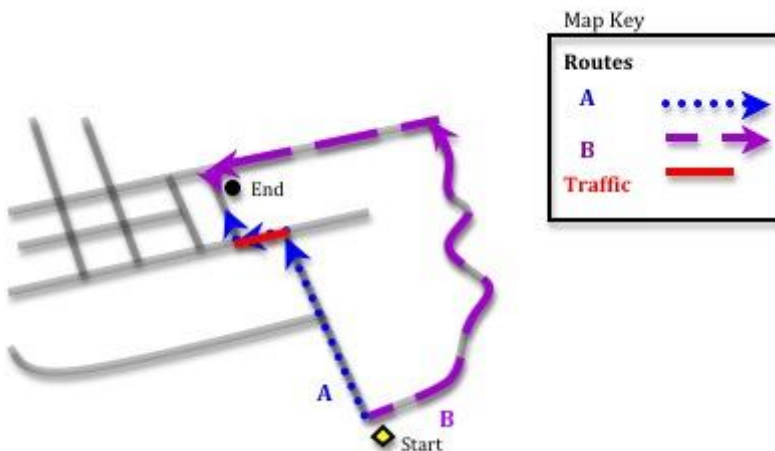


***30. Which route would you choose?**

A

B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***31. Which route would you choose?**

 A

 B

***32. What is your country of origin?**

Country:

33. What is your sex?** Male Female34. What is your age**
***35. What is your first language?**
***36. What other languages do you speak? (In order of ability?)**
***37. What is your primary method of transportation?** Bicycle Bus Car Subway/ Underground Train Walking Other (please specify)

***38. Do you come from an environment that is:**

- Mostly rural
- A small town
- A small city
- A large city

***39. How far from where you live now is the nearest supermarket?**

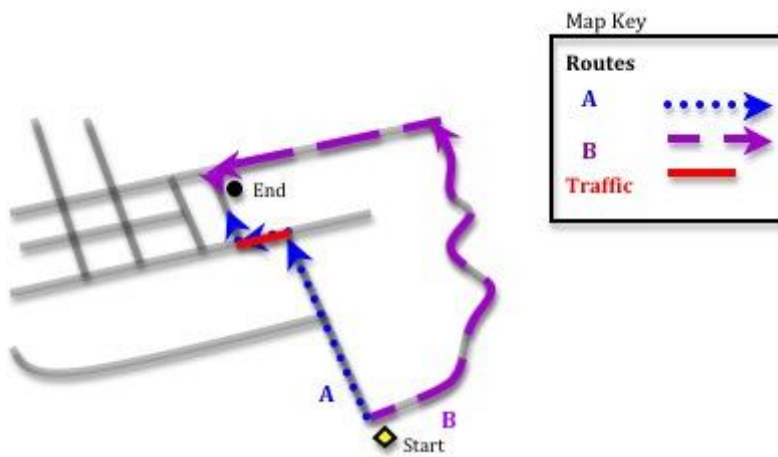
6

***40. On what day of the month were you born?**

- Even Day
- Odd Day



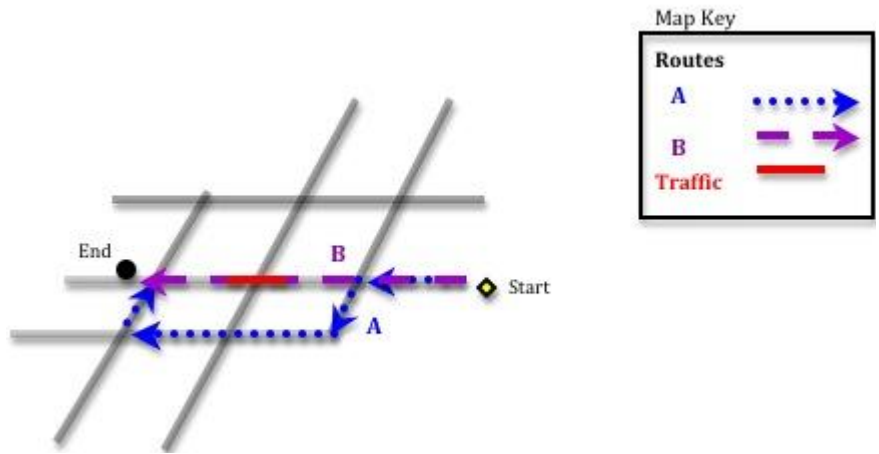
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***41. Which route would you choose?**

- A
- B

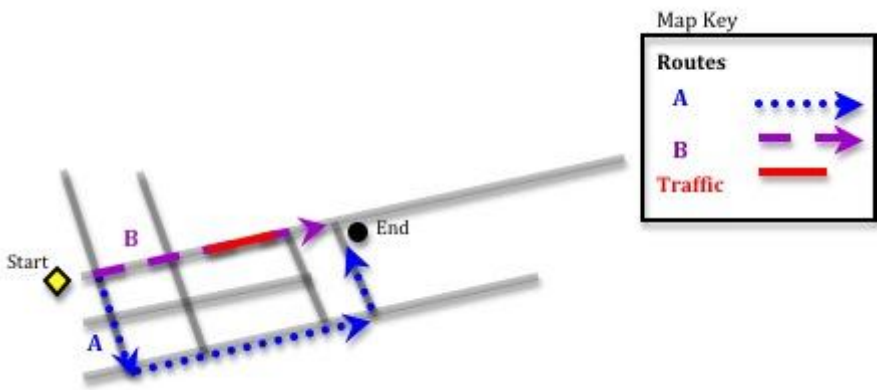
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***44. Which route would you choose?**

- A
- B

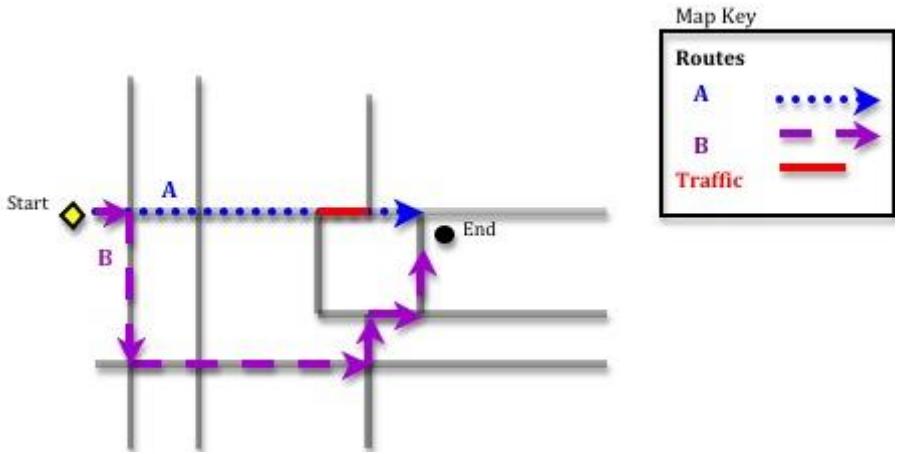
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***45. Which route would you choose?**

- A
- B

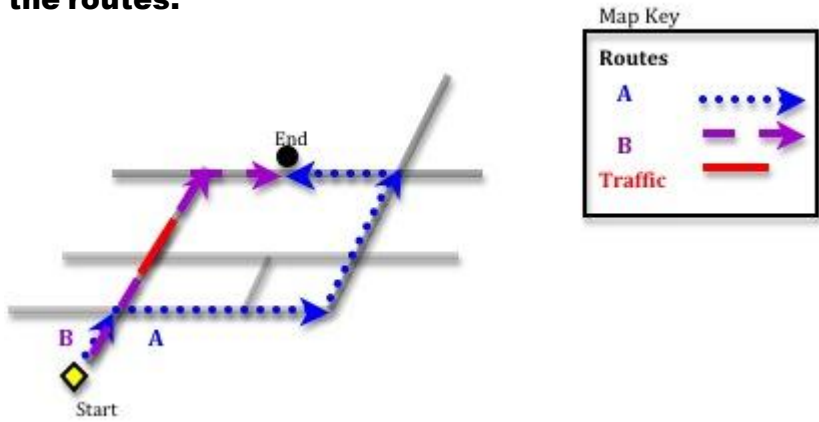
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***46. Which route would you choose?**

- A
- B

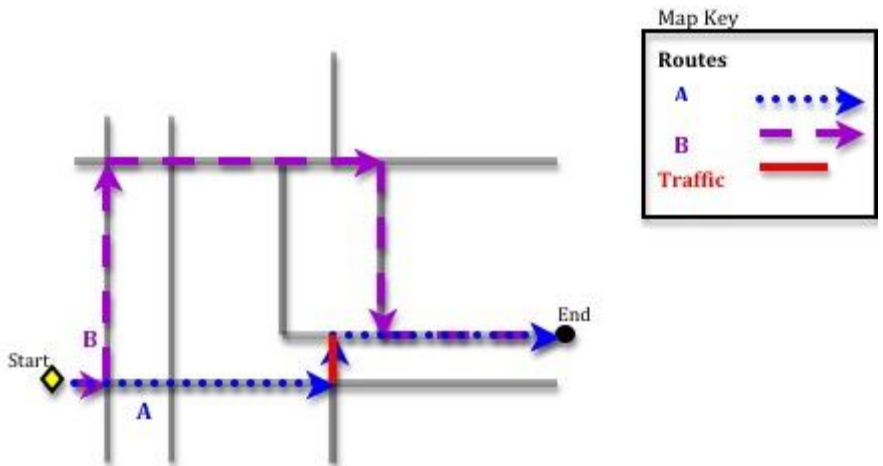
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***47. Which route would you choose?**

- A
- B

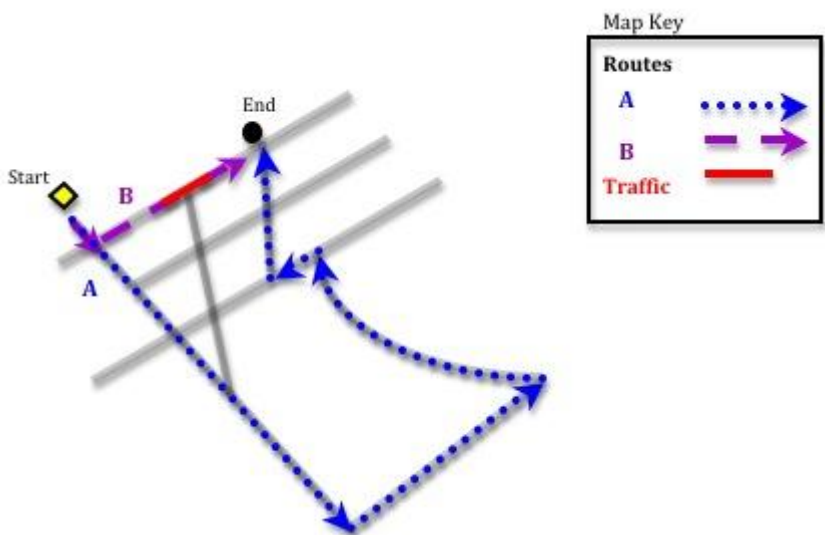
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***48. Which route would you choose?**

- A
- B

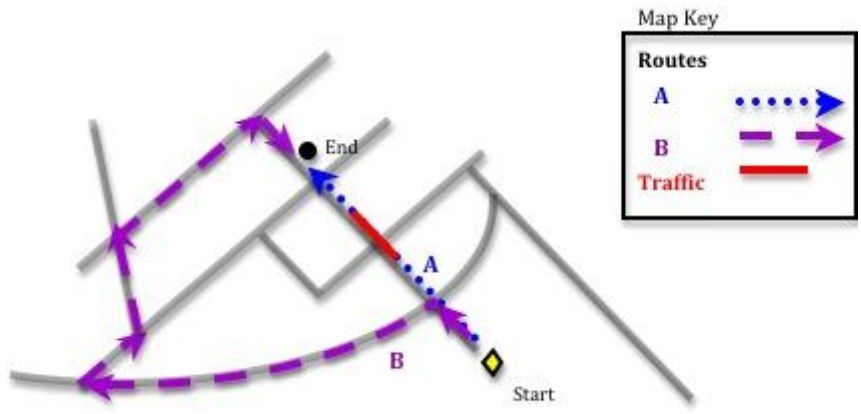
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***49. Which route would you choose?**

- A
- B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.

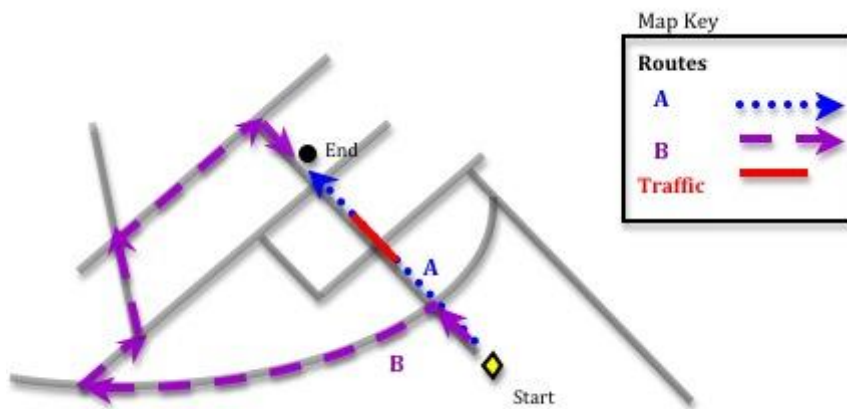


***50. Which route would you choose?**

- A
- B



The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.

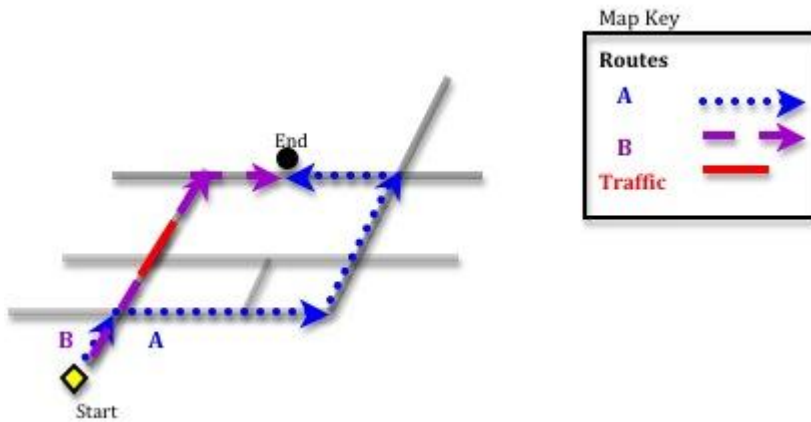


***51. Which route would you choose?**

A

B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.

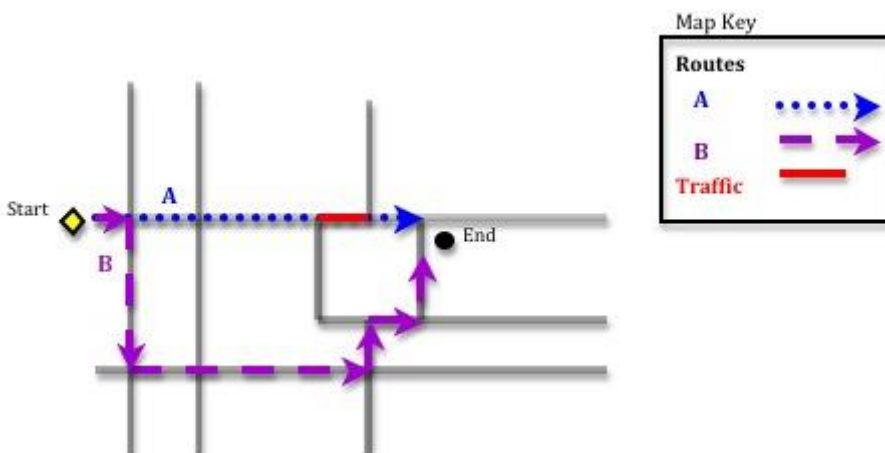


***54. Which route would you choose?**

A

B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.

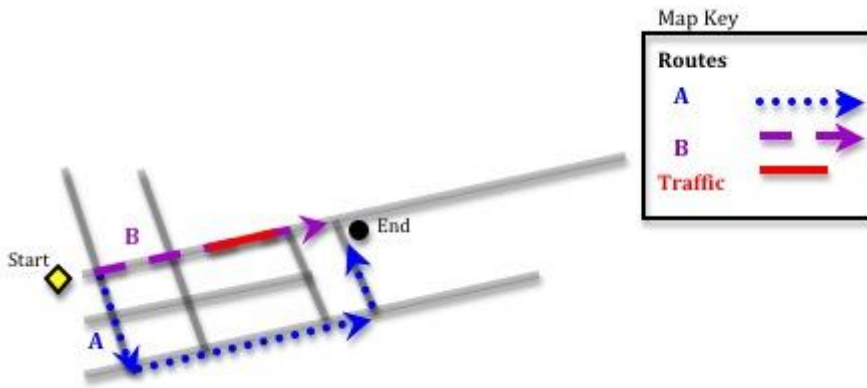


***55. Which route would you choose?**

A

B

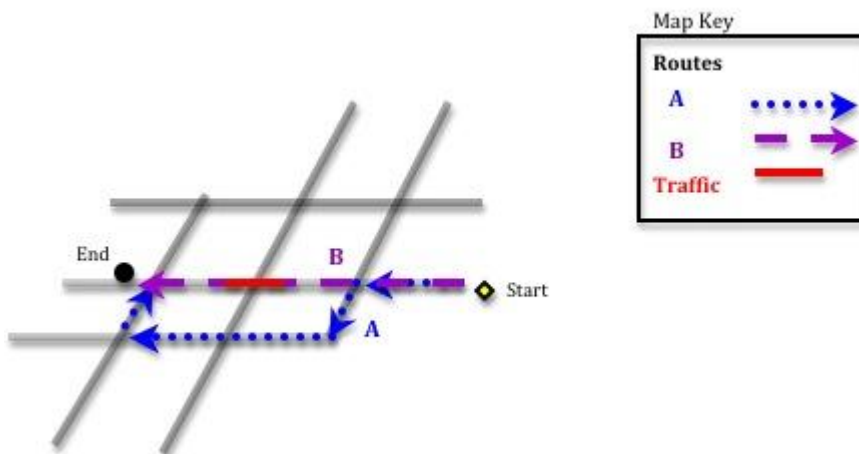
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***56. Which route would you choose?**

- A
- B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



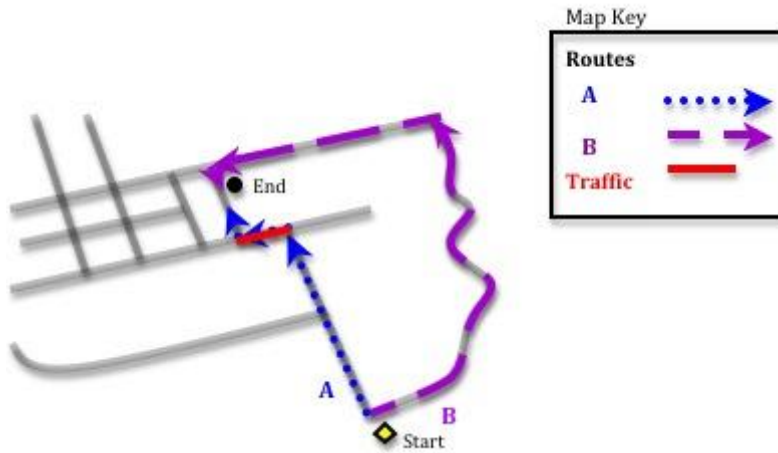
***57. Which route would you choose?**

- A
- B

***59. Which route would you choose?**

- A
- B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***60. Which route would you choose?**

- A
- B



***61. What is your country of origin?**

Country:

***62. What is your sex?**

Female

Male

***63. What is your age?**

5

6

***64. What is your first language?**

5

6

***65. What other languages do you speak? (in order of ability)**

5

6

***66. What is your primary method of transportation?**

Bicycle

Bus

Car

Subway/ Underground

Train

Walking

Other (please specify)

***67. Do you come from an environment that is:**

- Mostly rural
- A small town
- A small city
- A large city

***68. How far from where you live now is the nearest supermarket?**

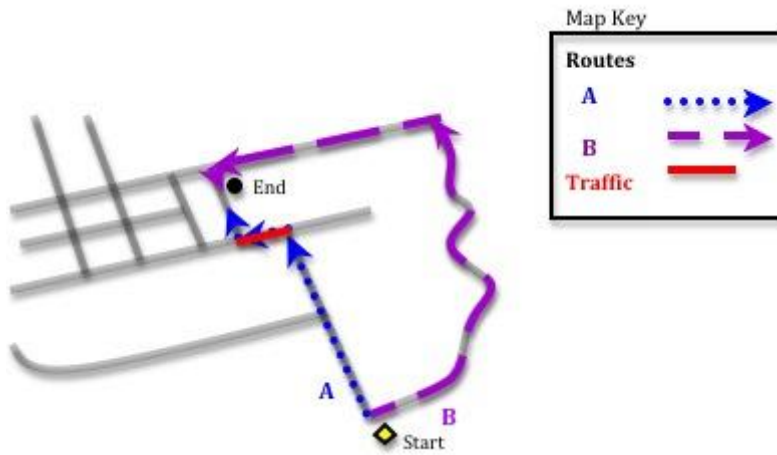
6

***69. On what day of the month were you born?**

- Even day
- Odd day



The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.

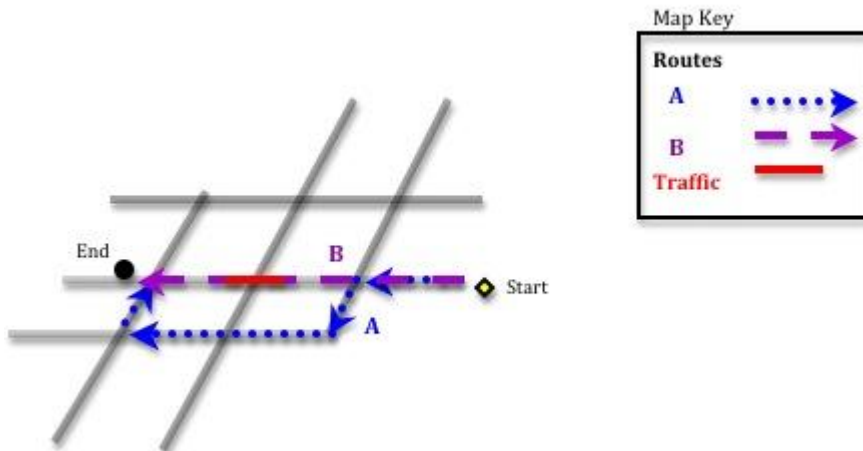


***70. Which route would you choose?**

A

B

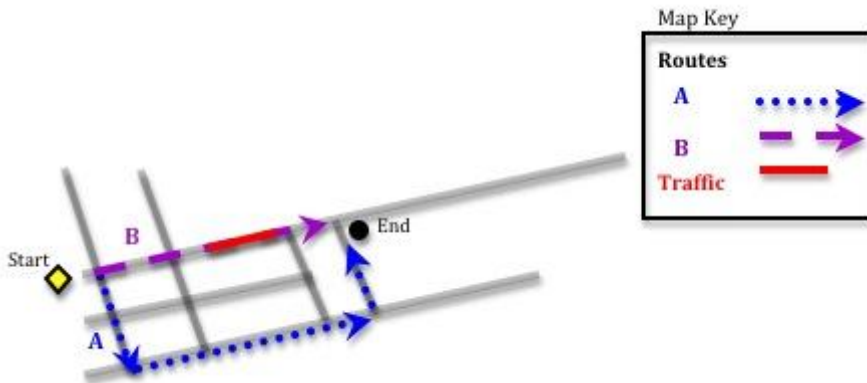
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



*73. Which route would you choose?

- A
- B

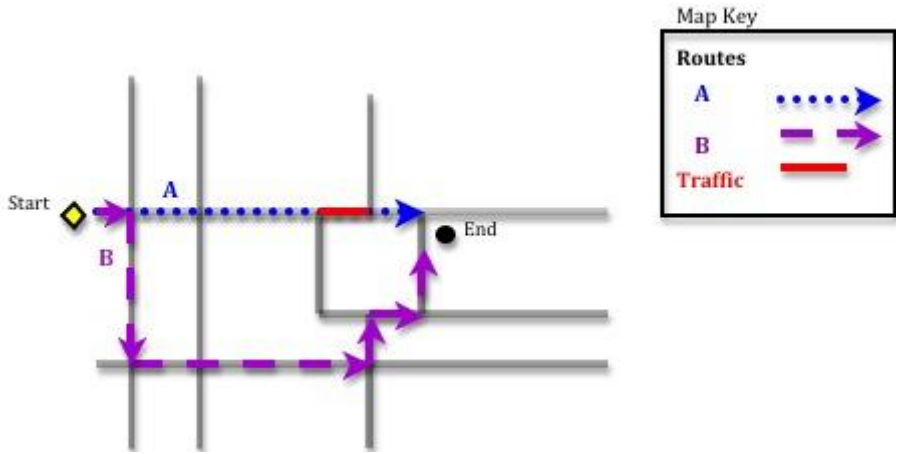
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



*74. Which route would you choose?

- A
- B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.

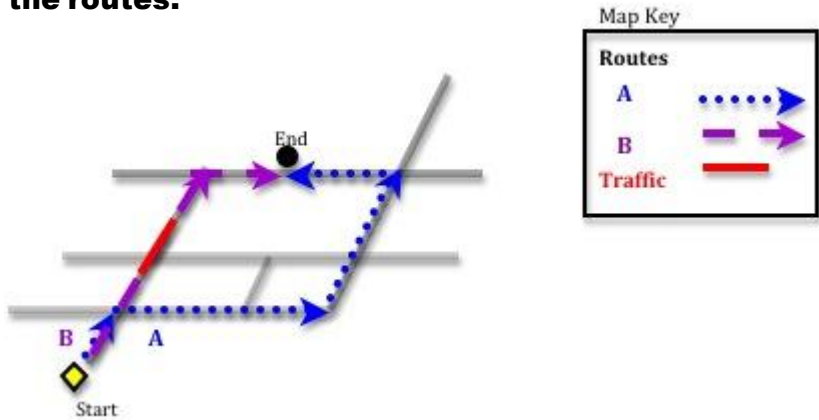


***75. Which route would you choose?**

A

B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.

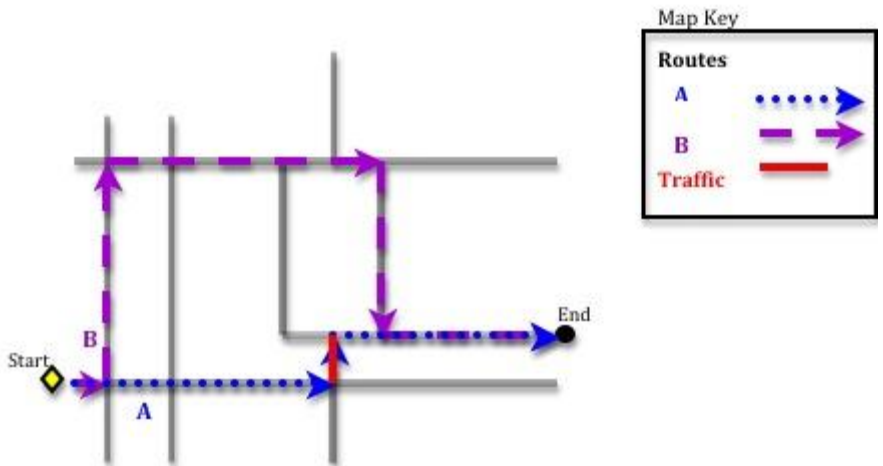


***76. Which route would you choose?**

A

B

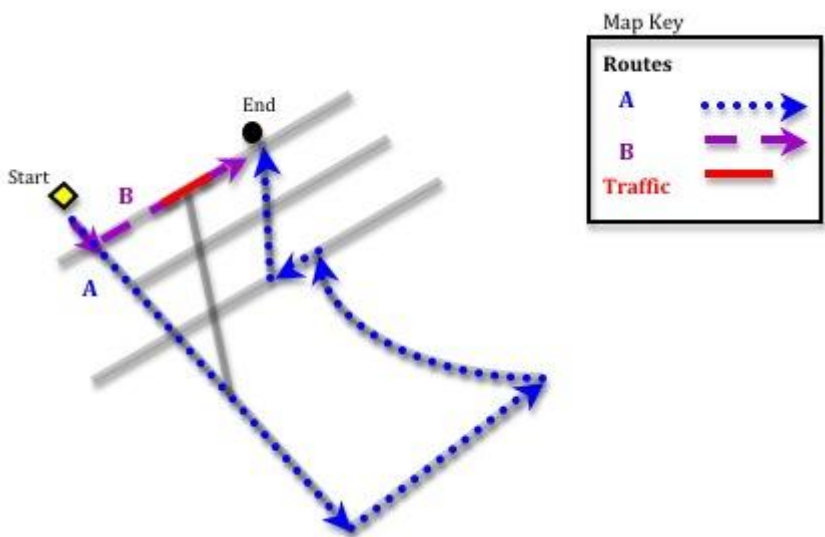
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***77. Which route would you choose?**

- A
- B

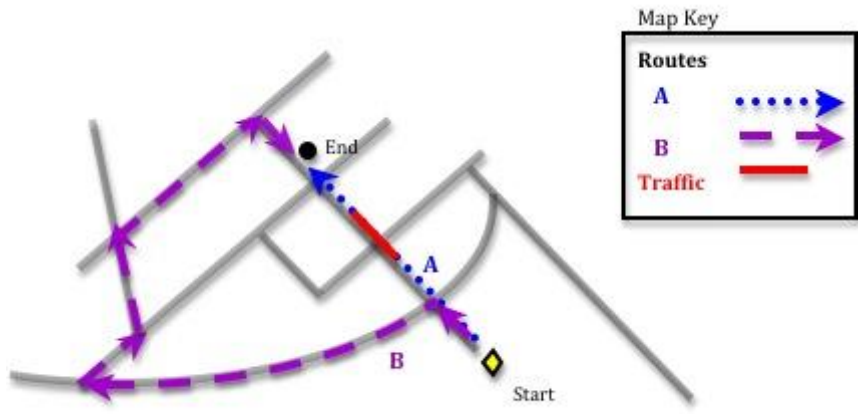
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***78. Which route would you choose?**

- A
- B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.

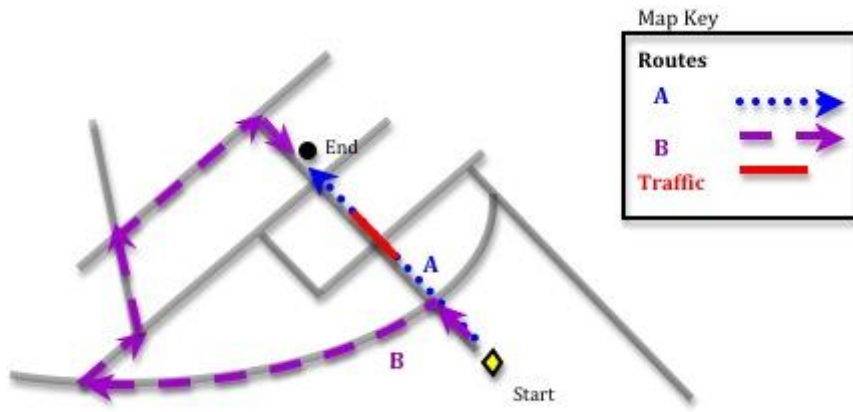


***79. Which route would you choose?**

- A
- B



The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.

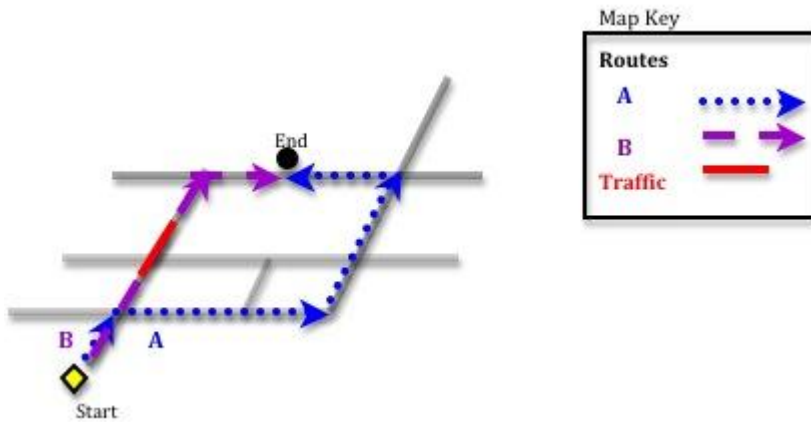


***80. Which route would you choose?**

A

B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.

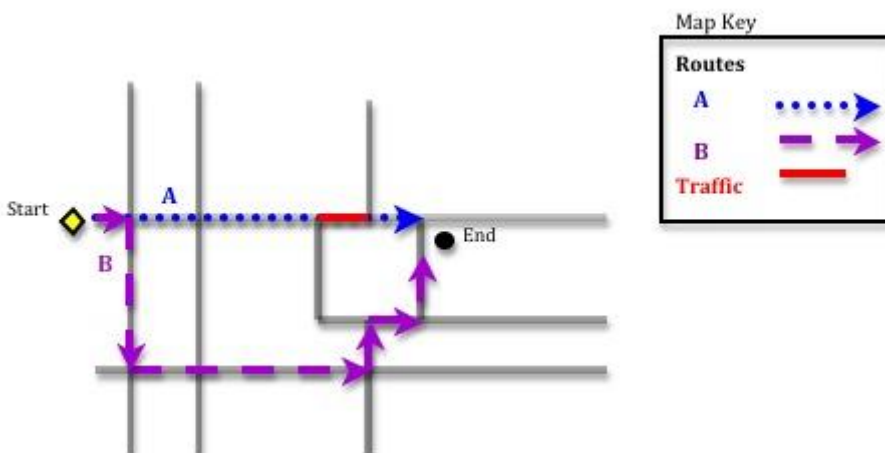


***83. Which route would you choose?**

A

B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.

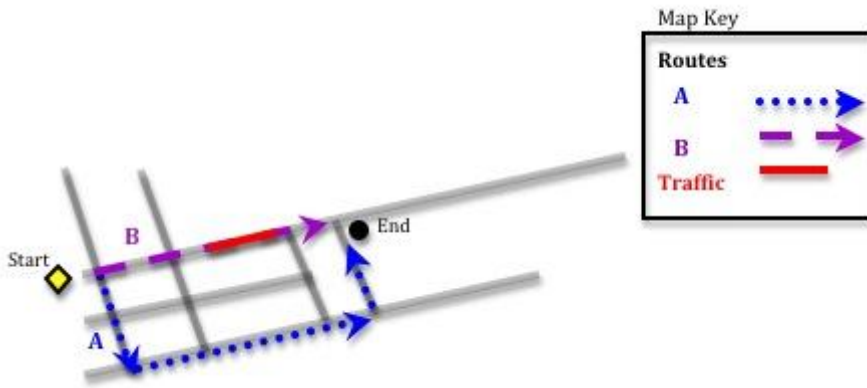


***84. Which route would you choose?**

A

B

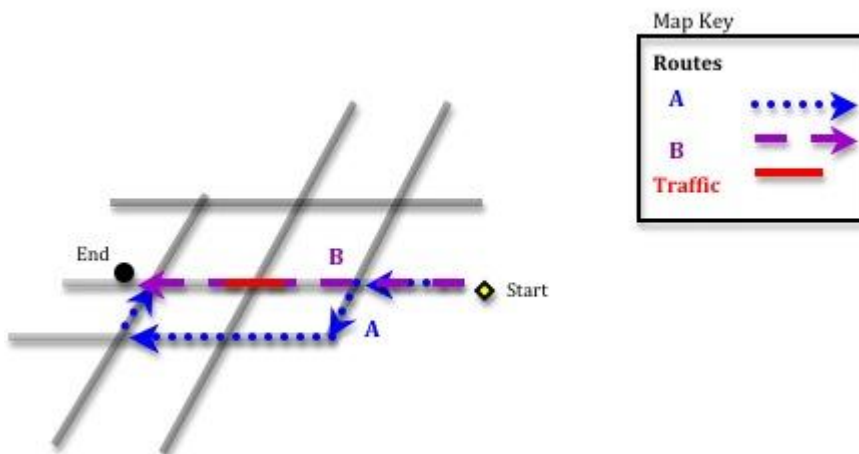
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***85. Which route would you choose?**

- A
- B

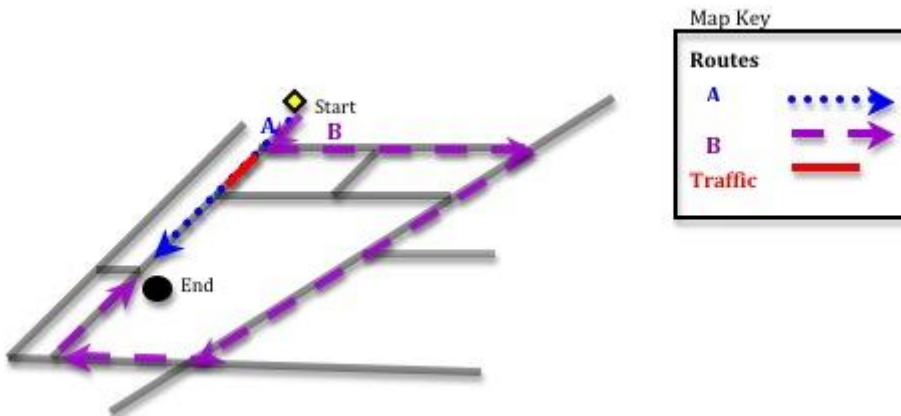
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***86. Which route would you choose?**

- A
- B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.

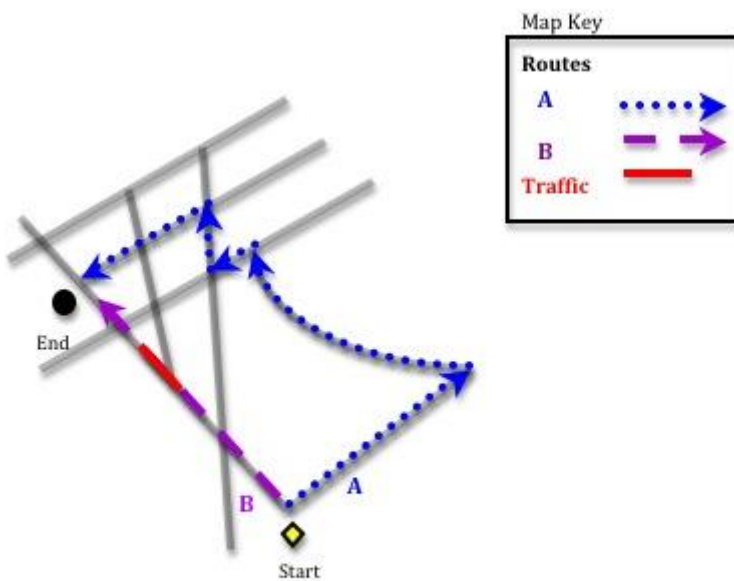


***87. Which route would you choose?**

A

B

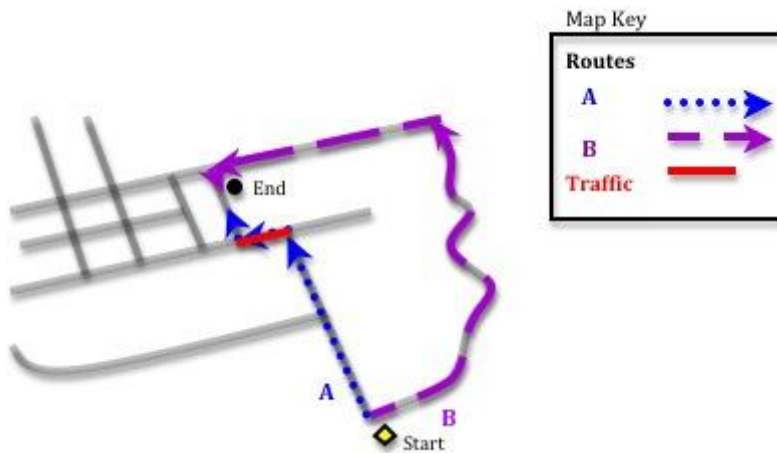
The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***88. Which route would you choose?**

- A
- B

The Blue Route [A] and the Pink Route [B] indicate two routes from a starting point to an end point destination. The red block indicates an area of heavy congestion along one of the routes.



***89. Which route would you choose?**

- A
- B

***90.**

Your completion code is: kmf0os

Please enter this completion code below, AS WELL AS in the space available on the HIT page where you accessed this study.

Thank you for your participation!

This study aimed to test whether the language that is used to describe distance (e.g., 15 minutes away vs. 1 mile away) influences individual perceptions of that distance. In addition, this study aimed to test whether the types of descriptions used to convey distances are influenced by culture.



If you have any further questions regarding the results of the study you may inquire here:
s1026816@sms.ed.ac.uk

91. If you would like to leave any feedback, please do so below. (Optional)

