Heuristic Processes During Route Planning: Race and the Southern Route Bias

An Honors Thesis for the Department of Psychology

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Abstract

Previous research has shown that when choosing between two routes of similar length on a map, individuals select the southern route, rather than the northern route, at an above-chance rate. In real world settings, non-spatial information is also involved when perceiving spatial environments. I sought to examine how a social component, information about racial categories, would interact with this proven heuristic during route planning. I hypothesized that the use of racial information would take precedence over other heuristic processes that operate during route planning, leading participants to select routes containing predominantly White residents more often than those containing Black residents, regardless of the direction of the route. Critically, I did not find a southern route bias when modifying the paradigm. However, I did find a bias on east/west dilemma trials: Participants chose western-going routes at an above-chance rate, as compared to eastern-going routes. Further, participants had a better memory for Black faces as compared to White faces, contrary to other-race effects. Implications for future research are discussed with regard to theories of navigation and spatial cognition.

Heuristic Processes During Route Planning: Race and the Southern Route Bias

The ability to perceive and act on the spatial world is essential to daily life. Individuals commute to and from work on familiar roads, follow detours to avoid accidents, and find unique shortcuts to reduce travel time. Wayfinding is the process of selecting and following a route from an origin to a destination (Golledge, 1999, p. 6). It is a complex process involving the strategic ability to map and act on the spatial environment. Thus, understanding how individuals perceive space and make decisions during navigation is essential. Importantly, Brunyé, Mahoney, Gardony, and Taylor (2010) identified a novel heuristic during route planning: During a wayfinding study, the researchers noted that participants selected the southern route, versus a northern route of equal length, at an above-chance rate. Based on this incidental finding, they hypothesized that subjects would use heuristic processes when choosing between routes of the same length. When a choice is ambiguous or unimportant, such as when choosing between two similar route options, individuals often rely on mental shortcuts to make their selections (Tversky & Kahneman, 1986). Thus, Brunyé and colleagues (2010) designed a series of studies to directly explore this preference for southern routes. These six experiments led the researchers to conclude that this preference for southern-going routes is a heuristic process during wayfinding. A subsequent study concluded that this bias was not influenced by the local topography of the area in which the study was conducted (Brunyé et al., 2012). Other researchers have identified a variety of strategies and heuristic processes that operate during wayfinding, including the initial segment and least angle strategies, suggesting that individuals systematically use a set of biases when moving through space (Bailenson, Shum, & Uttal, 2000; Hochmair & Frank, 2002). These heuristic processes enable individuals to proceed in systematic ways when understanding their spatial world and conserving physical and mental resources (Tenbrink & Wiener, 2007).

When navigating through an environment, many non-spatial cues are present (e.g., street signs, pedestrians). Accordingly, Maddox, Rapp, Brion, and Taylor (2008) examined how social categories (i.e., racial categories) influence performance on a map memory task. The researchers found that the racial make-up of neighborhoods influenced participants' performance on a person-location matching task and that subjects viewed minorities as farther away, compartmentalizing separate racial groups in space. Critically, these findings illustrate that spatial and non-spatial information *interact* during spatial memory tasks. Combining Brunyé and colleagues' (2010) southern route bias with the finding that spatial and non-spatial information interact when perceiving maps, new questions emerge. The present research examines whether adding non-spatial information to a map will affect wayfinding behavior in the context of Brunyé and colleagues' (2010) route selection paradigm.

Research predicts that adding social information to a map will change attention and processing strategies during spatial perception. First, humans are inherently social animals. Indeed, newborns visually track faces and face-like patterns as soon as 36 hours after birth, and infants as young as two months old prefer the complexity of facial features as compared to other intricate patterns (Fantz, 1961; Field, Woodson, Greenberg, & Cohen, 1982). Critically, infants are especially attentive to fearful faces beginning at five months of age, suggesting that that individuals are beginning to process danger responses, stressing the importance of in-group/out-group distinctions (Peltola, Leppänen, Mäki, & Hietanen, 2009). From an evolutionary perspective, humans are uniquely positioned for *social* communication: They developed complex emotions, rich facial muscles necessary for processing these emotions, and theory of mind to understand the intensions of others (see Brune & Brune-Cohrs, 2005, for review). Indeed, individuals evaluate others from very little information, or thin slices (Ambady, Bernieri, & Richeson, 2000). Related, framing a problem in a social manner attenuates the hypothesis confirmation bias: The Wason Selection task is easier to solve when the puzzle involves social relations (Cosmides & Tooby, 1992). Thus, if there are faces on a map, subjects will likely use that information in addition to spatial information to make navi

As stated above, Maddox and colleagues (2008) found that spatial and racial categories interact during a task of spatial memory and found race to be salient non-spatial information. Substantiating these findings, there is much evidence that implicit racial biases affect cognition in many contexts, especially when situations are ambiguous (e.g., Payne, 2011; Correll, Park, Judd, & Wittenbrink, 2002; Fazio Jackson, Dunton, & Williams, 1995). Importantly, such implicit attitudes may be working beyond one's awareness (e.g., Greenwald, McGhee, & Schwartz, 1998; Devine, 1989; Bargh, Chen, & Burrows, 1996; Moskowitz, Gollwitzer, Wasel, & Schaal, 1999; Antonakis & Dalgas, 2009). Stereotyping, based on prior experiences and mental rules, allows individuals to bridge informational gaps, but can also lead to incorrect perception (see McGarty, Yzerbyt, & Spears, 2002, for review). For example, individuals more often attribute negative characteristics to minority groups and view out-groups as more homogeneous then in-groups (Hamilton & Gifford, 1976; Judd & Park, 1988). Based on these findings, presenting racial information on a map is likely to draw participants' attention and influence their decision-making processes.

The previous discussion has presented two established biases during spatial cognition: a southern route heuristic and the interplay between spatial and non-spatial cues in map memory. Research from embodied cognition helps to explain the mechanisms through which these heuristic processes operate. Embodied cognition is the idea that high- and low-level concepts are mapped onto each other, helping humans understand new ideas and conserve mental and physical resources (e.g., Bargh & Shalev, 2011; Barsalou, 2008; Niedenthal, 2007). There is ample evidence in the realm of embodied cognition to suggest that non-spatial elements indeed affect spatial cognition. For example, Gagnon Brunyé, Robin, Mahoney, and Taylor (2011) found that spatial and social categories merge: They found that lower status people were seen as corresponding to the "down" direction. Low social power and physical direction in space are understood in similar ways. Power facilitates the attainment of group goals and the conservation of material resources. Thus, out-groups may be perceived as belonging to the "down" direction due to their perceived low social power.

This strand of research ties to the present study, explaining why southern routes might seem shorter, and thus "better," to participants. Individuals' understanding of space is rooted, or "grounded," in their bodies (see Barsalou, 2008, for review). High-level cognitive processes (i.e., thought and language) use partial reactivations of states in sensory, motor, and affective systems. Thus, thinking about the concept of anger might involve tension in muscles used to punch, activation of facial muscles to scowl, and a rise in blood pressure (Niedenthal, 2007). There are implications for spatial perception. Open, expansive versus closed, constrictive postures can *cause* an individual to experience feelings of power (Carney, Cuddy, & Yap, 2010). The practical implications of this are that being in a position that takes up space for as little as one minute can change one's physiology, one's confidence, and one's subsequent performance on evaluative tasks. Further, being physically tired changes spatial perception by making an incline appear steeper (Proffitt, 2006). This is another heuristic during route planning: When an individual does not have the energy to follow a steep path, his perception of that path is changed. Similar mechanisms may underlie the southern route bias. People may equate "down" (south) with less energy to expend, and therefore as the "shorter" or "best" route (Giessner & Schubert, 2007). Indeed, Brunyé and colleagues (2010) concluded that the southern route bias functions because, in order to conserve mental resources, individuals perceive the southern routes as "downhill."

The present study examined whether information about racial group membership would lead participants to avoid certain routes on a map-based route selection task. Specifically, would individuals use non-spatial information when perceiving and selecting routes? To test this research question, I modified Brunyé and colleagues' (2010) paradigm. They presented maps to participants with two highlighted routes. Some trials had northern- and southern-going routes and other trials had eastern- and western-going routes. The trials of interest had two routes of similar length (called dilemma trials), and filler trials contained one route that was perceptively shorter than the other (called no-dilemma trials). I modified these maps by adding Black and White residents along the routes. I hypothesized that individuals would use race to influence the selection of routes. On the no-dilemma trials, I predicted that participants would select the shorter route. Further, I hypothesized that the results of Brunyé and colleagues would be replicated: Individuals would select the southern route at an above-chance rate when choosing between southern and northern routes of similar length. Conversely, I predicted that the selection of eastern versus western routes would not deviate from chance.

I also made predictions about how race would interact with spatial perception. I hypothesized that on the east/west dilemma trials race would influence route selection so that participants would more often avoid routes with predominantly Black residents versus routes with White residents. Critically, I predicted that the southern route bias would be attenuated when the southern route overlapped with Black residents. In other words, the use of racial information would take priority over other heuristic processes used during route planning, leading participants to choose the routes containing predominantly White people more often than those containing Black people, regardless of the direction of the route. Because the goal of wayfinding is to select the quickest, easiest route, individuals might perceive the southern route as the faster one. However, they would also see out-group residents along this route on certain trials, which would implicitly signal competition, danger, or simply, “otherness” (Sherif, 1961; Schaller, Faulkner, Park, Neuberg, & Kenrick, 2004; Moscovici, 2000). Importantly, this research will lead to comprehensive theories of spatial navigation and embodied cognition, both of which are still in their infancy.

Method

Participants and Design

Eighty-nine participants completed the study: Sixty-seven Tufts University undergraduates (43 female; age M = 19.18, SD = 1.22) participated for course credit, and 22 Amazon Mechanical Turk subject (9 female; age M = 38.32, SD = 12.06) participated for monetary compensation. The total sample contained 52 females and 37 males between the ages of 18 and 59 (age M = 23.97, SD = 10.361). Due to the difficulty of recruiting an equal number of Black and White participants from the Tufts undergraduate population, only White Tufts undergraduates participated. Non-white minorities participated through Mechanical Turk.

I used a mixed-design. Route Race (2: Black and White), Route Direction (2: north/south and east/west), and Route Length (2: same and different) varied within participants. This repeated-measures design included five trial types: north/south dilemma with Black residents on the north, north/south dilemma with White residents on the north, east/west dilemma with Black residents on the west, east/west dilemma with White residents on the west, and no dilemma. I recorded which route option participants chose for each Dilemma Type (north/south or east/west) and the race of the residents along the chosen route (Black or White).

There were two between-subjects variables for counterbalancing purposes: Map Flip (2: rotated 0 and 180°) and Race Flip (2: Orientation 1 and Orientation 2). The race of the northern/western route was flipped across participants (i.e., a map with Black residents along the northern route and White residents along the southern route became a map with White residents along the northern route and Black residents along the southern route, and vise-versa; the same applies for east/west dilemma pairs).

Omission of participants. The original sample contained 108 participants, recruited through both Tufts Sona Systems and Amazon Mechanical Turk. Twelve in-lab participants and seven Mechanical Turk participants did not complete the route selection tasks and were omitted from further analysis. An attention-check question confirmed that all remaining participants were following the written directions ("Select 'yellow' from the list of colors below.").

Materials

Maps. I modeled the route selection task after Brunyé and colleagues' (2010) route selection paradigm. The researchers created two maps of real-world environments using images of Pittsburgh, PA and Chicago, IL from Google Maps™ (see Figure 1). Each map had 13 landmarks, with a legend defining each of the landmark icons. There were 20 maps for each Map Type (Pittsburgh and Chicago): Ten were dilemma maps and 10 were non-dilemma (filler) maps. Of the 10 dilemma maps, five had routes oriented north-south (north/south dilemma trials) and five with routes oriented east-west (east/west dilemma trials). On both types of dilemma trials, participants selected the "best" route from two routes of similar length. On non-dilemma (filler) trials, one route was perceptively shorter than the other. The researchers created two versions of each map (Pittsburgh and Chicago) by swapping the origin and destination landmarks (0 and 180° flip) to control for route complexity and the cardinal direction of the routes. This yielded 80 unique maps.

I adapted the maps from Brunyé and colleagues' (2010) experiments by adding social information to the routes, which yielded 160 maps. In order to examine the effect of racial information on spatial perception, each route was designated as either "Black" or "White," with one Black route and one White route per map. For Black routes, two thirds of the residents were Black and for White routes, two thirds of the residents were White (i.e., Black routes had pictures of residents along the route in the pattern Black-White-Black, and White routes had pictures of residents along the route in the pattern White-Black-

White; see Figure 2). As stated above, the race of the northern/western route was flipped across participants.

Faces. Black and White male faces were taken from the Tufts Social Cognition Lab face database. The stimuli had been pre-tested to ensure that individuals reliably perceived each face as belonging to a particular racial group (Black or White). Only race was considered when placing the faces onto the maps; orientation (i.e., facing forward or turned to the side), facial expression (e.g., smiling), and any physical characteristics other than race (e.g., hairstyle) were not considered.

Procedure

After written informed consent, participants performed all portions of the study on a computer in the Tufts Social Cognition Lab. Both in-lab and Mechanical Turk subjects accessed the entire study via an anonymous Qualtrics survey link. The cover story explained that the study examined how individuals perceived interactive maps. They were told to pay attention to the faces on the maps because their memory would be tested at the end of the study. Subjects completed two test blocks, one for each of the two maps (Pittsburgh and Chicago), in counterbalanced order across participants. First, participants had a map learning session where they saw a route-less map of either Chicago or Pittsburgh. They saw 13 maps on the screen, presented in random order, each with the instructions: “Click on the [landmark] icon to indicate its location on the map.” Participants identified landmarks on the map by clicking on them. Next, subjects performed the route selection task for the first city’s map, which consisted of 20 trials. They received 20 maps on the screen, in random order, and answered the question: “What is the best route from [origin] to [destination]?” They were told that the “best” route was the shortest and/or the fastest one. Each participant then completed another block of map learning and route selection for the second city's map (Pittsburgh or Chicago).

Each subject saw a total of 40 maps, 20 from Chicago and 20 of Pittsburgh. Together, the two route selection test blocks contained 10 north/south dilemma trials and 10 east/west dilemma trials. Half of these trials contained Black residents in the north/west and half contained White residents in the north/west. The non-dilemma conditions were not considered in the analysis. There were four between subjects conditions, with the control variables of Map Flip and Race Flip counterbalanced across participants: Twenty-two participants had a 0° flip (original orientation). Twenty-three participants had a 0° flip with Black/White routes switched from Condition 1. Twenty-one participants had a 180° flip. Twenty-three participants had a 180° flip with Black/White routes switched from Condition 3 (see Figure 3). Participants were randomly assigned to one of these between-subjects conditions with the Qualtrics randomization capability.

Finally, the facial memory task added to the cover story. Participants saw 64 pictures of Black and White faces, presented in random order: sixteen Black faces they had seen during the route selection task, 16 White faces they had seen during the route selection task, 16 Black faces they had not seen and 16 White faces they had not seen. Subjects answered the question "Did you see this face?" using a forced-choice Yes/No option (see Figure 4). Because all participants saw the same faces on the same trials, this task was the same across all subjects. Before verbal debriefing, participants submitted demographic information as part of the Qualtrics survey. They indicated gender, age, student class year, racial/ethnic identity, and whether they had been to Chicago and/or Pittsburgh. There was no time limit on any of the portions of the study.

Results

Scoring and Analysis

Quantitative measures included the selection of the best route from two map-based route options (north or south, east or west) during the route selection task and Yes/No responses during the facial memory task. For each route selection trial, participants reported which of two routes they perceived to be the "best" route. Southern/eastern routes were coded as "1" and northern/western routes were coded as "0," yielding the proportion out of 1 that participants selected the southern versus northern route and the eastern versus western route during dilemma trials. For the facial memory task, participants indicated whether they had seen a particular face ("Yes") or had not seen a particular face ("No") during the route selection test blocks. A proportion out of 1 represented the fraction of hits, misses, and correct rejections of Black and White faces for each participant. All analyses collapse across Map Type (Pittsburgh and Chicago) and Map Flip (0 and 180° rotation).[1]

Route choice. My first set of analyses determined whether the results replicated the findings of the previous study: I examined whether participants' route selection choices during north/south and east/west dilemma trials departed from chance behavior (50/50). On north/south dilemma trials, participants chose the southern route on 52.2% of trials and the northern route on 47.8% of trials (*SDs* = .17, see Figure 5). On east/west dilemma trials, participants selected the eastern route on 42.6% of trials and the western route on 57.4% of trials (*SDs* = .17).

My hypothesis was that route selection behavior on north/south dilemma trials would deviate from chance, while behavior on east/west dilemma trials would not, replicating the previous study. I found the opposite effect: A one-sample t-test comparing route selection to the test value of 50% (chance) demonstrated that participants selected the western route versus the eastern route at an above-chance rate, $t(88) = -4.19$, $p < .001$. On north/south dilemma trials, route selection choices did not depart from chance behavior, $t(88) = 1.18$, $p = .242$.

Race flip and map flip. I used a mixed design for the next set of analyses: Route Race (2: Black and White) varied within subjects, while Map Flip (2: 0 and 180° rotation) and Race Flip (2: Orientation 1 and Orientation 2) varied between subjects. A repeated-measures ANOVA revealed that Route Race and Race Flip interacted on east/west dilemma trials, $F(1, 85) = 30.17$, $p < .001$ (see Figure 6). There was no significant interaction between Route Race and Race Flip in the north/south dilemma condition, $F(1, 85) = 1.72$, $p = .194$. Further, there was no interaction between Route Race and Map Flip in either dilemma condition, allowing all analyses to collapse across Map Flip (0 and 180° rotation).

Facial memory task. Participants correctly identified Black faces they had seen on 36.9% of trials ($SD = .28$) and White faces they had seen on 27.9% of trials ($SD = .24$, see Figure 7). Participants correctly rejected Black faces they had not seen on 77.6% of trials ($SD = .23$) and White faces they had not seen on 68.2% of trials ($SD = .25$). Two paired-samples t-tests demonstrated statistically significant differences between the recognition of Black faces and White faces. Participants more accurately identified Black faces they had seen as compared to White faces they had seen, $t(86) = 4.02$, $p < .001$. Further, participants were better at identifying Black faces they had not seen as compared to White faces they had not seen, $t(86) = 4.75$, $p < .001$.

Facial memory by dilemma type. Most correlations between Face Recognition (Black and White; hit and correct rejection) and Dilemma Type (north/south and east/west; Black north/west and White north/west) were not statistically significant (all *p*s > .05). Two correlations were significant, but weak: Selection behavior for north/south dilemma trials with Black residents along the northern route showed a weak positive correlation with recognition (hits) of White faces, $r(87) = .23$, $p = .033$. Also, north/south dilemma trials with Black residents along the northern route showed a weak negative correlation with correct rejections of Black faces, $r(87) = -.22$, $p = .041$.

Discussion

This study was a synthesis of two previous strands of research, exploring heuristic processes during spatial cognition. In this mixed-design study I examined whether non-spatial information would affect spatial perception. This allowed me to replicate a previous study in the context of a new research question. I predicted that adding racial information to the maps would attenuate the southern route bias. Further, I hypothesized that subjects would avoid routes with Black residents as compared to routes with White residents. Finally, I predicted that participants would have a better memory for White faces as compared to Black faces, in line with cross-race effects (Sporer, 2001; Tanaka, Kiefer, & Bukach, 2004; Beaupré & Hess, 2006). Contrary to my hypotheses, I did not find a southern route bias: I neither found a replication of the original results of Brunyé and colleagues' (2010) route selection study nor the attenuation of the southern route bias with the addition of racial information to the maps. I did, however, find an east/west bias: Participants chose western-going routes at an above-chance rate, as compared to eastern-going routes. Related, there was an interaction between the race of the route and the flip of the race on east/west dilemma trials that was absent for north/south dilemma trials. The discussion that follows seeks an explanation for these findings, outlines the strengths of the study, and explores how the research could be improved and extended. Then, I explore the practical and theoretical significance of the present research.

I did not find a southern route bias, but did find a *western route bias*. Critically, Brunyé and colleagues (2010) found that the southern route selection bias did not operate when participants adopted an allocentric or a mixed perspective. For this reason, individuals appear to employ the southern bias during specific conditions (e.g., when adopting an egocentric perspective). The current study has shown another condition under which the southern route bias does not operate: when there is salient non-spatial information (race) on the map. However, it does not provide insight into the mechanisms under which these biases operate. There are a few possible reasons for this western route bias. First, individuals are drawn to social information, and processing goals can change how people perceive, attend to, and comprehend information (Field et al., 1982; Fantz, 1961; Aarts et al., 2004; Brune and Brune-Cohrs, 2005). That is one reason the southern bias may have disappeared: The social information could have trumped the spatial cues, altering how participants attended to the information on the map. More work must be done to outline how attention and perception change when non-spatial cues are added to the spatial cues (i.e., the 4 cardinal directions).

Further, why did a western route bias appear with the addition of new information to the map? One explanation is that the concept of west is mapped onto the concept of "left." Previously, Brunyé and colleagues (2010) concluded that misperception of north as "up" led subjects to view north as increased elevation, and therefore, a more effortful path to choose. It logically follows that individuals perceive south as less effortful. Further, work has shown that power is understood as “up” and that powerful people are associated with mountainous terrain on the Implicit Association Test (IAT), with average people facilitating IAT performance when associated with level terrain (Gagnon et al., 2011). Thus, combining directional cues with in-group/out-group distinctions could have produced a similar cognitive effect during east/west dilemma trials. Baumeister, Bratslavsky, Muraven, and Tice (1998) suggest that humans primarily function on autopilot to conserve energy and must override these automatic processes to engage in controlled action. Indeed, heuristic processes during route planning operate in order to reconcile ambiguous situations and conserve mental and physical resources (Tversky & Kahneman, 1986). Considering that individuals use heuristics to conserve mental resources, while also aiming to conserve physical resources, it logically follows that if participants perceived west as “left,” and if humans in general have a tendency to choose left over right, then the western route bias could be explained by a leftward preference.

Support for this explanation comes from the spatial framework model of three-dimensional space perception. This model posits that perception of three-dimensional space is not uniform; rather, an observer understands the canonical world as divided into one vertical and two horizontal dimensions: up/down, front/back, and left/right (Franklin & Tversky, 1990). Critically, the perception of the spatial world is biased by this organization. For example, when locating an object in space, reaction times are faster in the up/down dimension as compared to the left/right dimension because the left/right dimension changes as the observer moves through space. According to this previous research, if north and south are understood as up and down, it follows logically that east and west are understood as left and right. Building from this, a western bias could be understood as a leftward bias.

Indeed, many studies point to a leftward bias in visuospatial perception. First, humans more often attend to the left side of space, as illustrated by psychometric line bisection and line cancellation tasks (Uttl & Pilkenton-Taylor, 2001; Bottini & Toraldo, 2003; Longo and Lourenco, 2007). One explanation of this leftward shift in attention is that the right hemisphere of the brain is dominant in the control of attentional resources (Posner, Inhoff, Friedrich, & Cohen, 1987; Nobre et al., 2004). Evidence for this comes from studies of patients with hemispatial neglect (Heilman & Valenstein, 1979; Rossetti et al., 1998). Healthy individuals also exhibit pseudoneglect: Longo and Lourenco (2007) found that individuals showed a leftward bias when estimating the distance between two numbers (i.e., bisecting a *mental* number line). On a conceptual level, time is mapped onto space in the horizontal dimension, from left to right, and humans use a mental number line, situated from left to right, to understand and manipulate numbers (Lakens et al., 2011; Dehaene, 1997). Such findings partially explain a *western route bias* if subjects map west onto the concept of "left" in the horizontal dimension, just as they mapped north onto the concept of "up" in the vertical dimension.

If one now assumes a leftward bias, why was there a heuristic process operating in the horizontal dimension, but not in the vertical one? Participants showed no overall preference for Black or White routes, so racial information alone did not affect this bias directly. However, the southern route bias may have been attenuated because maps in the present study included non-spatial cues, providing more information for subjects to draw upon. When human faces were added to the map, it may have changed which information was more salient. With few cues, participants may use cardinal direction to help them make the ambiguous route choice, but when there are faces, specifically faces of different racial groups (in-group and out-group), attention may be drawn to this information. As stated previously, humans are predisposed to attend to human faces and social information. As one of many examples, the classic study by Heider and Simmel (1944) illustrates that people anthropomorphize objects, perceiving moving geometric shapes as having intentions and a guiding narrative. In the absence of such opportunities, subjects chose the southern versus northern route, but in this study there was a human component.

Further, when more information was added to the map in the present study, the search strategy and subsequent selection of information for further processing could have been altered. Several theories delineate how individuals attend to visuospatial cues. For example, feature integration theory is an early selection theory, assuming that individuals perceive low-level perceptual features and select a subset of information for further processing based on visual scanning and implicit selection criteria (see Ward, 2006, for review). In contrast, late selection theories such as negative priming posit that individuals process incoming information to the level of semantics before selecting information for further processing. Perceptual load theory reconciles these two models of selective attention: Individuals ignore stimuli unrelated to the task if there are a lot of irrelevant stimuli (Lavie 1995; Lavie, Hirst, de Fockert, & Viding, 2004). However, if there are a small amount of irrelevant stimuli, individuals process both task-related and non-task related stimuli as relevant. Thus, when social information was added to the map in the present study, attention allocation may have shifted. Because there was a manageable amount of social stimuli (i.e., six faces per map), subjects could have processed the racial information, in addition to the spatial information, shifting the heuristic processes operating during the task. More research should be done to determine how a change in such strategies would lead to a bias in the horizontal dimension and no bias in the vertical dimension

In this study, as well as in the previous study, the flip of the map did not affect route selection behavior (Brunyé et al., 2010). However, the flip of the racial information, a between-subject control variable, significantly affected results: Route selection changed as a function of Race Flip on east/west dilemma trials. In the north/south dilemma trials, a similar pattern emerged and was approaching significance. One explanation is that routes were not perfectly north/south or east/west. This made the routes more realistic, as they were from a map of a real-world environment, but this could have affected results. A future study could explore whether Race Flip would interact with Route Race when the routes are symmetrical (i.e., mirror images).

Further, participants accurately identified Black faces as compared to White faces. Based on other race effects, I would have predicted that participants would have better memory for in-group (White) faces. Because participants showed both hits and correct rejections of Black faces, the results were not due to a response bias (see signal detection theory; Green & Swets, 1966). One explanation is that faces of minorities commanded more of participants' attention, and this led to better memory. Indeed, racial information is salient and more salient faces have been shown to draw more attention (Light, Kayra-Stuart, & Hollander, 1979). Further, untrustworthy faces are better remembered than trustworthy faces, perhaps because these faces produce more vigilance and fear (e.g., Oda, & Nakajima, 2010; Mealey, Daood, & Krage 1996; Barclay & Lalumiere, 2006). For this reason, out-group faces could have been perceived as untrustworthy and to-be-avoided.

Additionally, out-group faces could have been seen as more rare and thus, more salient (e.g., Barclay, 2008). For such reasons, participants could have paid more attention to out-group (Black) faces, and these faces could have been better remembered.

There were many strengths in the current study. First, this study had good theoretical underpinnings and was well conceptualized: It was rooted in previous research that established a new heuristic during spatial navigation. It sought to extend this finding by making a controlled change to a previously used paradigm, the route selection task. This aided in the creation of materials. Because the maps were previously used, this limited the manipulation to simply the racial information. Further, the data analysis followed Brunyé and colleagues' process closely. Further, the cover story worked: Informal debriefings of participants revealed that they believed the memory task was the task of interest and that the map task was the cover. Finally, the study was well controlled. All test items were randomized, and two between-subjects variables were added to control for map orientation and the position of Black and White residents on the map.

A final strength is that the study provided an elegant way to do new research and simultaneously replicate existing research. The issue of misrepresenting research is a hot topic in the field of psychology. The need for exciting research drives scientists to strive to produce dazzling paradigms and groundbreaking results. Simmons, Nelson, and Simonsohn (2011) demonstrated the ease of manipulating data to produce a significant result where one does not exist. Other researchers have begun to question the validity of research findings (e.g., Ioannidis, 2005; Draghici, Khatri, Eklund, & Szallasi, 2006; Asendorpf et al., 2012). As the above issues are gaining more attention, researchers and academics have begun to consider possible solutions. In response, replicability was a major theme at the

Association for Psychological Science (APS) conference this year (APS, 2013). Critically, there has been debate on both sides. Some researchers state the focus on replicability is over-zealous and the concern over methodology issues is overblown (e.g., Pashler & Harris, 2012). These researchers argue that conceptual replications are common and, arguably, more valuable than direct replications. Regardless of which side is correct, being honest about what goes wrong, shedding light on where theories *do not* lead to a replication, and continuing theory development remain major goals of research in the social sciences.

By examining the methodological issues present in this study, a more honest picture comes to light. Limitations of the present study center on the point that I used Qualtrics, instead of SuperLab, to create the survey. In the previous study, the southern route bias was only found when participants adopted an egocentric, versus mixed or allocentric, perspective. Participants adopted varying perspectives by verbally describing their route choice to the experimenter. In the present study, participants did not describe the route and were not forced to follow it using certain kinds of language (e.g.," north"/"south" for allocentric; "forward"/"back" for egocentric). Participants did not verbally report the route because this study dealt with racial prejudice. To avoid participant discomfort and increase the likelihood of unbiased responses, no experimenter was present during the experimental tasks. Instead, textual instructions at the beginning of the study asked subjects to adopt an embedded perspective. If this study were redesigned, one question could be added to the end of the survey asking subjects which set of terms best described their inner monologues as they performed the route selection task (e.g., forward, back; north, south; mixed).

Further, Brunyé and colleagues (2010) included a two-minute period during which participants familiarized themselves with the maps. Then, the experimenter verbally probed the participants for landmark knowledge. In the current study, landmark knowledge was tested on the computer screen and the participants clicked the landmark to identify it. This required some data to be thrown out because some participants did not complete this task. If an experimenter had been present to administer this portion verbally, more data could have been used. Furthermore, there was no reaction time data collected. This would have provided better control to ensure that participants completed the tasks in a timely fashion.

In future studies examining race and spatial cognition, race could be manipulated differently. The facial memory task performance functioned as a partial manipulation check, especially because informal debriefings revealed the participants believed that the facial memory task was the task of interest. However, the results of this study were contrary to all hypotheses. To improve the manipulation of race along the routes, Black routes could have contained all Black residents and White routes could have contained all White residents. Subjects believed the cover story, so there was no need to worry about transparency of the research question. Having only two thirds of the residents of the race of interest along each route could have failed to manipulate race. This may have especially been the case in north/south trials: Heuristically, north is “up,” so the resident in the middle may have been elevated in the participants’ minds (Gagnon et al., 2011; Giessner & Schubert, 2007). On Black trials, a White resident was in the middle, meaning that a White resident may have been remembered on Black routes (and vise versa for White routes). In future studies, instructing subjects to form an impression of the people associated with each location, similar to Maddox and colleagues' (2008) paradigm, would also better manipulate race. The cover story could be one about understanding the racial demographics of cities and towns. This would require subjects to attend to and process the racial information. Such changes could shed more light on the results of the current study.

The involvement of new technology will continue to provide new directions for research. Using real world environments was a strength of this study. When exploring research questions of spatial perception and navigation, virtual reality and the use of real-world environments adds to mundane realism and ecological validity (e.g., Spiers & Maguire, 2011; Dotsch & Wigboldus, 2008; Custers & Aarts, 2003; Viard, Doeller, Hartley, Bird, & Burgess, 2011; Morgan, MacEvoy, Aguirre, & Epstein, 2011). In the future, adding more information to maps will better approximate real world environments. Further, allowing participants to explore maps in a virtual way will better simulate realistic locomotion. It remains to be seen whether such heuristics (e.g., southern and western route biases) will operate in virtual environments.

In addition, the IAT is a useful tool for measuring implicit racial attitudes (Greenwald et al., 1998). As previously discussed, Gagnon and colleagues (2011) found that social power is mapped onto space. This points to new uses of the IAT. As discussed by Greenwald and colleagues (1998) in their original paper establishing the paradigm, the IAT can be adapted to explore any pairs of semantic concepts. For example, one could test racial attitudes (Black and White) on the dimension of safe-dangerous, examining the difference in reaction times when each race is paired with each safety dimension. A bigger gap would point to a larger relative effect. Further, the IAT is especially effective in investigating racial attitudes because this tool resists self-presentation forces and cannot be controlled easily, unless subject slow down task completion (see Fiedler & Bluemke, 2005, for review). This would eliminate one limitation of the study, the manipulation of race in such a way as to avoid self-presentation concerns inherent in research on stereotyping. Future studies could examine how implicit racial attitudes, as measured by the IAT, correlate with route selection performance.

Brunyé and colleagues (2010) concluded that the southern route bias functions because, in order to conserve mental resources, individuals perceive southern routes as "downhill." This suggests a grounded representation of space (see Barsalou, 2008, for review). The idea that higher-order concepts are mapped onto lower-order ones is a huge paradigm shift in the field of psychology and therefore important to explore. As stated above, the degree of pseudoneglect in physical perception correlated with the degree of leftward bias in the mental bisection of the number line (Longo & Lourenco, 2007). Thus, this hemispheric asymmetry biased both physical and mental space perception. Future research could pair the route selection task with line bisection tasks to examine whether the degree of pseudoneglect (i.e., a hemispheric asymmetry in the perception of space) predicts route selection behavior on east/west dilemma trials. A positive correlation between number of western routes chosen and degree of leftward bias on line bisection tasks would provide more evidence for the western route bias as a product of greater attention paid to the left side of space.

Further, much like a cognitive load, an "embodiment load" could alter performance on the route selection task. Spatial perception is affected not only by external reality, but also by the internal goals and mental state of the perceiver. Researchers have demonstrated that individuals perceive desirable objects as physically closer, and subjects over-toss a beanbag when they are mentally weighed down by a secret (Balcetis & Dunning, 2010; Slepian, Masicampo, Toosi, & Ambady, 2012). Indeed, research has shown that carrying a heavy backpack makes a path appear longer, perhaps because the metabolic cost to travel the path would be greater with the extra load (Proffitt, 2006). Thus, if participants performed the route selection task, following Brunyé and colleagues' (2010) paradigm, wearing a heavy backpack, the southern route bias may be even more pronounced, versus attenuated. Such extensions would delineate the mechanisms underlying the southern route bias and other heuristic processes during wayfinding.

Another extension involves an embodied priming task. Humans associate in-groups and out-groups with the concepts of approach and avoidance. Individuals are more willing to approach those they perceive as similar and avoid those they perceive as different (see Elliot, 2006, for review). Priming approach-avoidance motivations with arm extension for approach and arm flexion for avoidance affects ratings of liking and perceptions of trustworthiness (Cacioppo, Priester, & Berntson, 1993; Slepian, Young, Rule, Weisbuch, & Ambady, 2012). Priming with approaching in-groups and out-groups may further shift the biases during route planning, leading subjects to choose Black/White routes if subjects are primed to mentally approach Black/White actors.

Further, in order to delineate the mechanisms underlying heuristics during navigation and to root theories of navigation in neurobiological findings, future studies should examine the activation of subjects' motor cortices during this route selection task. For example, do individuals perceive northern versus southern routes differently on the motor level? Multiple studies have found that individuals show motor simulation when perceiving, remembering, and planning action: An MEG study found that when individuals read head- and arm-related words, the motor cortex was somatotopically activated; TMS over motor areas affected word processing of action verbs; and when reading about sports, professional athletes simulate more actions than do novices (Pulvermüller, 2005; Weiss et al., 2013; Barsalou, 2008). Such studies would predict that participants would equate southern routes with the down direction on the neurological level. Further, their brain activation may mimic activation when traveling downhill. Future research can answer these and other questions.

Related, there is more research to be done to explain the neurobiology of spatial navigation. Tolman (1948) proposed that animals use a metaphorical *cognitive map* during navigation/wayfinding, and O'Keefe & Nadel (1978) rooted this theoretical concept in a neurological substrate, the hippocampus. Indeed, there are navigation-related structural changes in the hippocampi of London taxi drivers, and the avian hippocampus enlarges in food-storing birds (Hampton, Sherry, Shettleworth, Khurgel, & Ivy, 2008; Woollett & Maguire, 2011). There has been renewed interest in spatial navigation after the discovery of place cells in rats and in humans (e.g., Best, White, & Minai, 2001; Jeffery, 2007; Hayman, Verriotis, Jovalekic, Fenton, & Jeffery, 2011; McNaughton, Battaglia, Jensen, Moser, & Moser, 2007; O'Keefe & Dostrovsky, 1971). Maddox and colleagues (2008), together with the findings of the present research, illustrated that non-spatial information changes how individuals perceive space. Because humans are not unbiased perceivers, researchers should look beyond the sensory modalities to examine what kinds of information affects spatial perception on the cellular level. Place cells use three main types of information: ideothetic cues from self-motion, distance information (metric), and contextual information (e.g., wall color; see Jeffrey, 2007, for review). Critically, place cells respond to non-metric (*contextual*) information. This finding parallels the use of non-spatial (*contextual*) information during route selection. Context can denote the external environment, but it can also relate to the internal state of the animal. For example, the motivational state of an animal changes how place cells fire. In one study, when moving toward a reward some place cells changed with the changing location of a reward, such a food or water (see Best, et al., 2001, for review). In general, when a salient change is made in the environment place cells "remap:" Some stop firing, some silent cells begin to fire, and others change their fields. Taken together, the present study illustrated that, behaviorally, non-spatial information affects spatial perception, and studies have shown that non-spatial information also affects spatial perception on the cellular level. More work can be done to understand how non-spatial cues in the environment influence spatial perception on the behavioral and cellular levels.

In conclusion, when racial information was added to Brunyé and colleagues' (2010) route selection paradigm the southern route bias disappeared, and a western route bias appeared. Future research is needed to outline the conditions underlying different heuristics during wayfinding. Embodied cognition is a parsimonious explanation of how individuals understand the world, and heuristic processes during navigation save time, energy, and cognitive resources. It logically follows that individuals would use both spatial and non-spatial cues when perceiving and navigating the environment. The ultimate goal with this strand of research, and research in general, is for all evidence; behavioral, neurobiological, and theoretical; to develop in parallel and ultimately converge.

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Footnotes

[1]An analysis of all-White participants (*n* = 81) produced similar results. A one-sample t-test comparing route selection to the test value of 50% (chance) demonstrated that participants selected the western route versus the eastern route at an above-chance rate, $t(80) = -3.83$, $p < .001$. On north/south dilemma trials, route selection choices did not depart from chance behavior, $t(80) = 1.36$, $p = .179$. On north/south dilemma trials, participants chose the southern route on 52.6% of trials and the northern route on 47.4% of trials (*SDs* = .17). On east/west dilemma trials, participants selected the eastern route on 42.6% of trials and the western route on 57.4% of trials (*SDs* = .17). A repeated-measures ANOVA revealed that Route Race and Race Flip interacted on east/west dilemma trials, $F(1, 77) = 22.74$, $p < .001$. On north/south dilemma trials there was no significant interaction between Route Race and Race Flip, $F(1, 77) = 2.62$, $p = .110$. Two paired-samples t-tests demonstrated statistically significant differences between the recognition of Black faces and White faces: Participants more accurately identified Black faces they had seen as compared to White faces they had seen, $t(79) = 3.84$, $p < .001$. Further, participants were better at identifying Black faces they had not seen as compared to White faces they had not seen, $t(79) = 4.97$, $p < .001$.

Author Note

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Figure Captions

Figure 1. A sample map of Pittsburgh, PA with original orientation (0° rotation), with examples of two dilemma trials: north/south (origin: Hotel, destination: Old Town Metro Stop) and east/west (origin: Restaurant, destination: Information Booth; reproduced with permission from Brunyé et al., 2010).

Figure 2. A sample map of Chicago, IL (original orientation) with racial information added to the map: north/south dilemma trial with White northern route and Black southern route.

Figure 3. Sample maps from each of the four between-subjects conditions for a map of Chicago east/west dilemma: Condition 1 (Map Flip 0°, Black-west and White-east), Condition 2 (Map Flip 0°, White-west and Black-east), Condition 3 (Map Flip 180°, White-west and Black-east) and Condition 4 (Map Flip 180°, Black-west and White-east).

Figure 4. Three sample items from the facial memory task.

Figure 5. Mean proportion and standard error for north/south and east/west dilemma trials from the route selection task.

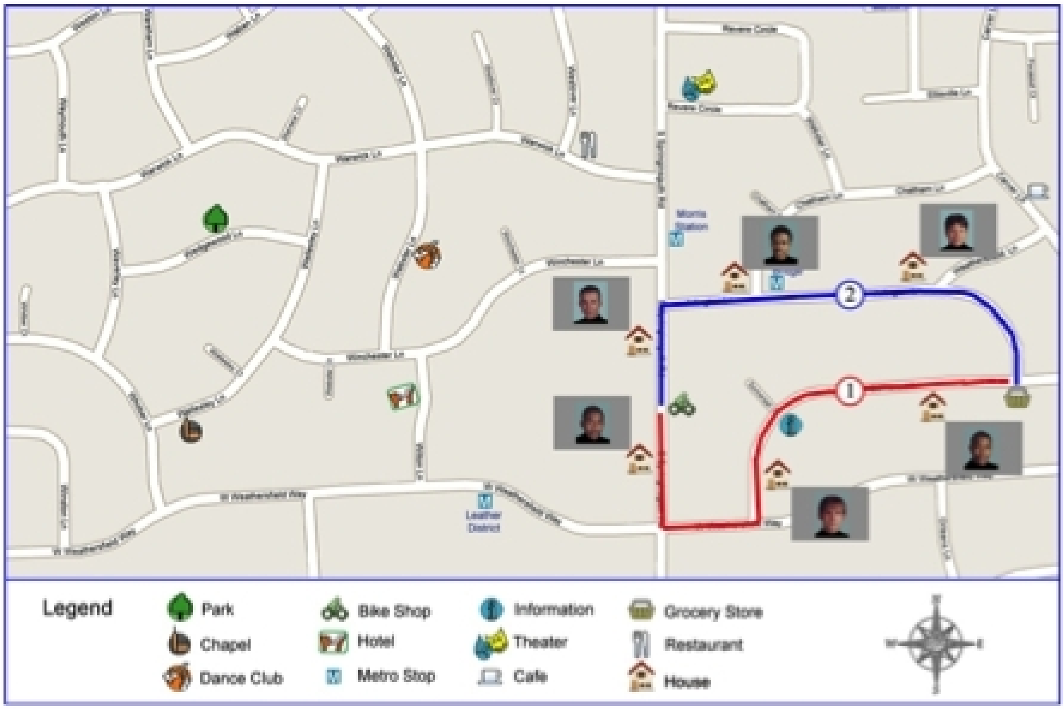
Figure 6. Mean proportion of eastern routes chosen on east/west dilemma trials. Route Race interacted with Race Flip for east/west dilemma trials. Error bars corresponding to each column represent the standard error of the means.

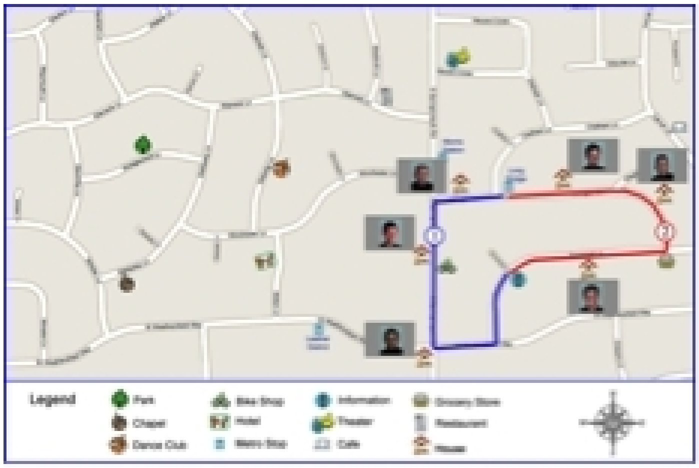
Figure 7. Mean proportion and standard error of hits and correct rejections for Black and White faces from the facial memory task.


Stewart Crossing
Theater District
Old Town
Western Option
Eastern Option
Northern Option
Southern Option
Legend
Park
Chapel
Dance Club
Bike Shop
Hotel
Metro Stop
Information
Theater
Cafe
Grocery Store
Restaurant
N
S
E
W

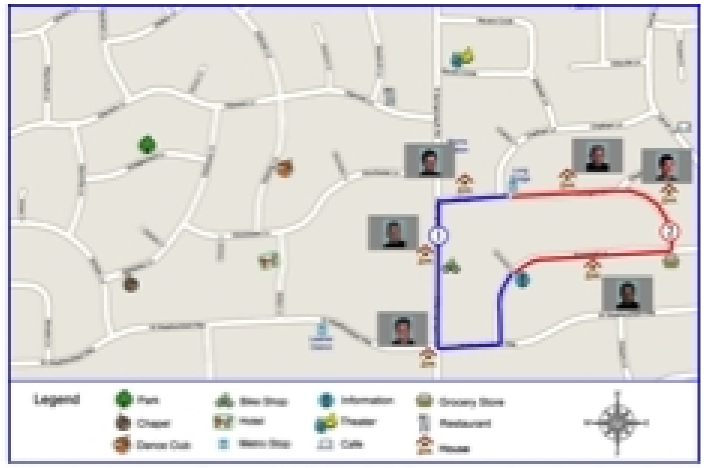
1

2

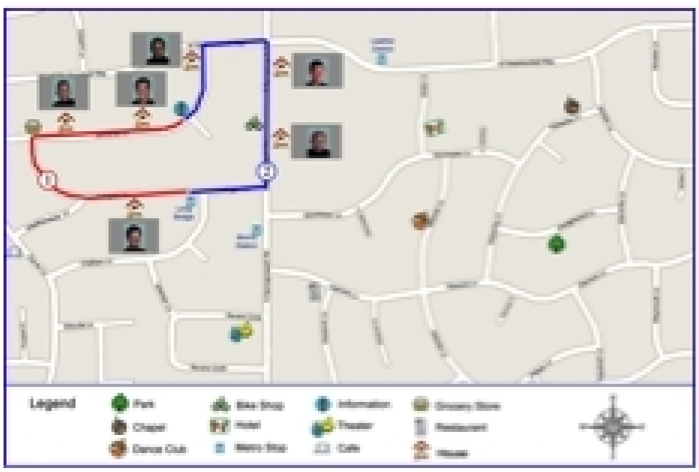

Leather District
1
2
Legend
Park
Chapel
Dance Club
Bike Shop
Hotel
Metro Stop
Information
Theater
Cafe
Grocery Store
Restaurant
House



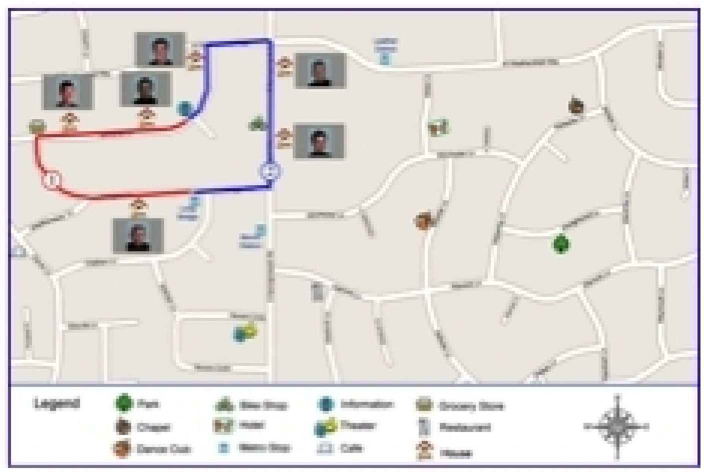
Map Flip 0°, Race Flip 1



Map Flip 0°, Race Flip 2

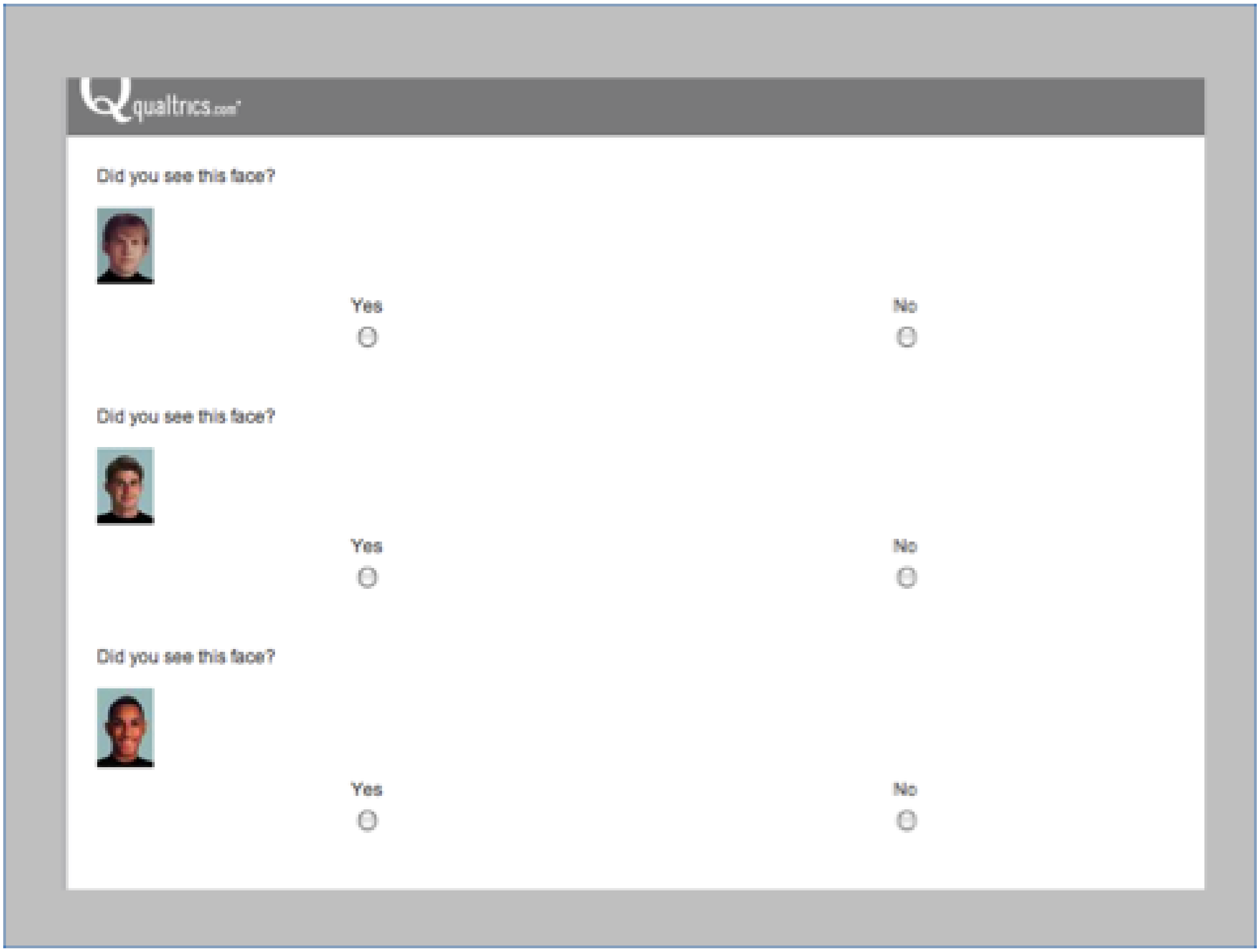


Map Flip 180°, Race Flip 1

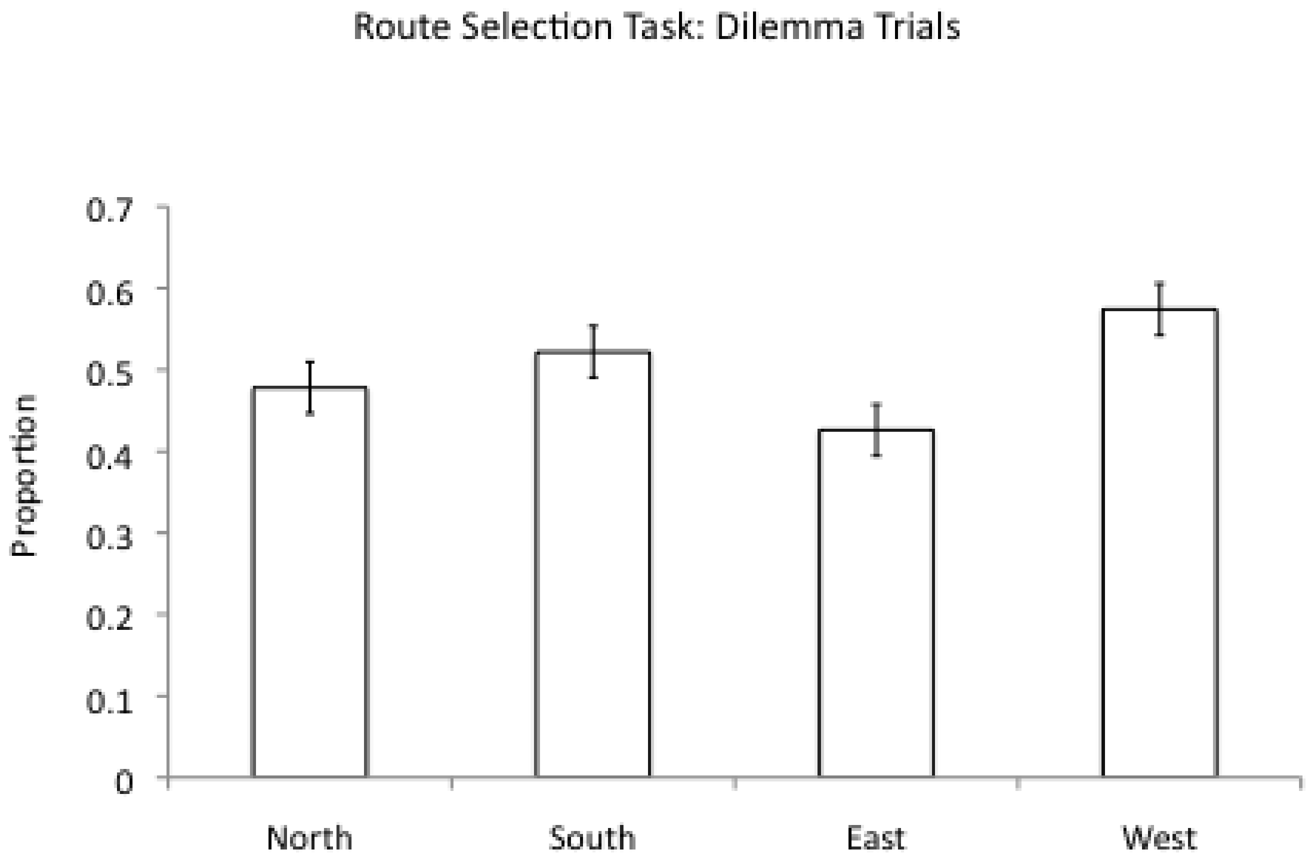


Map Flip 180°, Race Flip 2

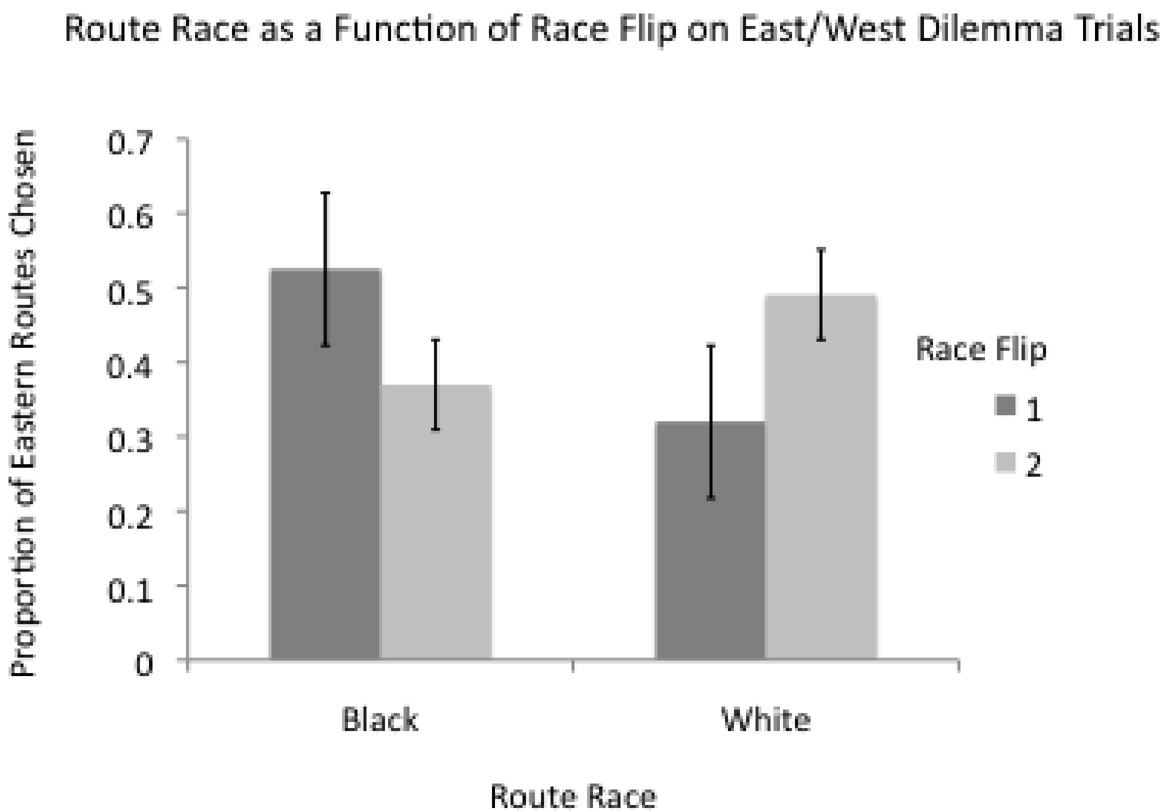
3


qualtrics.com
Did you see this face?
Yes
No
Did you see this face?
Yes
No
Did you see this face?
Yes
No

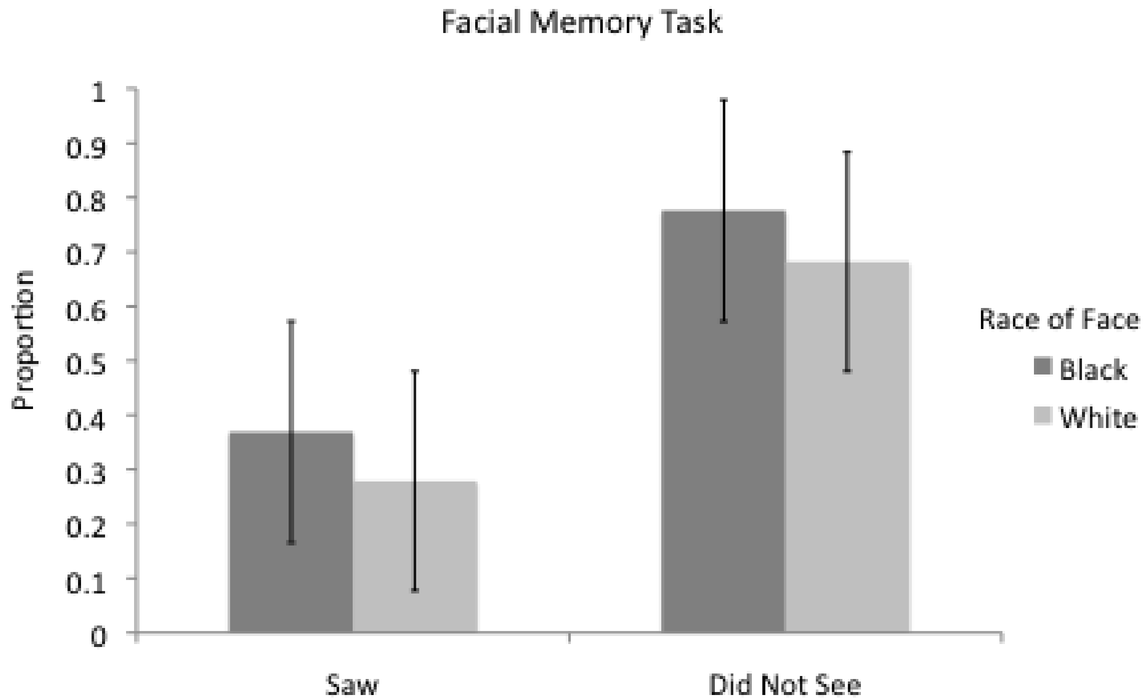
4


Route Selection Task: Dilemma Trials
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Proportion
North
South
East
West

5


Route Race as a Function of Race Flip on East/West Dilemma Trials
Proportion of Eastern Routes Chosen
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Black
White
Route Race
Race Flip
1
2

6



Facial Memory Task
Proportion
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Saw
Did Not See
Race of Face
Black
White

7