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Effects of access to public open spaces on walking: Is proximity enough?

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Highlights

- No measures of proximity were related to walking to and within POSs.
- Greater distance to the nearest POS was related to more minutes of walking.
- Residents reported more walking to and within POSs located on less integrated streets.

1. Introduction

Public open spaces (POSs) such as parks and playgrounds confer many social and physical benefits to communities (Bedimo-Rung, Mowen, & Cohen, 2005; Kaczynski & Henderson, 2008). Within urban design guidelines, proximity to POS is frequently cited as a key principle for encouraging physical, mental, and social outcomes such as improved air quality (Davies, Edmondson, Heinemeyer, Leake, & Gaston, 2011), quality of life (Coombes, Jones, & Hillsdon, 2010), and community cohesion (Davies, et al., 2011). As well, a burgeoning number of studies have examined different aspects of POS, including the distance to, size, and attractiveness of POS, to uncover their associations with physical activity (PA) (Aspinall et al., 2010; Coombes, et al., 2010; Giles-Corti et al., 2005; Hino, Reis, Parra, Brownson, & Fermino, 2010; Kaczynski, Potwarka, Smale, & Havitz, 2009; Sugiyama, Francis, Middleton, Owen, & Giles-Corti, 2010; Sugiyama & Ward Thompson, 2008; Timperio et al., 2008). Indeed, much of the positive effects from POS emanate from their ability to encourage residents to walk both within their neighborhoods and within nearby POS (Cohen et al., 2007; Sugiyama, et al., 2010). However, little research has explored optimal measures of proximity to better understand how living near POS influences walking. Examining these possible associations could assist with the development of guidelines for urban designers and policy-makers who need specific place-based data to inform decisions about creating and locating POS in neighborhoods.

In many previous studies, the role of POS proximity on walking has been examined primarily using the concept of shortest distance to a POS (e.g., Witten, Hiscock, Pearce, & Blakely, 2008). While a nearby park or open space may have an important influence on PA, considering the impact of only a single closest POS on walking ignores the effects of having multiple POSs with different sizes in the vicinity of participants' homes. As one example of an

alternative approach, Kaczynski et al. (2009) included two other measures, the number of parks and the total area of parks within 1 km, in addition to the distance to the nearest park, when investigating associations with residents' moderate-to-strenuous PA undertaken in three different contexts: total PA (irrespective of location), neighborhood-based, and park-based. In general, it was found that both the number and total area of nearby parks were associated with PA that occurred in neighborhoods and parks, but that distance to the closest park did not play a significant role in increasing PA. In another example, Sugiyama et al. (2010) considered not only the distance to nearby open spaces, but also their size and attractiveness, and concluded that having a larger, attractive open space within walking distance may be more important than simply the presence of a smaller or less attractive open space within a shorter distance. Emerging studies such as these help to better delineate the influence of park proximity exposure on PA.

Additionally, proximity measures that have been employed in almost all previous studies are based on standard metric measures without considering the topological dimensions of a network. The topological dimension of a network considers each space within that network in relation to the other available spaces. People perceive and navigate urban spatial layouts in “geometrical and topological” rather than “metric” terms (Hillier & Iida, 2005) and their understanding of spatial configurations such as urban streets are influenced by topological rather than metric terms (Penn, 2003). Consequently, metric measures such as the shortest distance to a POS are not entirely representative of the spatial configuration of a network. Spatial configuration refers to the “relations among spaces in a complex taking into account all other spaces in the complex”, and it differs from spatial relations which “need invoke no more than a pair of related spaces” (Hillier, Hanson, & Graham, 1987, p. 363). Considering only metric proximity measures cannot fully answer the question of the optimal location of POSs to

influence walking, since even within the same metric proximity measures for a person, POS can still be distributed differently across a neighborhood. For example, in Figure 1, resident **b** needs to change his/her direction several times en route to the POS, while resident **a** requires no turns to travel to the POS; network distance to the POS is the same for both residents, but the topological distance would be quite different.

As an alternative, a growing number of studies have applied space syntax theory to analyze the influence of spatial configuration of neighborhoods on a wide range of issues, including walking (Baran, Rodríguez, & Khattak, 2008; Ozbil, Peponis, & Stone, 2011), crime (Chang, 2011; Van Nes & López, 2010), and spatial segregation (Vaughan, 2007). Space syntax, introduced through the work of Hillier and Hanson (1984), analyses the interactions between space and social life based on the spatial configuration of cities (for a review of this method, see Bafna, 2003; Peponis & Wineman, 2002; Vaughan, 2007).

Within space syntax methods, several topological descriptors are defined to quantify spatial structures. The first step in representing a spatial structure is to draw an axial map, the basic measurement unit in space syntax on which the calculations of all other syntactical measures are based. The axial map is “the least set of such straight lines which passes through each convex space and makes all axial links” (Hillier & Hanson, 1984, p. 92). Figure 2 depicts the same neighborhood using both the normal street pattern (left side) and axial lines (right side).

Two aspects of human movement include the selection of a destination (“to-movement”) and the selection of spaces that should be traversed to reach the destination (“through-movement”) (Hillier & Iida, 2005). Two kinds of syntactic measures which are defined using space syntax consider these two movement aspects. Integration measures (also called closeness) refer to “how close each segment is to all others under each definition of distance” and choice

measures (also called betweenness) refer to “how many distance minimizing paths between every pair of segments each segment lies on under different definitions of distance” (Hillier, 2009, p. 4).

Over time, it is expected that people visit destinations that are closer to them more frequently than farther destinations. However, several factors influence destination choice, including individual preferences (Hillier & Iida, 2005) and the facilities available within the destinations (e.g., features or quality of a park). All things being equal, however, theoretically, destinations located on the most integrated segments will be chosen more frequently. Notably, though, no research has examined the association of proximity to POS with walking taking into account this level of street segment integration or other principles or measures of space syntax. Doing so may considerably alter the simple relationship between distance to POSs and level of walking. For example, POS located on the most spatially integrated street segments (i.e., those which require fewer turns to access) may be visited more frequently by residents, thereby increasing the amount of walking undertaken both to and within these destinations. To explore these issues further, the current study examined associations between several proximity measures – three traditional metric measures (nearest POS, number of POS, total area of POS) and one topological measure from space syntax (POS integration) – with the behavior of walking to and within POS.

2. Methods

2.1. Setting and sample

Data for this study were collected in three diverse neighborhoods in Melbourne, Australia in 2011. The neighborhoods were purposively selected based on different street configurations and the equivalent area level socio-economic status. A typology developed by Marshal (2005)

was used to include three different street configuration patterns in the study. Marshal (2005) identified four types of street patterns (labeled ABCD) ranging from the “core of a settlement” to the “periphery”. Type A, which is “the core area of old cities”, was not used in this research as this configuration type is absent in Melbourne. Type B is a grid pattern, type C is a “mixture of regularity and irregularity” and “streets typically curved or rectangular”, and type D is a “hierarchical layout” associated with many cul-de-sacs (Fig. 3).

Also, to account for the area-level socioeconomic status, the socioeconomic index for area (SEIFA) index of advantages/disadvantages (Australian Bureau of Statistics, 2008a) was considered when selecting the neighborhoods. This index includes income, education, employment, occupation, housing, and other indicators of relative advantage or disadvantage. For example, an area can have a high score when it has “many households with high incomes, or many people in skilled occupations; AND few households with low incomes, or few people in unskilled occupations” (Australian Bureau of Statistics, 2008b, p. 12). One neighborhood representing each of the three different street patterns was selected from the lowest four deciles of the index. Each of the three neighborhoods included several Census Collection Districts, with the Type B neighborhood covering 35 hectares, the Type C neighborhood 23 hectares, and the Type D neighborhood 39 hectares. Neighborhoods from lower deciles were selected because it was deemed particularly important to better understand the impact of parks and open spaces on walking and health for individuals who may not have access (financial or transportation) to other mostly costly community resources for PA.

Three hundred and thirty households were randomly-selected from each neighborhood (i.e., more than half of the number of households in each neighborhood) and a self-administered questionnaire mailed to all 990 addresses in May 2011. Anyone over the age of 18 within the

household was eligible to complete the questionnaire. Also, as another option for participating in the study, an online version of the questionnaire was created and described within the single follow-up reminder letter that was sent to households that had yet to respond. As a final step, households that had not responded were visited in-person to request residents to complete the questionnaire.

2.2. Measures

2.2.1. Outcome variable

People can walk through their neighborhood streets to reach a POS and they also can walk within that POS. As such, two context-specific measures of walking – walking to and within POS – were the outcome measures in this study. To ascertain this, both the frequency and duration of walking to and within POS were measured using questions modeled after those used in the International Physical Activity Questionnaire (Craig et al., 2003) and the Neighborhood Physical Activity Questionnaire (Giles-Corti et al., 2006). Specifically, participants first reported the number of days within the past 7 days that they had walked *to* a POS like a park or playground within their neighborhood (with neighborhood defined for participants as a 10-15 minute walk from home). Those who reported some walking to POSs were then asked the average amount of time spent doing so per day. The same two questions were then asked about walking within neighborhood POSs.

2.2.2. Independent variables

Nearest POS, number of POS, total area of POS: These three measures, which are more representative of traditional metric distance, were measured objectively using GIS. The distance between the participant's home and the nearest POS was calculated using network distance, which has been shown to be more accurate than Euclidean distance (Kaczynski, Koohsari,

Wilhelm Stanis, Bergstrom, & Sugiyama, In Press; Witten, Exeter, & Field, 2003). Points separated by a predetermined distance (20 meter) along POS boundaries were considered as destination points (Proposed by Apparicio & Seguin, 2006), and the shortest network distance between the participants' home and these new points were calculated. To determine the number of POS and the total area of POS, a 1 km network buffer around the participant's home was created using ArcGIS 9.3. This 1 km buffer size is in line with several past studies of PA and the built environment (e. g., Frank, Schmid, Sallis, Chapman, & Saelens, 2005; Kaczynski, et al., 2009; Lee & Moudon, 2008; Lovasi et al., 2008). The number of POSs and the total area of all POSs whose centroids fell within 1 km were then calculated.

POS integration: Each POS in the neighborhood was assigned an integration score using the following procedures and these individual POS scores were used to derive a total POS integration score for each participant. First, all streets in the study neighborhoods were assigned an individual integration score based on space syntax. Space syntax analysis was conducted on all the street centerlines using UCL DepthMap software version 10 (developed by Alasdair Turner at University College in London). Each street (segment) received a score of integration (closeness) considering all the other streets within 1 km of that street center. Then, each POS was allocated a score of integration based on the street on which its entrance was found using both Google street map and onsite visits. In the situation in which a POS had several entrances on several streets, the score was given based on the street which had the highest integration score. Finally, a score for integration based on the mean integration score of all POSs within the 1 km area was assigned to each participant. A higher value for a participant meant that POSs within 1 km around that person were located on more integrated streets. For example, the POSs are

mainly located on the most integrated streets in figure 4 left, but mainly laid on the less integrated streets in figure 4 right (heavy darker lines show higher integration).

2.2.3. Control variables

Four perceptual qualities of the neighborhood – aesthetics, safety from traffic, safety from crime, and the availability of facilities for walking – were measured using related sections of the Australian version of the Neighborhood Environment Walkability Scale (NEWS-AU). The NEWS-AU is a self-report instrument developed by Leslie and colleagues (2005) and its validity has been reported by Cerin et al. (2011).

In several previous studies, attractiveness of POS has been measured via audits which are expensive and do not always represent residents' perceptions of their nearby POS. Alternatively, the current study used a subjective measure, and participants were asked to evaluate the quality of their nearby POSs with a single statement: 'There are attractive public open spaces like parks and playgrounds in my neighborhood (1=*strongly disagree*, 4=*strongly agree*).

Several sociodemographic variables, including the participant's age, gender, employment status, annual household income, education level, presence of children less than 12 years in the household, and having a dog, were also included in the questionnaire. Further, to partially account for possible self-selection issues, participants were asked to rate on a 5-point scale (1=not at all important, 5=very important) the importance of several factors including 'closeness to public opens spaces such as parks and playgrounds' in their decision to move to their current neighborhood (Frank, Saelens, Powell, & Chapman, 2007).

2.3. Analyses

The role of proximity measures was analyzed among all participants and among only those who reported some walking to or within POS. First, the outcome measures were

dichotomized into some walking to and some walking within POS versus no walking to and no walking within POS. Then, all participants were included in two binary logistic regressions to examine the factors associated with higher odds of any walking to and any walking within POS. Then, among those who reported some walking to or some walking within POS, several analyses of covariance (ANCOVAs) were conducted to identify how varying levels of proximity (for each of the four proximity measures) were associated with the actual amount of walking to and within POS. Total minutes values for walking to and within POS were skewed and were thus normalized using a log 10 transformation. All models were adjusted for several potential confounding factors, including the measures of neighborhood perceptions and self-selection, as well as sociodemographic variables including gender, age, education, having a child, and having a dog. All analyses were conducted in SPSS 20 for Windows (SPSS Inc., Chicago, IL).

3. Results

From 990 questionnaires that were mailed to Melbourne residents, 40 were undeliverable and 335 were returned (response rate=35.3%). Of the 320 respondents who provided useable data, 103 lived in the type B neighborhood, 116 lived in the type C neighborhood, and 101 lived in the type D neighborhood. Overall, 56 percent were female, the mean age was 44 years (s.d.=15), 66 percent had completed a tertiary degree, 64 percent were employed, 39 percent had an annual income greater than \$80,000, 25 percent had a dog, and 26 percent had children under 12 years in the household (Table 1). About 50% of participants reported some weekly walking to POS and about 43% of participants reported some weekly walking within POS. Among these walkers, the average walking time to and within POS was 100 minutes per week (s.d.=91 min) and 92 minutes per week (s.d.=59 min), respectively. The mean values for the four proximity

measures – *nearest POS, number of POS, total area of POS, and POS integration* — were 273 meters, 9 POS, 14 hectares, and 5, respectively.

Table 2 shows the odds of engaging in some walking both to and within POS according to proximity to the *nearest POS*, the *number of POS*, *total area of POS*, and the *POS integration* score. None of these factors were significantly associated with an increased likelihood of walking either to or within POS.

Table 3 shows the log-transformed total number of minutes walking to and within POS among people who reported at least some walking to or within POS. There were no significant differences in the amount of walking to POS across the quintiles for total area of POS within 1 km ($F=1.92$; $p=0.11$). However, there were significant differences in the total amount of walking to POS between the quintiles for distance to the nearest POS ($F=3.27$; $p<0.05$), number of POS within 1 km ($F=5.45$; $p<0.001$), and the POS integration score ($F=10.23$; $p<0.001$). The average amount of time spent walking to POS for people who lived further from their nearest POS (quintile 1) was significantly greater than that for certain people who lived closer to POS (quintile 4), although there were no differences between quintiles 1 and 5. Likewise, for the number of POS within 1 km, people who had fewer POS nearby (quintiles 1, 2, and 3) reported significantly more minutes walking to POS than those who had the highest number of POS within 1 km (quintile 5). Finally, people who lived in areas in which POSs were located on the least integrated streets (quintiles 1, 2, and 3) engaged in a significantly larger amount of walking to POS than those who lived in areas in which POSs were found on the most integrated streets (quintiles 4 and 5). In addition, there were no significant differences in the amount of walking within POS across the quintiles for distance to the nearest POS ($F=0.89$; $p=0.47$), number of POS within 1 km ($F=2.32$; $p=0.07$), and total area of POS within 1 km ($F=0.89$; $p=0.47$).

However, those participants who lived in areas in which POSs were located on less integrated streets (quintile 2) reported a significantly larger amount of walking within POS than those who lived in areas in which POSs were found on the most integrated streets (quintile 5).

4. Discussion

Given that parks and open spaces are widely acknowledged as important community resources for PA, it is worthwhile to begin to examine how different aspects of POS influence walking in order to extract more specific recommendations about how neighborhoods should be (re)designed. Many studies have started to document how internal park characteristics such as facilities, amenities, and quality influence park usage and PA (Floyd et al., 2011; Giles-Corti, et al., 2005; Kaczynski & Havitz 2009; Shores & West, 2008; Sugiyama, et al., 2010). However, the location of POSs remains a critical factor determining access to these resources. A rapidly expanding body of literature is exploring the role of proximity to POS on walking and other forms of PA, but few studies (e.g., Boone-Heinonen, Casanova, Richardson, & Gordon-Larsen, 2010; Kaczynski, et al., 2009) have comprehensively examined how different measures of proximity are associated with PA (especially that which directly involves parks and open spaces). Some research (e.g., Sugiyama, et al., 2010) has begun to explore how assorted park-related variables interact to influence POS usage and PA (e.g., distance to the most attractive POS, size of the closest POS). This study, however, strictly examined how diverse proximity measures, including both metric and topological proximity measures, were associated with a specific context-based type of walking – walking to and walking within POS.

There were no associations between the three metric measures of proximity – nearest POS, number of POS, and total area of POS within 1km – and the likelihood of participants having walked to and within POS. This is somewhat consistent with some previous research

(Jilcott, Evenson, Laraia, & Ammerman, 2007; McGinn, Evenson, Herring, Huston, & Rodriguez, 2007; Witten, et al., 2008) showing the proximity of PA facilities *per se* to be unrelated to PA, although most former studies have used less specific outcome measures (e.g., accelerometer-based total PA, general walking within the neighborhood). Contrary to expectations, among people who reported walking to POS weekly in this study, further distance to their nearest POS and having a fewer number of POS within 1 km were positively related to the total amount of walking to POS. This is likely to be explained by the fact that open spaces that are *too* proximal may actually limit the amount of recreational walking residents obtain to get there. Moreover, even if a park is located nearby, its small size, uninteresting features, or poor quality may limit awareness of it or its attractiveness as a destination. Indeed, there may be an optimal distance threshold at which to site parks that not only encourages awareness and use of these resources for PA, but also facilitates the attainment of additional walking on the way to the parks themselves. For example, Sugiyama et al. (2010) found that a shorter distance to attractive open spaces was associated with doing *any* recreational walking, but that having a large and attractive open space within 1 mile of home was related to an increased likelihood of actually *meeting* physical activity recommendations through recreational walking (>150 min/week). Research that examines these types of thresholds is a priority in better understanding relationships between POSs and PA.

One of the unique aspects of this study was the introduction of topological space syntax measures – specifically, integration – in considering how the location of POS may influence walking to these destinations. POS that were located on more integrated streets were those that required fewer direction changes on the routes to reach them. This makes the walk to the POS more legible. Notably, POS integration had no effects in predicting some (vs. no) walking,

though it did affect the amount of walking among those who did walk to and within POS. Since people with different levels of PA have different perceptions of features of the built environment (Carnegie et al., 2002; Kaczynski, 2010), it is likely that the built environment measures influencing walking can be different for people who are walkers versus non-walkers. In this study, participants reported a greater amount of walking to or within POS when the POSs were located on less integrated streets. Thus, street integration adds a useful dimension to the understanding of how POS proximity influences walking, but not in the expected direction. This type of exploration may assist urban designer in the design of future neighborhoods.

Space syntax method suggests that if destinations (e.g., POS) are located on the most integrated streets, they will be visited more than those located on less integrated streets. One explanation for the opposite effect in our study is that more integrated streets inevitably encourage increased vehicular traffic (Leck, 2006). It is likely that when a POS is located on the most integrated streets, reaching that POS requires travelling on and/or likely crossing a busy street occupied by vehicular flow. Traffic is one of the frequently cited barriers to residents' walking (Sallis, Floyd, Rodríguez, & Saelens, 2012) and it has been shown that crossing a busy street negatively influences walking of vulnerable groups like children (Veitch, Salmon, & Ball, 2007) and older adults. Thus, traffic safety concerns might discourage use by preventing people from walking to or within POS in areas where POS are located on the most integrated streets (Kaczynski, et al., In Press).

Walking to a park is largely a recreational activity and it is likely that distance and time are less important for people who walk for more leisure-related purposes. Thus, close proximity is possibly less important than attractiveness and POS quality. For example, the impact of distance on walking toward a destination can be overshadowed by the quality or utility of that

destination. Indeed, one study found that the number of features within a park was more important than its size or distance in encouraging park-based PA (Kaczynski, Potwarka, & Saelens, 2008). Similarly, other research has reported that access to larger attractive open spaces is associated with engaging in greater levels of walking (Giles-Corti, et al., 2005; Sugiyama, et al., 2010). Future research should examine whether this holds true for other population groups (e.g., children, older adults) who might be more restricted to the POS in their neighborhood. Moreover, future studies might consider which park features are most important to attract different population groups.

These results demonstrate that simply examining associations between POS proximity and walking can be problematic. It is likely that characteristics of the routes that people traverse to reach POS (Dills, Rutt, & Mumford, 2012) or the perceptual qualities of the surrounding built environment (Sugiyama, Leslie, Giles-Corti, & Owen, 2009) may be more important in encouraging walking to and within POS than proximity alone. Also, it is possible that proximity measures may have different effects on residents' and non-residents' walking to and within POS since the level of familiarity with a place can substantially influence perceptions of distance (Montello, 1997; Popp, Platzer, Eichner, & Schade, 2004). It remains to be seen how street integration and other contextual and topological variables operate in impacting walking to and within POS among people with different levels of familiarity with an area, but this presents a fruitful area for future urban design and health research. For example, future studies may also like to consider how much traffic is carried on well integrated streets, and whether this indeed, impacts POS use which is a recreational activity, more so than other types of utilitarian destinations (e.g., shops and other services).

4.1. Limitations

This study had several limitations that should be noted. Using a cross-sectional research design, we were unable to draw inferences about any causal relationships between POSs and neighborhood attributes and behavior. However, this study did attempt to partially control for the issue of self-selection through the use of a question asking respondents about the extent to which open spaces factored into their decision to move to the neighborhood. Moreover, a recent study partially refuted such issues of self-selection in so far as residents with similar preferences for green space but differential proximity to parkland engaged in varying amounts of park-based physical activity; specifically, even among people with lower preferences for living near green space, those with more proximal parkland were more likely to use parks for physical activity (Kaczynski & Mowen, 2011). Another limitation was that the self-reported measure of walking to and within POS may be subject to some issues related to recall error (Sallis & Saelens, 2000). Moreover, our context-specific measures were not specific to the ‘nearest park’. Thus, participants may have walked to or within a POS, but we were unable to determine to or within which POS they walked. In addition, this study only focused on walking and we did not capture measures of driving to the POS. Future research may wish to examine the associations between proximity measures and driving to a POS. Finally, in this study, proximity measures were derived based on objective data, while participants’ perceptions of proximity (subjective measures) were not included. Using only objective measures may not be completely representative because some previous studies have found poor agreement between objective and subjective measures of proximity to parks and open space (Ball et al., 2008; Lackey & Kaczynski, 2009).

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Table 1
Characteristics of study participants

Participant Characteristics	Total sample (n=320)		Some walking to POS (n=161)	
	N	%	N	%
Gender				
Female	180	56	82	51
Male	131	41	73	45
Age				
18-24	21	7	10	6
25-34	81	25	31	19
35-44	75	23	40	25
45-54	60	18	33	20
55-64	43	13	24	15
65-74	21	7	13	8
> 75	14	4	7	4
Education level				
Did not complete year 12	21	7	12	7
Completed VCE	34	10	19	12
Completed trade or TAFE	49	15	31	19
Completed tertiary degree	211	66	96	60
Employment status				
Employed	206	64	106	66
Unemployed	4	1	2	1
Retired	48	15	27	17
Student	33	10	13	8
Other	28	9	12	7
Annual income				
<\$19,999	13	4	8	5
\$20,000-\$39,999	29	9	15	9
\$40,000-\$59,999	47	15	19	12
\$60,000-\$79,999	56	18	30	19
>\$80,000	124	39	62	39
Dog ownership				
Yes	80	25	51	32
No	240	75	110	68
Child <12 yrs in household				

Yes	84	26	56	35
No	232	73	103	64

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576 Note: VCE = Victorian Certificate of Education; TAFE = Technical and Further Education.

577 Percentages do not add up to 100% because of missing data.

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Table 2
Association of proximity measures with some walking to and within POS

	Some walking to POS		Some walking within POS	
	OR	95% CI	OR	95% CI
Distance to POS				
1 Furthest	0.80	0.24-2.64	0.79	0.26-2.39
2	0.56	0.26-2.10	0.73	0.27-1.97
3	1.10	0.41-2.96	1.22	0.48-3.09
4	0.38	0.14-1.03	0.73	0.28-1.87
5 Closest	1.00		1.00	
Number of POS within 1 km				
1 Least	1.23	0.26-5.88	2.20	0.51-9.61
2	0.99	0.21-4.64	1.64	0.39-6.96
3	0.80	0.17-3.84	1.57	0.36-6.91
4	1.01	0.36-2.86	0.96	0.35-2.61
5 Most	1.00		1.00	
Total area of POS within 1 km				
1 Least	0.98	0.22-4.41	2.14	0.52-8.77
2	0.65	0.16-2.62	1.88	0.51-6.99
3	0.69	0.17-3.03	2.01	0.52-7.83
4	0.80	0.25-2.62	0.95	0.31-2.88
5 Most	1.00		1.00	
Integration of POS				
1 Least	2.60	0.45-15.18	1.71	0.31-9.50
2	3.57	0.92-13.90	2.56	0.69-9.49
3	2.61	0.54-12.50	1.03	0.24-4.50
4	0.50	0.16-1.51	1.03	0.36-2.94
5 Most	1.00		1.00	

583 All models were adjusted for socio-demographic variables, neighborhood perceptions,
584 attractiveness of POS, and a measure of residential self-selection.

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Table 3
Differences in time spent walking to and within POS by POS proximity and integration

	Time Spent Walking to POS (Lg)		Time Spent Walking within POS (Lg)	
	Mean	SE	Mean	SE
Distance to POS				
1 Furthest	1.06 ^a	0.11	0.94	0.12
2	0.98 ^{a,b}	0.12	0.82	0.12
3	0.94 ^{a,b}	0.11	0.80	0.12
4	0.56 ^b	0.11	0.63	0.12
5 Closest	1.03 ^a	0.12	0.83	0.12
Number of POS within 1 km				
1 Least	1.09 ^a	0.10	0.98	0.10
2	1.13 ^a	0.13	0.89	0.14
3	1.05 ^a	0.12	0.88	0.13
4	0.81 ^{a,b}	0.11	0.67	0.12
5 Most	0.51 ^b	0.11	0.57	0.11
Total area of POS within 1 km				
1 Least	0.86	0.11	0.88	0.12
2	0.77	0.11	0.81	0.12
3	0.89	0.11	0.84	0.12
4	0.83	0.11	0.61	0.12
5 Most	1.21	0.12	0.87	0.13
Integration of POS				
1 Least	1.10 ^a	0.12	0.80 ^{a,b}	0.13
2	1.30 ^a	0.11	1.07 ^a	0.12
3	1.10 ^a	0.10	0.90 ^{a,b}	0.11
4	0.54 ^b	0.11	0.68 ^{a,b}	0.12
5 Most	0.54 ^b	0.10	0.58 ^b	0.11

All models were adjusted for socio-demographic variables, neighborhood perceptions, attractiveness of POS, and a measure of residential self-selection.

^{a,b} All group means with different superscript letters were significantly different from one another (Bonferroni post-hoc test, $p < 0.05$).

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608 **Figure 4.** Differences in POS integration.

Figure 1
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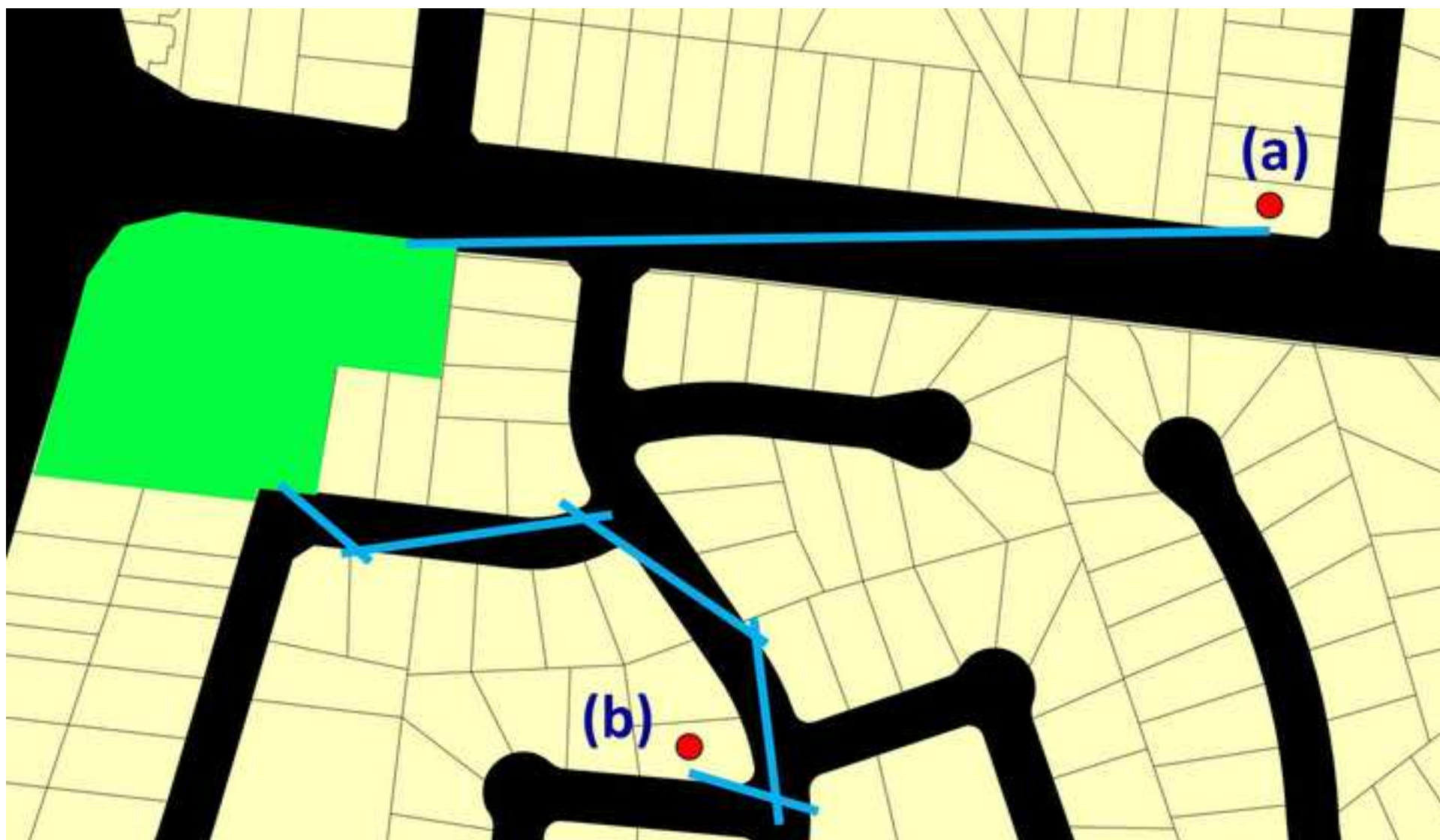
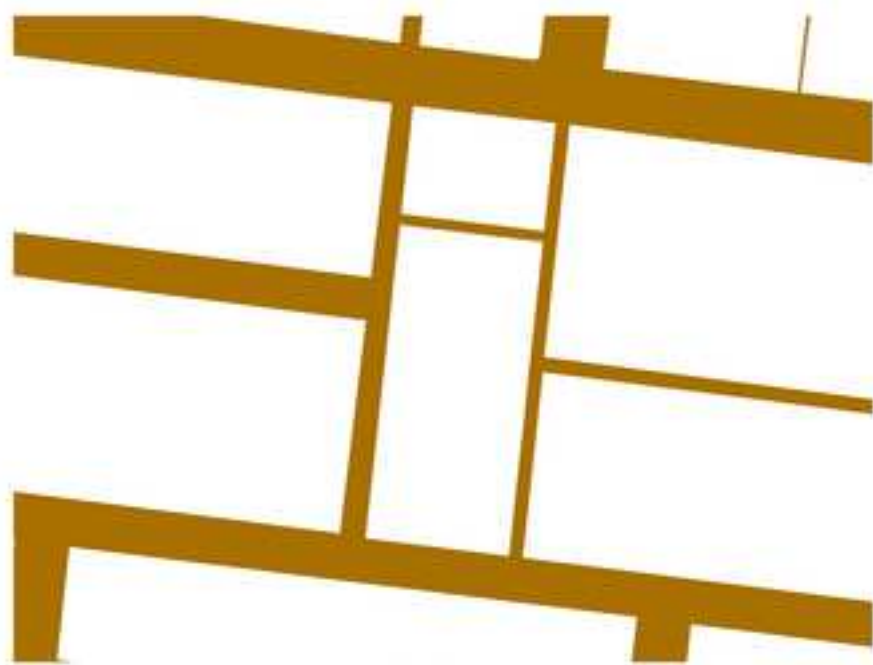
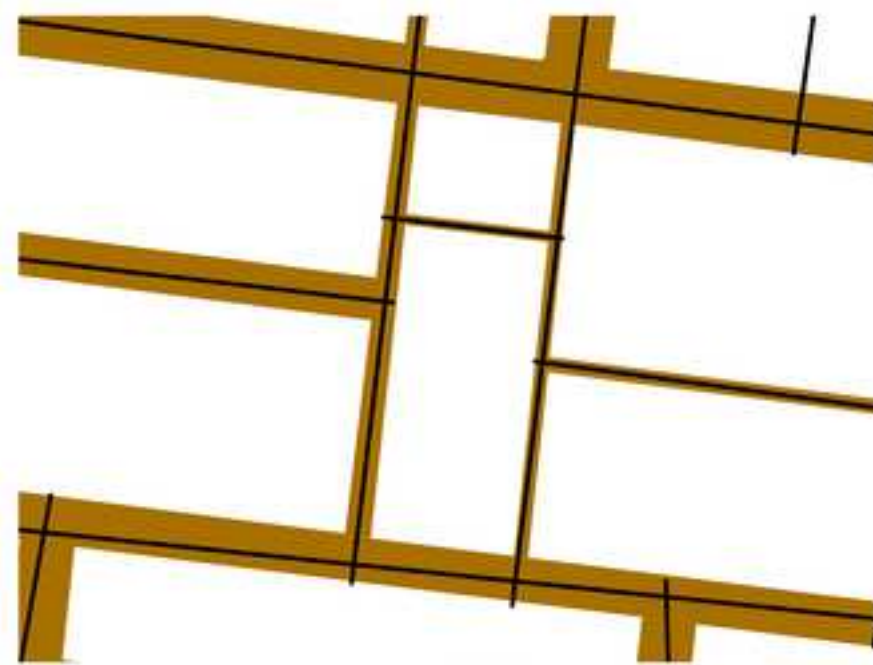


Figure2
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(a)



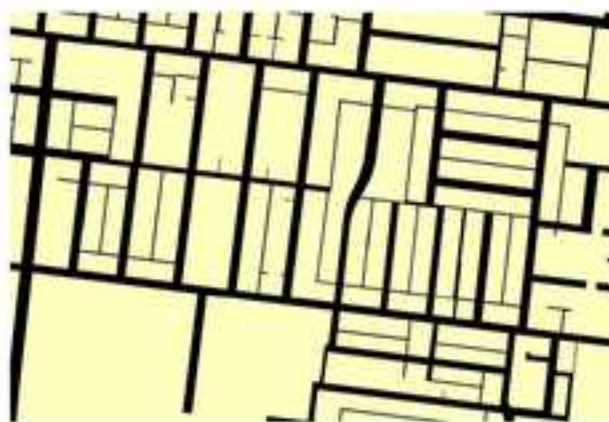
(b)

Figure3

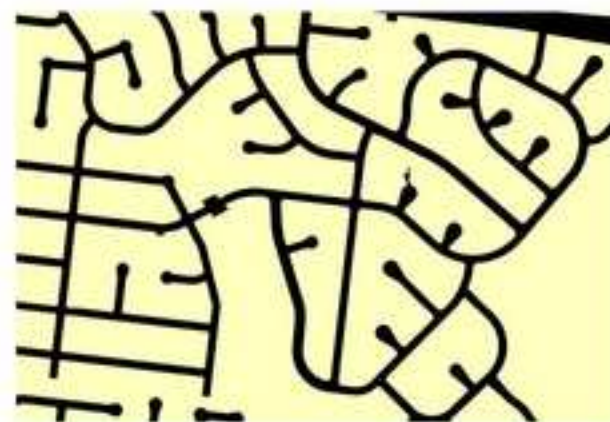
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Type B



Type C



Type D

Figure 4
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