



Original article

Shortcuts in urban green spaces: An analysis of incidental nature experiences associated with active mobility trips

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ABSTRACT

Nature experiences and active mobility both deliver well-being and health benefits but have rarely been investigated together. Conceptualizations of nature experiences largely focus on intention, and the planned motivations for visits. However, nature experiences can also be perceived incidentally, if daily living activities like trips are encouraged towards green spaces. In a public participation GIS (PPGIS) survey of five local districts in Copenhagen, 517 respondents mapped 688 places along their walking or cycling shortcut trips through green spaces. This study investigated what types of green space provide opportunities for such shortcuts, what incidental nature experiences can be perceived there and the different responses of pedestrians and cyclists. This study also explored the relation between incidental nature experiences and green space characteristics in the form of tree cover density. Lastly, this study explored whether frequent short trips through green spaces relate to nature connectedness. The results show that public green spaces and urban cemeteries in Copenhagen allow for such shortcut trips. Enjoyment of pleasing views is the most perceived incidental nature experience. Pedestrians are found more prone to experience surprise, inspiration and emotion, while cyclists prefer shortcuts close to water, which they value highly. The study suggests that high tree cover density is key to delivering incidental nature experiences. Furthermore, the study shows that people who make frequent trips through green spaces have higher levels of nature connectedness, indicating that incidental nature experiences during shortcut trips trigger the reconnection of people and nature. The study's results support a synergistic approach to integrating green spaces and active mobility in planning and management practice, where incidental nature experiences should be emphasized.

1. Introduction

Nature experiences in the city can provide multiple well-being and health benefits (Hartig et al., 2011). Frequent contact triggers nature connectedness, and further promotes pro-environmental behavior that benefits the environment and society at large (Martin et al., 2020). Urban active mobility – walking and cycling as a means of transport – happens outdoors and delivers individual well-being and health gains in the form of physical activity (Kozowski et al., 2019), as well as benefiting society by the use of non-motorized transport (Pisoni et al., 2022). However, nature experiences and urban active mobility are rarely studied in tandem.

There has been increasing research into conceptualization of urban

nature experiences as, e.g., the cultural ecosystem services of green spaces (Krellenberg et al., 2021) and perceived sensory dimensions of green spaces (Yakınlar and Akpınar, 2022). These conceptualizations deal with various aspects of valued characteristics of nature (trees, water, and space), social values, and multisensory engagement in nature (Bentley et al., 2023). Work on nature experiences has mostly focused on intentional processes, where the experiences are built into the planned purpose of the visits (e.g. Manfredo et al., 1996). However, nature experiences can also be had incidentally. An incidental experience is defined as a “sudden awareness of previously unnoticed, yet regular natural features that come to one’s attention in unplanned or unexpected ways” (Beery et al., 2017, p.719), and is often related to the perceived qualities of green spaces (Tveit et al., 2006). Beery et al.

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Table 1
The adapted conceptual green space typology.

Nine main categories of green spaces	19 sub-categories of green spaces
Public green spaces*	Large-sized green spaces (>10 ha) Medium-sized green spaces (2–10 ha) Small-sized green spaces, including pocket parks (<2 ha)
Urban cemeteries	Cemeteries, churchyards
Nature parks	Nature parks
Community green spaces	Allotment gardens, orchards Community gardens Green courtyards
Public open spaces	Public squares, plazas Sport areas (e.g. football pitches) and nearby greenery
Street greenery	Street trees, street verges, trails
Informal green spaces	Brownfields Railways Vacant lots, abandoned lots
Blue spaces	Lakes (including nearby trails) Harbor (parks) and beach (parks) Channels, streams Wetlands
Private gardens	Private gardens

* based on size categorization of Copenhagen municipality (2018).

(2017) argue that there is great potential for promoting incidental nature experiences if daily living activities can be encouraged towards taking place within green spaces.

Trips are an important part of daily living activity (Vilhelmson, 1999), given that traveling between destinations is unavoidable. Trips do not just constitute the physical displacement between origin and destination, they also include social activities afforded by the situational, contextual and material context of urban mobility (Henckel et al., 2013). This understanding of urban mobility connects theoretically to the new mobility paradigm (Sheller and Urry, 2006), which aims to construct the meaning of urban mobility using experiences from the corporeal body as an affective vehicle that is multisensorial and bounded by day-to-day practice. If green spaces can afford such trips, people can have incidental nature experiences as part of their daily routines (Beery et al., 2017). To the best of our knowledge, a combined assessment of incidental nature experiences in green spaces during active mobility trips has not previously been undertaken. There appears to be an absence of studies of which types of green spaces afford, trigger, and promote incidental nature experiences.

Walking and cycling are often jointly understood as active mobility in mobility studies, although they have distinct characteristics in regard to physical environments (Saelens et al., 2003) and route choices (Fossum and Ryeng, 2022). The incidental nature experiences of pedestrians and cyclists may differ due to differences in speed and, accordingly, attention capacity (Pashkevich et al., 2022), but such presumed differences have not been investigated before.

From the perspective of green space design and planning, it is necessary to understand which features of green spaces can promote active mobility (Harani et al., 2021). These features can be deduced from the shortest routes between origin and destination, the shortcuts that offer the least effort and time, and provide the least mental constrain to choose active mobility for transport (Khan, 2016). Skov-Petersen et al. (2018), studying the route preferences of cyclists, found a preference for cycling shorter distances. To better understand the relation between active mobility, incidental experiences, and features of everyday green spaces (Tartia, 2018), this study works with active mobility users' mapped places along shortcuts in a daily perspective. Knowing what types of green space provide shortcut trips, and what incidental nature experiences they afford, is important for future green space design, planning and research.

Moreover, experiencing nature in shortcut trips through green spaces

might encourage an increase in the intentional use of green spaces for recreational purposes beyond the daily commute. Frequent green space visitations can benefit people not only through improved health and quality of life as a consequence of the physical activity of walking and cycling (Mytton et al., 2012), but also with human-nature interactions or nature connectedness (Ives et al., 2017). Trips through green spaces may thus contribute to nature connectedness and therefore play an important role in human-nature connection (Beery et al., 2017), although empirical evidence is lacking.

This study addresses the incidental aspect of the nature experience in green space planning and management, adding to the existing literature by exploring incidental nature experiences during active mobility shortcut trips within urban green spaces. By applying an online map-based public participatory GIS (PPGIS) survey, this study aimed to address the following research questions:

- What type of green space allows for shortcut trips by walking or cycling?
- What types of incidental nature experiences do people have as part of green space shortcut trips, and how is this related to the type of mobility (walking, cycling) and green space characteristics (tree cover density)?
- Are frequent shortcut trips in green spaces related to nature connectedness?

Based on the results, we further discuss the implications for integrated green space and active mobility planning and management practice.

2. Material and methods

2.1. Study area

Copenhagen is one of the most cycling-friendly cities in the world (Nielsen et al., 2013). Currently, 42% of Copenhageners choose to cycle in their everyday commute to work or school (City of Copenhagen, 2021). Copenhagen has a wider vision of promoting sustainable urban mobility and a goal that 50% of all trips should be on foot or by bike by 2025 to meet its carbon-neutral target (City of Copenhagen, 2012). While expanding and updating existing infrastructures, Copenhagen has also initiated green cycling routes, connecting green spaces, lakes, and diverse neighborhoods with unique experiences (City of Copenhagen, 2015a).

2.1.1. Green space typology in Copenhagen

In Copenhagen, a strategic plan embracing the natural environment targets all the places that can accommodate living beings (City of Copenhagen, 2015b). The Urban Nature Strategy plan unfolds the concept of green space broadly across a city-nature spectrum, including public urban spaces, parks, cemeteries, yards, lakes, coasts and nature parks (City of Copenhagen, 2015b). We developed a conceptual green space typology, adapted to the characteristics of green spaces in Copenhagen, with nine main categories and 19 sub-categories (Table 1). Different categories of green space in Copenhagen demonstrate various tree cover densities due to different design and planning focuses and objectives (Koefoed, 2019).

2.2. Participatory mapping – PPGIS survey

PPGIS surveys generally aim to collect spatial information and communication among people for sharing common interests (Brown and Kyttä, 2014). In studies related to green spaces and natural environments, PPGIS surveys are applied to spatially locate users' experiences, and the perceived landscape features as non-expert input into future decision-making processes, on scales from the local and regional to the national level (Brown et al., 2020). In transport planning, PPGIS surveys

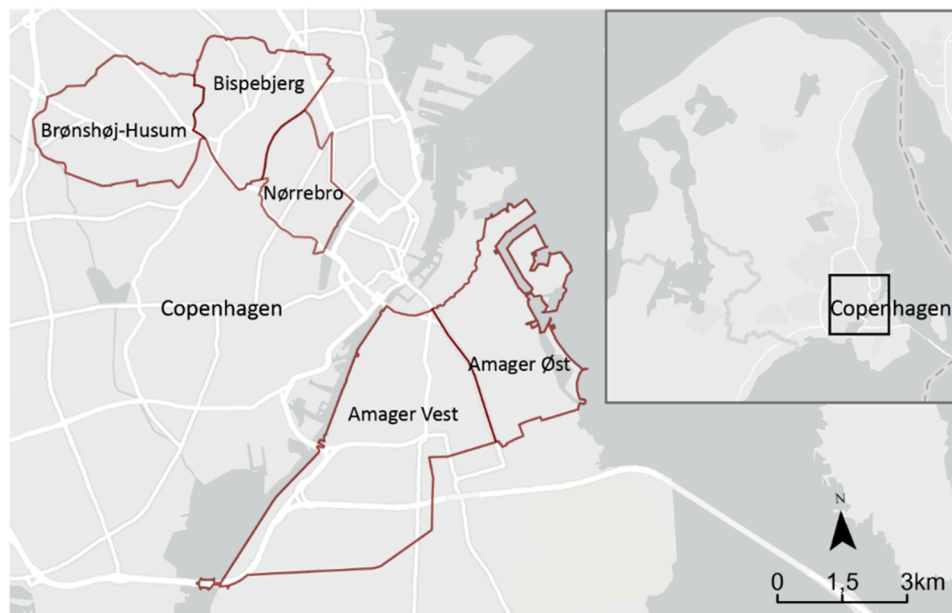


Fig. 1. Study area: the five local districts in Copenhagen.

have been used to involve the public in transportation infrastructure planning (N. Mladenović et al., 2021; Waleghwa and Heldt, 2022). In this study, a PPGIS survey was applied to analyze the incidental nature experiences during active mobility trips through green spaces.

2.2.1. Data collection

The PPGIS data used in this study were collected over nine weeks (15 May–15 July 2020). The PPGIS survey was distributed via email to members of citizen panels in five local districts in Copenhagen. The district citizen panels consist of voluntary residents who have signed up to provide feedback on local planning issues. Among the five districts, 4–10% of the adult population (over 18 years old) were members of the panels (Table A2). The five local districts, Nørrebro, Bispebjerg, Brønshøj-Husum, Amager Øst, and Amager Vest (Fig. 1), cover 48.8 km² of land, with 321,999 inhabitants. The average population density is 6970 inhabitants per km², with the densest district being Nørrebro (19,146 inhabitants per km²). The average share of green space per inhabitant is 46.2 m² (Table A1) (City of Copenhagen, 2018; EEA, 2022).

The PPGIS survey was operated on the cloud-based Maptionnaire platform (Maptionnaire, Community Engagement Platform, n.d.). During the mapping exercise, respondents were able to choose background maps using either Google hybrid view or Google basic map. To ensure precision, zoom level of background maps was fixed to 16 (1:18,000) or better.

2.2.2. PPGIS survey content

The PPGIS survey collected data on places where people spend time outside during the pandemic (Fagerholm et al., 2022). Respondents were asked to group the visited places into three categories: “used normally in their everyday life (before the pandemic)”, “only during the pandemic”, or both. The majority (95.6%) of mapped places were in the category “used normally in their everyday life”. For this study, we interpreted the data as representing the regular use of green spaces in Copenhagen regardless of the Covid-19 context.

A pop-up list contained specific questions about each mapped place, including whether it is part of a shortcut, the type of active mobility undertaken there, and visit frequency (“daily”, “almost daily”, “every week” and “a couple of times a month”). Respondents were also asked to select one or more incidental nature experiences (detailed in Section 2.2.2.1) associated with each place, and were asked to indicate the level of nature connectedness on a five-point Likert scale from “totally

disagree”, “disagree”, “not disagree nor agree”, “agree” to “totally agree” (detailed in Section 2.2.2.2).

2.2.2.1. Incidental nature experience. In this study, we understand incidental nature experiences as the attentive sensing of natural features, and the associated cognitive and affective benefits resulting from shortcut trips through green spaces. Seven incidental nature experiences were included in the study: two nature features related to ideas about urban nature – perceived biodiversity, and closeness to water; four direct sensory experiences and related affective benefits – aesthetic views, nature sounds, pleasant smells, and nature observations; and a single category covering surprises, inspiration, and emotion. Such perceived sensory and emotional experience qualities have also been labeled as ecosystem service benefits (Fagerholm et al., 2021) or cultural ecosystem services (Rall et al., 2019) in other green-space-focused PPGIS studies.

2.2.2.2. Nature connectedness. The seven statements used here were measured by a combination of cognitive, affective, experiential, and personality factors (Lumber et al., 2017; Fagerholm et al., 2021), and were listed as follows:

- It's easier to be myself in nature than in the built environment.
- Spending time in nature instead of in the built environment is important for my good mood.
- Nature increases the meaning of life.
- When I see nature, it evokes positive emotions in me.
- I feel like I am part of something bigger than myself when I spend time in nature.
- My problems seem less when I spend time in nature.
- I feel that socializing and making contact with people is easier when I spend time in nature.

2.3. Data analysis

In this study, respondents mapped places along their shortcut trips (n = 688) within green spaces by either walking or cycling. We called these mapped places “shortcut places” in this study.

To understand what type of green space can afford shortcut trips, each mapped shortcut place was coded with one of the categories of

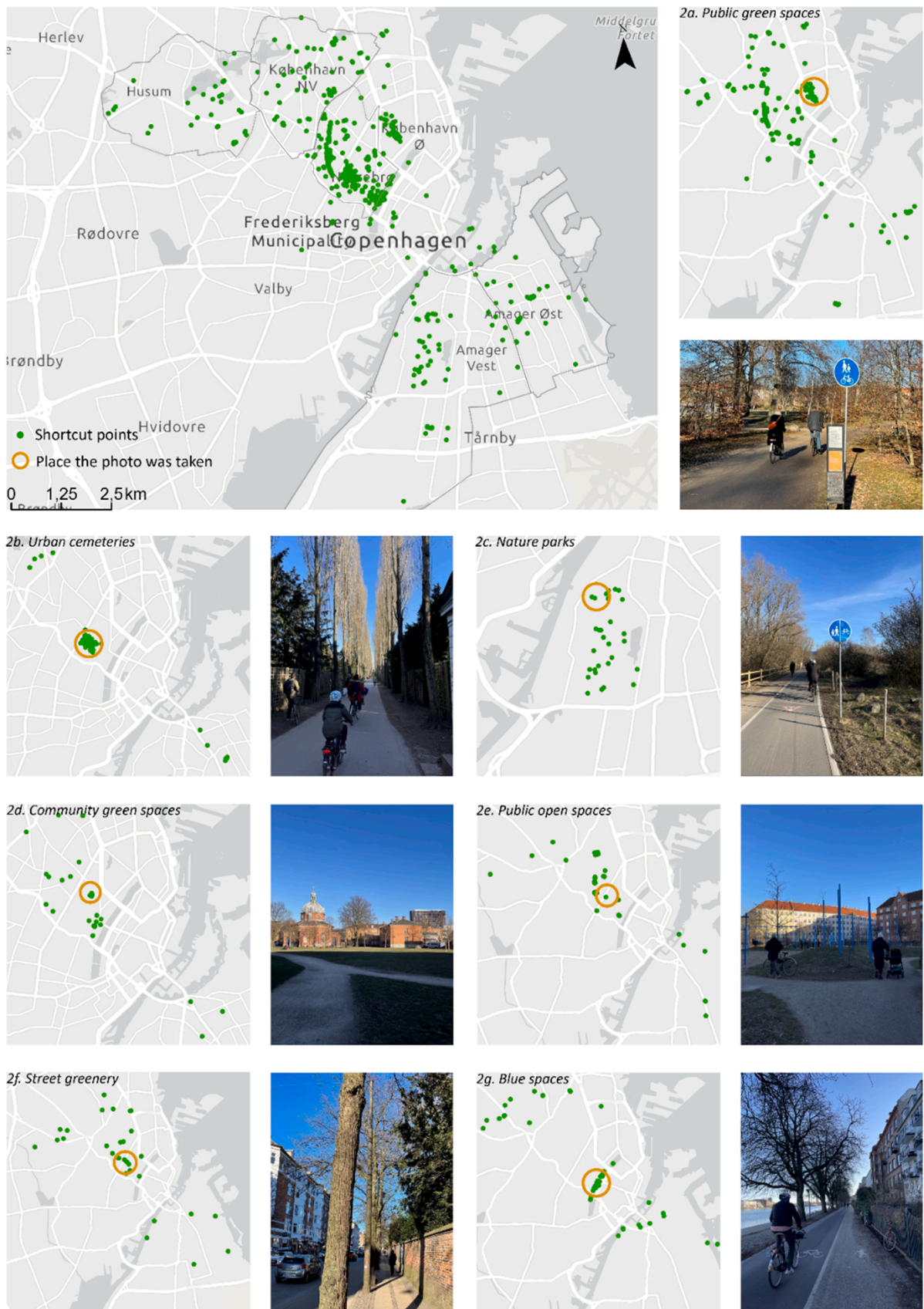


Fig. 2. Shortcut places in individual green space categories: 2a, public green spaces; 2b, urban cemeteries; 2c, nature parks; 2d, community green spaces; 2e, public open spaces; 2f, street greenery; 2g, blue spaces. The circle indicates where the accompanying photograph was taken, illustrating the green space context and type of infrastructure (e.g., bike lane, trail or sidewalk) associated with shortcuts. The categories of informal green spaces and private gardens were not included due to the limited number of shortcut places identified there.

Table 2
Relative share (percentage) of shortcut places in the main and sub-categories of green spaces.

Main categories of green spaces	Percentage (n = 688)	Sub-categories of green spaces	Percentage (n = 688)
Public green spaces*	39.7	Large-sized green spaces (>10 ha)	7.4
		Medium-sized green spaces (2–10 ha)	16.1
		Small-sized green spaces including pocket parks (<2 ha)	16.1
Urban cemeteries	27.9	Cemeteries or churchyards	27.9
Public open spaces	8.7	Public squares and plazas	6.4
		Sport areas (e.g. football pitches) and nearby greenery	2.3
Blue spaces	8.7	Lakes (including nearby trails)	4.2
		Harbor (park) and beach (park)	0.9
		Channels	1.6
		Wetlands	2.0
Community green spaces	4.7	Allotment gardens / orchards	0.3
Street greenery	4.5	Green courtyards	4.4
		Street trees, street verges, trails	4.5
Nature parks	4.4	Nature parks	4.4
Private gardens	0.9	Private gardens	0.9
Informal green spaces	0.6	Brownfields	0.1
		Railways	0.3
		Vacant lots, abandoned lots, parking lots	0.1

* based on size categorization of City of Copenhagen (2018).

Table 3
Green space cover in five local districts identified by City of Copenhagen.

Green spaces cover identified by City of Copenhagen in five local districts*	size (ha)	Percentage of total green space cover (%)
Public green spaces	Large-sized green spaces (>10 ha)	619.6 31.8
	Medium-sized green spaces (2–10 ha)	120.5 6.2
	Small-sized green spaces including pocket parks (<2 ha)	91.9 4.7
Urban Cemeteries	80.8	4.1
Nature parks	883.7	45.3
Community garden	154.2	7.9

* data source extracted from City of Copenhagen, (n.d.)

Table 4
Incidental nature experiences and comparison between cyclists and pedestrians.

Category of incidental nature experiences	Percentage of individual category among all incidental nature experiences (n = 1434)	Active mobility modes	
		Incidental nature experiences by cyclists (percentage, n = 262)	Incidental nature experiences by pedestrians (percentage, n = 1151)
Perceived biodiversity	11.1	11.8	10.9
Surprises/ Inspiration/ Emotion	12.6	9.5	13.4
Nice smells	10.7	9.9	10.9
Aesthetic views	25.0	26.0	24.7
Closeness to water	5.2	8.4	4.4
Nature sounds	16.3	16.4	16.4
Nature observation	19.0	17.9	19.3

Table 5
Mean tree cover density (TCD) values for shortcut places (with a 100 m buffer), mean numbers of incidental nature experiences, and percentage of shortcut places mapped with incidental nature experiences in each green space typology.

Green space typology*	Mean TCD (percentage, with 100 m buffer)	Mean numbers of incidental nature experiences per shortcut place	Shortcut places associated with incidental nature experience in each green space type (percentage)
Public green spaces	9.5	1.4	54.2
Urban cemeteries	53.0	3.3	92.2
Nature parks	19.8	3.8	93.3
Community green spaces	1.7	1.1	53.1
Public open spaces	4.9	1.2	43.3
Street greenery	6.7	1.0	41.9
Blue spaces	11.6	2.6	88.3

* The categories of informal green spaces and private gardens were not included due to the limited number of shortcut places identified there.

Table 6
Relative share (percentage) of visit frequency in active mobility modes, and mean nature connectedness score.

Visit frequency	Shortcut places mapped by cyclists (percentage, n = 138)	Shortcut places mapped by pedestrians (percentage, n = 539)	Total shortcut places (percentage, n = 677)	Mean nature connectedness score (n = 674)
Daily	14.5	19.1	18.2	4.06
Almost daily	23.2	36.2	33.5	3.96
Every week	37.0	31.9	32.9	3.90
A couple of times a month	25.4	12.8	15.4	3.91

green spaces (Section 2.1.1). The shortcut places within public green spaces, urban cemeteries, nature parks and community green spaces were coded by a spatial overlay analysis based on thematic green space maps from the City of Copenhagen (n.d.). The shortcut places within the rest of green space categories were classified and coded accordingly by visual inspection based on aerial photos from GeoDenmark (Dataforsyningen, 2021). To validate the visual classification, the process was repeated after eleven months after the first time, where 98% of the points were in accordance of the two assessment. The distribution of shortcut places was presented with visual graphic and descriptive statistics. Moran’s I analysis was used to identify clusters of shortcut places.

To investigate the distribution of incidental nature experiences, and whether cyclists and pedestrians perceived them differently, the relative proportion of each type of incidental nature experience within the overall total was calculated. Similarly, the different distribution of incidental nature experiences provided by different categories of green spaces was summarized through descriptive statistics, and the relative share (percentage) was compared across the sub-categories of green spaces and tested by one-way ANOVA. The Chi-squared test was applied to analyze the difference of incidental nature experiences between pedestrians and cyclists.

As different categories of green spaces in Copenhagen demonstrate various tree cover densities, tree cover density was selected as the green space characteristic for testing the correlation to the number of incidental nature experiences. The tree cover density data were extracted

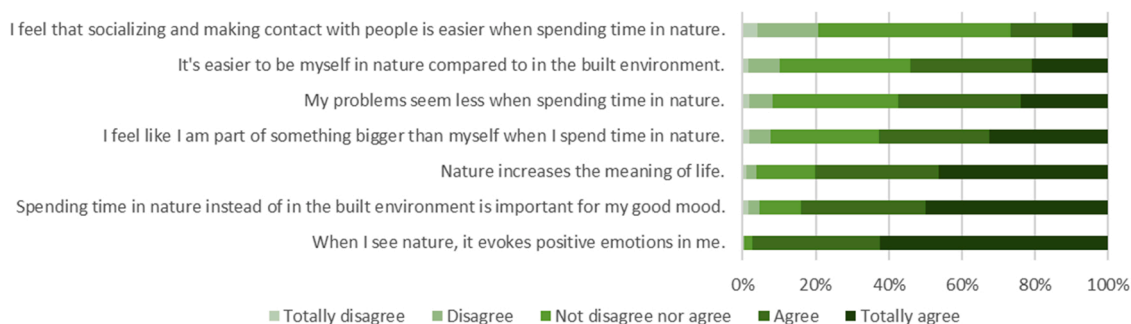


Fig. 3. Respondents' replies to seven nature connectedness statements.

from Copernicus Land Monitoring Service provided by the European Environment Agency (EEA, 2018). The mean tree cover density was calculated for each shortcut place with a 100 m buffer. Spearman correlation was performed to analyze the relationship between the mean tree cover density and the number of incidental nature experiences in each main category of green spaces. To validate the statistical correlation, the mean tree cover density was also calculated for each place with a 50 m and 150 m buffer, followed by a Spearman correlation test.

The range of nature connectedness measurement, from “totally disagree” to “totally agree”, was assigned a score from 1 to 5. Then the mean nature connectedness score was calculated for each shortcut place. The mean nature connectedness score was calculated with descriptive statistics, where the outliers (nature connectedness score lower than 2.30) were excluded. To identify the statistical correlation between the nature connectedness scores and visit frequency, a Kruskal-Wallis test was performed. The results of the seven statements were presented in a stacked bar with relative shares. IBM SPSS Statistics 28.0 and ArcGIS pro 2.9 (Esri Inc, 2022) were used for statistical and spatial analyses respectively.

3. Results

3.1. Shortcut places in green spaces

The PPGIS survey yielded 688 shortcut places in green spaces (Fig. 2) mapped by 517 respondents. The highest concentration of shortcut places (40%) were in the category of public green spaces (Table 2), followed by urban cemeteries (27.9%). Both public open spaces and blue spaces shared 8.7% of total shortcut places, followed by community green spaces (4.7%), street greenery (4.5%), and nature parks (4.4%). According to the percentage of green space cover in five local districts identified by City of Copenhagen (Table 3), large-sized green spaces and nature parks are less represented, while urban cemeteries, medium- and small-sized green spaces are overrepresented in this study.

A visual interpretation of the resulting maps combined with cluster analysis revealed that the shortcut places were clustered in specific type

Table A1 Statistics in five districts ^a.

District	Population	Green spaces (m ²)	Size (km ²)	Share of green space (m ² per inhabitant)	Population density (per km ²)
Nørrebro	78,591	434,849	4.1	5.5	19,146.6
Brønshøj-Husum	44,053	2586,926	8.7	58.7	5041.3
Bispebjerg	53,934	2006,332	6.8	37.2	7893.4
Amager Øst	61,455	1885,297	9.8	30.7	6281.1
Amager Vest	83,966	7961,553	19.4	94.8	4334.8
Total	321,999	1,4874,957	48.8	46.2	6970.3

of green spaces across the city, namely urban cemeteries (Moran's I = 0.88; p < 0.01), and blue spaces (Moran's I = 0.96; p < 0.01) (Fig. 2b, c, g). The distribution of shortcut places in public green spaces was more scattered across the city, affording shortcut opportunities in all districts. This also applied to other main categories of green space, community green spaces, public open spaces, and street greenery (Fig. 2a, d, e, f).

3.2. Incidental nature experiences, difference between pedestrians and cyclists, and tree cover density

An average of 2.1 incidental nature experiences (n = 1434) were indicated for each individual shortcut place. The most frequent incidental nature experiences were aesthetic view (25%) and nature observation (19%), followed by nature sounds (16.3%). Surprises, inspirations, and emotions evoked in green spaces accounted for 12.6% of the experiences. To a lesser degree, respondents also mentioned perceived biodiversity (11.1%), pleasant smells (10.7%), and proximity to water features (5.2%) (Table 4).

For both pedestrians and cyclists, the most perceived incidental nature experience was the aesthetic view (26% and 24.7%, respectively). Pedestrians were found more prone to experiences characterized as “surprises, inspirations and emotions” than cyclists when shortcutting green spaces ($\chi^2(1, n = 681) = 6.208, p = 0.013$); and cyclists were more likely to use shortcut routes where they valued the closeness to

Table A2 Population (age above 18) and local panel size in five local districts.

	Population (age above 18)	Local panel size	Percentage of population (age above 18)
Nørrebro	66,892	7126	10.7
Bispebjerg	46,525	2000	4.3
Brønshøj-Husum	34,172	3628	10.6
Amager Øst	50,039	4000	8.0
Amager Vest	64,158	3000	4.7
Total	261,786	19,754	7.5

Table A3 Comparison of survey respondents (n = 517) to population (age above 18) of the five districts in Copenhagen (n = 261,786).

	Survey respondents	Copenhagen population in five districts
Gender percentage (n = 514)		
Male	27.2	49.0
Female	72.0	51.0
Other	0.8	NA
Age distribution percentage (n = 517)		
18–29	13.7	32.9
30–64	77.2	55.4
65 +	9.1	11.7

^a Source Statistics Copenhagen 2021.

water ($\chi^2(1, n = 681) = 4.761, p = 0.029$).

However, 32% of shortcut places ($n = 220$) were purely shortcuts with no associated incidental nature experiences. The majority of the shortcut places in urban cemeteries (92.2%), nature parks (93.3%), and blue spaces (88.3%) were associated with at least one incidental nature experience (Table 5). Shortcut places in public green spaces (54.2%), public open spaces (43.3%), and street greenery (41.9%) were less likely to be associated with incidental nature experiences ($F(6, 671) = 32,847, p < 0.001$). Accordingly, urban cemeteries, nature parks, and blue spaces have higher mean incidental nature experiences (>2.5) associated per place than other green spaces categories, such as public green spaces and public open spaces (<1.5) (Table 5).

Tree cover density was calculated for each shortcut place with a 100-meter buffer. Shortcut places in urban cemeteries were surrounded by the highest tree cover density (53%). Shortcut places within nature parks and blue spaces had mean tree cover density values of 19.8% and 11.6% respectively. The mean tree cover density of shortcut places within public green spaces was 9.5%. It was found that shortcut places in green spaces with higher tree cover density indicated a larger spectrum of incidental nature experiences (Spearman correlation $r = 0.433, p < 0.001$) (Table 5). The positive correlation was validated by applying 50-meter buffer (Spearman correlation $r = 0.415, p < 0.001$) and 150-meter buffer (Spearman correlation $r = 0.443, p < 0.001$) for each shortcut place.

3.3. Visit frequency and nature connectedness

In this study, respondents were found to have a high level of nature connectedness, with a mean score of 3.95 (Std. Dev. = 0.57, $n = 674$) out of a maximum score of 5. People who had daily shortcut trips in green spaces were found to have the highest mean nature connectedness score, 4.06 (Table 6). Moreover, according to a Kruskal-Wallis test, the frequency of shortcuts in green spaces and the level of nature connectedness were positively correlated ($H(3) = 8.372, p = 0.039$). Respondents generally found nature could provide positivity, good moods, and increased meaning to life (54.2–97.2% strongly agreed or partly agreed across six out of seven statements, Fig. 3).

4. Discussion

This study investigated shortcut trips by walking or cycling in green spaces with associated incidental nature experiences. It was found that higher tree cover density was positively correlated to a broader spectrum of incidental nature experiences. In addition, the frequency of trips within green spaces and the level of nature connectedness were positively correlated. This expanded previous literature on what experiences different green spaces can deliver to active mobility users. In the following, we discuss the results and highlight the possibility of integrated green spaces and active mobility planning with implications for practice.

4.1. Shortcut trips, incidental nature experiences, and active mobility planning

More than half the shortcut trips took place in public green spaces and urban cemeteries, which highlighted the possibility of promoting daily trips by involving these two types of green spaces. This suggested that future green space design and planning could incorporate daily trips as a multifunctional use of green space. The specific design and planning should be considered at site level, allowing for coordination between functions (Hansen et al., 2019). Incidental nature experiences can potentially encourage trips as a function of green spaces. This study identified aesthetic view as the most frequent incidental nature experience, which was also confirmed by previous studies into people's preferences for aesthetically pleasing nature (Qiu et al., 2013; Carrus et al., 2015; White et al., 2017). The importance of aesthetic aspects of walking

and cycling was also mentioned by Timms and Tight (2010) in stressing that the fabric of the built environment for walking and cycling should be visually attractive for enjoyment. According to the new mobility paradigm (Sheller and Urry, 2006), all senses need equal attention when constructing the meaning of active mobility. However, as Conniff and Craig (2016) argue, much research has focused only on the visual. Due to the high subjectivity involved in planning and constructing sensory meaning in mobility planning (Timms and Tight, 2010), a closer collaboration between mobility planners and green space planners is necessary in practice.

4.2. Importance of tree cover density for incidental nature experiences

In this study, we found that higher tree cover density was positively correlated to a wider spectrum of incidental nature experience. Similar observations have also been made that people are sensorially engaged in places rich in vegetation species or with high levels of tree cover (Gao et al., 2014; Carrus et al., 2015; Beery and Jørgensen, 2018). In Copenhagen's context, the green space categories with high tree cover density – urban cemeteries, nature parks, and blue spaces – evoked a wide range of incidental nature experiences. These incidental nature experiences indicate the importance of integrating a wide variety of vegetation that can enhance the attractiveness of green spaces, for example, incorporating seasonal color changes or varied plant shapes (Tribot et al., 2018). However, a density of green environment can bring darkness, with attendant potential safety issues (Skov-Petersen et al., 2018). Despite all the positive effects of high tree cover density to incidental nature experiences, a balance between incidental nature experiences and safety should be considered.

4.3. Empirical evidence about visit frequency and level of nature connectedness

High frequency of green space visits is associated with better physical and mental health outcomes (Flowers et al., 2016; White et al., 2021). In this study, we provided empirical evidence that the frequency of cycling and walking shortcut trips within green spaces and the level of nature connectedness are positively correlated. The linkages shaped by humans connecting with nature can support biospheric concern and thus potentially foster pro-environmental behaviors with sustainability-related outcomes, such as changing transport modes in everyday mobility practices (Mikiki and Papaioannou, 2012; Martin et al., 2020). However, the direction of the relationship (causality) remains unknown, since the data collected in this study did not support the understanding of whether nature-connected people seek such shortcut trips or whether shortcut trips enhance the level of nature connectedness.

4.4. Implications for planning and management practice

Overall, this study highlighted the possibility of promoting shortcut trips in green spaces, and incidental nature experiences should be emphasized when integrating green spaces into active mobility planning. As mentioned, the mobility function should be addressed in multifunctional green spaces that can support close human-nature relationships and potentially encourage walking and cycling as physical activities (Mytton et al., 2012). However, the trade-off of promoting shortcut trips in green spaces should also be noted. Promoting trips in green spaces makes unavoidable the conversion of green to grey surfaces, i.e. bicycle infrastructure, with implications for ecological connectivity and urban ecosystem service supplies. Seemingly, the greening of grey infrastructure by tree-covered bicycle lanes with the intention of delivering sensory incidental nature experiences may also bring complications of ecosystem disservices (e.g., tree root damage to paved surfaces and underground pipes, and possible loss of water infiltration capacity) (Lyytimäki et al., 2008).

Furthermore, integrating the natural environment into urban planning as an ecological design approach raises awareness of the importance of biodiversity. Thus, a higher level of vegetation maintenance is always required to keep trails clear, e.g., of falling branches, which can jeopardize the safety of users, especially cyclists (Ahern, 2013). Contact is also common in these shared green spaces between pedestrians, cyclists and other users, even though injuries are rare and incidents too minor to report. To secure the safety of people walking and cycling, strategies to reduce conflicts should be considered, such as clear signage, separating modes, and reducing cycling speed (Gkekas et al., 2020). Therefore, integrating active mobility within green spaces requires a coordinated and joint effort of sectors in charge of both urban mobility and green space, and high quality of maintenance and design is important to mitigate conflicts and disservices.

Green spaces in the city can provide a “breathable” environment that the people would like to pass through as an escape from traffic routes, as supported by previous studies (Broach et al., 2012; Zhang et al., 2020). The shortcut trips in this study highlight the possibility of integrating active mobility routes into public green spaces and urban cemeteries for future planning in Copenhagen. It should be noted that not every type of green space can provide for a shortcut trip with the mode of cycling. Urban cemeteries are used differently between countries and cities (Nordh et al., 2022). In Copenhagen, urban cemeteries provide multiple recreational uses, including public and private events, such as picnicking and guided excursions (Grabalov and Nordh, 2021). However, they also serve as active burial grounds and are regulated by zoning and separation to avoid user conflicts (Skår et al., 2018). There are limits to integrating active mobility modes, such as cycling, into green spaces for fostering a multifunctional green space.

Due to rules and regulations, there is limited capacity for integrating urban cemeteries into active mobility planning. This speaks to the importance of other types of green spaces. Apart from urban cemeteries, this study reported that nature parks and blue spaces provided a large range of incidental nature experiences. Therefore, it might be beneficial to plan for walking or cycling shortcut opportunities through these types of green space. In this study, informal green spaces were the least mapped type for shortcut trips. However, Rupperecht and Byrne (2014) argued that informal green spaces, although often overlooked, have the potential to provide new possibilities for multifunctionality. This suggests that further attention to informal green spaces is required in urban green space planning. The unique location of informal green spaces (such as the corner of a street or next to a multistory building) leads to a scattered spatial distribution in cities that is hard to join up. Thus, future active mobility infrastructure implementation can function as a conduit to link informal green spaces with other types of green spaces for better green space connectivity in cities. For example, pocket parks and street trees can function as green corridors, with manifold benefits (Peschardt and Stigsdotter, 2013). In return, a green corridor created by informal green spaces can separate off the car-dominated traffic, providing cyclists and pedestrians with a safer travel environment (Zhang et al., 2019).

4.5. Future research and limitations

An integrated green space and active mobility planning approach requires coordination of the urban sectors in charge of urban mobility and green space planning and maintenance. Therefore, the way urban sectors can strategically work together for mobility planning and the multifunctional use of green space should be explored. Further, in this study, we identified the differences between the active mobility modes of cycling and walking in terms of perceived incidental nature experiences. Other studies have also pointed out the differences between cycling and walking when it comes to preferences regarding the physical environment, e.g., pedestrians are sensitive to street greenery and require a higher level of greenery than cyclists (Wu et al., 2020). Therefore, future research should address these differences and better

connect these two modes for informing design and planning. Furthermore, this study implied recreational walking and cycling for shortcut trips. Whether the nature experiences perceived through recreational active mobility modes could lead to increases in utility walking and cycling is raised as a subject for further investigation. In addition, our study highlighted cemeteries as hotspots for shortcut trips with associated incidental nature experiences, providing options for the increased use of urban cemeteries (Grabalov and Nordh, 2021). However, how to balance the use of cemeteries as multifunctional green spaces and as active burial grounds requires investigation from a long-term planning perspective.

Some limitations of this study should be mentioned. Firstly, we applied an adapted typology of green spaces in Copenhagen. The green space typology can vary according to different classifications, definitions, and explanations of green spaces. The typology applied in this study could, in some cases, be simplified, for example, by situating water bodies in green spaces. Therefore, the co-presence of green and blue should be taken into account. Secondly, the participatory approach can cause a bias in the data (Brown and Kytä, 2014). The data accuracy level may vary with the devices used by respondents for the online PPGIS survey. Thirdly, the sample was biased in terms of demographic characteristics. The middle-aged (aged 30–64) and females were over-represented in this study (Table A3), which was to be expected as the local panels showed the same overrepresentation pattern. Other PPGIS studies also observed that females and the middle-aged are more likely to participate and respond to the surveys (e.g., Fagerholm et al., 2021). Additionally, the survey topic and personal interests may influence the response rate (Fan and Yan, 2010), with people who use green spaces more often being more likely to respond to the survey. This study did not consider vulnerable social groups, such as people with mobility disabilities. Therefore, how this integrated planning approach can address social inclusion should be further explored.

5. Conclusion

This study applied a participatory mapping approach (PPGIS) for understanding place-based active mobility experiences with green spaces. Shortcut trips in green spaces are generally associated with incidental nature experiences, especially aesthetic views, and nature observations. To deliver a wider spectrum of incidental nature experiences, higher tree cover density is important. We provide insight that frequent walking or cycling trips in green spaces can support a close human-nature connection. This study highlighted the possibilities and potential of integrated green space and active mobility planning, while rules and regulations of different types of green spaces and trade-offs should be considered in planning practice. This integrated planning approach requires, furthermore, a joint effort from the urban sectors in charge of green spaces and active mobility in order to deliver synergistic benefits.

CRedit authorship contribution statement

Yu Liu: Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft, Writing - Review & Editing, Visualization. **Nora Fagerholm:** Resources, Writing - Review & Editing. **Hans Skov-Petersen:** Writing - Review & Editing, Supervision. **Thomas Beery:** Conceptualization, Writing - Review & Editing, Supervision. **Anne Margrethe Wagner:** Writing - Review & Editing, Supervision. **Anton Stahl Olafsson:** Conceptualization, Methodology, Investigation, Resources, Writing - Original Draft, Writing - Review & Editing, Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A

see Tables A1-A3.

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