# How urban green spaces relate to health and well-being

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# Chapter 5

## Green Space Attachment and Its Interrelations with Neighborhood Attachment, Connectedness to Nature, and Quantity and Quality of Green Spaces: A Construct Validation Study

## Abstract[4]

Green Space Attachment (GSA) has been introduced as a specific form of place attachment that captures people's emotional bonds with their neighborhood green spaces (Zhang, Van Dijk, Tang, & Van den Berg, 2015). To measure GSA, a multidimensional scale was developed, encompassing four dimensions of place dependence, affective attachment, place identity, and social bonding. In the current study, we aimed to examine the reliability and validity of the GSA scale by exploring its factor structure as well as its convergent and discriminant validity with measures of Neighborhood Attachment (NA) and Connectedness to Nature (CN). We also examined the scale's sensitivity to variations in the objective quantity and perceived quality of neighborhood green spaces. Confirmatory factor analysis of data from an online survey among a sample of 227 adults in the Netherlands from diverse geographical backgrounds confirmed the four-dimensional structure of the GSA scale. GSA was significantly related to NA and CN with low-to-moderate positive correlations. As both scales measure similar but distinct concepts, this supports the construct validity of the GSA. While GSA varied with perceived green space quality, it showed little variation with the quantity of green space. This further supports the validity of GSA as a measure that is sensitive to specific aspects of green space that are considered to play an important role in the development of attachment to places. Taken together, these findings suggest that GSA is a promising construct in studying the more fine-grained relationships between people and their neighborhood environment.

Key words: place attachment; scale validation; urban green spaces; well-being

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## 5.1 Introduction

With over half of the world's population living in cities, there is growing interest in the contribution of green space to people's health and well-being. Especially the quality of green space, in terms of accessibility and usability, has increasingly been implicated in pathways linking urban green space to health and well-being (Francis Wood, Knuiman, & Giles-Corti, 2012; Marselle, Irvine, Lorenzo-Arribas, & Warber, 2014; Van Dillen, De Vries, Groenewegen, & Spreeuwenberg, 2012; Wheeler et al., 2015). High-quality green spaces not only provide opportunities for health-promoting physical activities and social contacts, they may also support the emotional bonding of residents with their local green spaces (Korpela, Ylén, Tyrväinen, & Silvennoinen, 2009). According to the biophilia hypothesis, this tendency of humans to affiliate with natural places may have a genetic basis shaped by human evolution in natural surroundings (Kellert & Wilson, 1993). A recent study found that stronger bonding or attachment to green space was related to better mental health in a neighborhood with high-quality green spaces compared to a neighborhood with low-quality green spaces (Zhang et al., 2015). Green space attachment (GSA) thus seems an important concept in understanding the beneficial affordances of urban green space.

To measure GSA, Zhang et al. (2015) developed a scale encompassing four dimensions of place dependence, affective attachment, place identity, and social bonding. The reliability of the scale was confirmed by factor analysis on the data of the study in the two neighborhoods with low and high green space quality. However, further validation of the scale with a more diverse sample and in comparison to other outcome measures is needed. The aim of the current paper is to analyze the internal consistency of the GSA (reliability) and its factorial structure (construct validity), its convergent and divergent validity with related self-report and objective measures including Neighborhood Attachment (NA) and Connectedness to Nature (CN), as well as its sensitivity to variations in the objective quantity and perceived quality of neighborhood green spaces. To address this aim we conducted a survey among respondents from a variety of geographical and socio-economic backgrounds. After describing the development of the scale, we will give an overview of the method and results of this study.

### *5.1.1 The measurement of green space attachment*

The GSA scale was developed using a theoretical approach based on models of place attachment. Place attachment can be defined as the emotional attachment between people and places where people endow values by steady accretion of sentiment (Tuan, 1977). Most of the studies on place attachment have focused on the level of neighborhood. However, neighborhood is a fuzzy and heterogeneous concept, and place attachment may vary with different components or zones within the neighborhood, like green spaces. Therefore, Lewicka (2011) called for the inclusion of a greater range of place types and meanings in studies of place attachment, both at higher and lower scale-levels. The investigation of people's attachment to the specific green space component of the neighborhood environment may thus add to a more fine-grained understanding of place attachment.

Our conceptualization of green space attachment draws from the work of Schreyer, Jacob, and White (1981), who considered place attachment in terms of two components: place identity and place dependence Place identity involves a cognitive connection between the self and a physical environment through ideas, beliefs, preferences, feelings, values, goals, behavioral tendencies and skills relevant to this environment (Proshansky, 1978). Urban green spaces have been found to provide many opportunities for urban residents to establish a personal identity, which in turn may foster environmentally sustainable attitudes (Budruk, Thomas, & Tyrrell, 2009). Place dependence refers to how well a place is able to satisfy occupants' needs and activities, relative to an existing range of alternative places (Stokols & Shumaker, 1981). Local natural areas tend to lend themselves well to strengthening this more functional attachment, presumably because they allow for frequent visitation (Vaske & Kobrin, 2001).

In the original conceptualization of Schreyer et al. (1981), place attachment as an overarching concept was decomposed into a cognitive and functional component. However, as suggested by Jorgensen and Stedman (2001), there is recognition that feelings of attachment should be discerned as a distinct affective component of place attachment. The opportunity to enjoy local green settings such as parks has been found to be particularly effective in establishing an affective attachment to a place (Kyle, Mowen, & Tarrant, 2004). In addition to cognitive, functional and affective components, a social component of place attachment has been distinguished to represent the meaningful social relationships between people and places developed from shared experiences

(Kyle, Graefe, & Manning, 2005). Local parks may provide the contexts that support social interaction and the development of social ties among neighborhood residents (Kaźmierczak, 2013), which may evolve in attachment to these nature settings over time.

A few studies have included all the four dimensions discussed above in examining place attachment in nature-based places (e.g., Ramkissoon, Weiler, & Smith, 2012; Wynveen, Kyle, & Sutton, 2012). A case study in a national park in Australia supported the second-order construct of place attachment with four sub-dimensions (Ramkissoon, Smith, & Weiler, 2013). In a related vein, a study of place attachment in the London Olympic Games examined venue attachment as a second-order factor with four sub-dimensions that are comparable to the four dimensions of place attachment, namely place identity, place dependence, place affect, and place symbolism (Brown, Smith, & Assaker, 2016).

In this study, we conceptualize GSA as a specific form of attachment to green spaces, consisting of a second-order factor with four sub-dimensions: place dependence, affective attachment, place identity, and social bonding. Following Zhang et al. (2015), we define place dependence as the extent to which green spaces functionally meet residents' goals and facilitate their activities; affective attachment examines the emotional ties that residents have formed with green spaces; place identity reflects the process by which, through interaction with green spaces, people describe themselves in terms of belonging to the green spaces; and social bonding refers to the meaningful social relationships between people and green spaces developed from shared experiences. On the basis of this conceptualization, we formulate our first hypothesis as follows:

Hypothesis1: GSA is a reliable construct with four sub-dimensions, place dependence, affective attachment, place identity, and social bonding.

### *5.1.2 Green space attachment and neighborhood attachment*

As a specific form of place attachment, GSA should be related to, but distinct from, more encompassing types of place attachment. To test this notion, it is thus important to compare GSA with more general measures of attachment to one's neighborhood. A high NA has been found to be predicted mostly by the strength of social relationships (Bonaiuto, Aiello, Perugini, Bonnes, & Ercolani, 1999; Lewicka, 2011; Mesch & Manor, 1998). For example, a study in four Central-European cities, revealed that residents who had stronger social ties with their

neighbors tend to report higher NA (Lewicka, 2010). However, physical features related to the use of green space may also contribute to fostering NA. For example, a case study in Montreal revealed that the proximity to physical features such as highways, public transit, and urban parks was positively related to NA (Jean, 2015).

In general, NA and GSA differ in that NA is more encompassing than GSA and more strongly linked to neighborhood ties. However, NA is also partly shaped by the positive perception and experience of neighborhood green spaces (Arnberger & Eder, 2012). Moreover, local residents may use nearby green spaces for recreation, relaxation, and physical activities, which may also indirectly influence NA by facilitating social contacts and strengthening social ties (Lewicka, 2011). Therefore, it can be expected that NA shares commonalities with GSA.

Hypothesis 2: GSA is positively correlated with NA and its sub-dimensions.

### *5.1.3 Green space attachment and connectedness to nature*

CN refers to the extent to which an individual feels that he/she and nature are interconnected (Mayer & Frantz, 2004). As such, it is an individual trait of the subjective connection to nature. Several instruments have been developed to measure this concept. For example, Schultz (2001) has developed a graphical measure, the inclusion of nature in self scale, which asks individuals to indicate which degree of overlap between circles representing 'self' and 'nature' best describes their relationship to nature. However, this measure has been criticized for being a single-item measure and for requiring people to assess their relation with nature at a very high level of abstraction (Mayer & Frantz, 2004). Alternatively, several multi-item scales have been developed, including the Connectedness to Nature Scale (CNS, Mayer & Frantz, 2004), the Nature Relatedness Scale (NRS, Nisbet, Zelenski, & Murphy, 2009), and the Connectivity with Nature Scale (Dutcher, Finley, Luloff, & Johnson, 2007). Especially CNS has been widely used as a self-report measure of CN which has been used and validated in many studies (Howell, Dopko, Passmore, & Buro, 2011; Howell, Passmore, & Buro, 2013). Theoretically, the concept of CN shares many similarities with the concept of GSA. Both concepts tap into an affective bond with the natural environment that strengthens one's self-identity. The two concepts also differ in that CN focuses on the natural world in general, while GSA focuses on neighborhood green spaces. However, since neighborhood

green spaces are the nature places that people most frequently experience in their daily lives, attachment to these places may form a basis for a more general connection to nature at large. As such, we expect CNS and GSA to be positively related.

Hypothesis 3: GSA is positively correlated with CN, with the strongest correlations for the more affective GSA-dimensions of place identity, affective attachment, and social bonding.

### *5.1.4 Indicators of neighborhood green space*

As a measure of place attachment situated at the level of green spaces, GSA should be sensitive to variations in characteristics of nearby green space. Particularly, the quantity and perceived quality of green spaces have been considered as important indicators of nearby green spaces in many studies (Groenewegen, Van den Berg, Maas, Verheij, & De Vries, 2012; Hur, Nasar, & Chun, 2010; Van Dillen et al., 2012). GSA may be promoted by a higher quantity of neighborhood green spaces, since more green space provides more opportunities for residents to visit green spaces, and thus form a bond with green space. In line with these notions, GSA can be expected to be positively related to the quantity of green spaces and visiting frequency. However, the quality of green spaces seems important as well. A high quality of green spaces is an important precondition for positive use experiences, which may promote the emotional attachment to green spaces. A case study conducted in urban and suburban areas of Vienna showed that the perceived supply and perceived quality of green spaces were strong predictors of community attachment (Arnberger & Eder, 2012). Based on these findings we hypothesize GSA to be sensitive to the quantity and quality of green space, as well as the visiting frequency of green space.

Hypothesis 4: GSA is positively correlated with the quantity, quality, and visiting frequency of neighborhood green spaces.

## 5.2 Methods

### *5.2.1 Survey and respondents*

Data were collected via an online self-completion questionnaire in the Netherlands in October 2016. Its understandability and clarity were checked by

a pilot test. The questionnaire started with an introduction of the aim and scientific use of the current study, indicating that personal information would be treated confidentially and anonymously. Respondents were recruited randomly by ThesisTools, an online survey service website. Invitations to participate in the survey were sent to potential participants by emails from ThesisTools within their pool of respondents in the Netherlands. A week after sending the invitations, the online questionnaire was closed. Participation was voluntary, and respondents did not receive any monetary compensation.

A total of 370 respondents opened the survey, of whom 246 completed the survey (completion rate of 66%). After excluding respondents younger than 16, a total sample of 227 participants remained (43% men, mean age 51 years, range 17-84 years). More than half of the respondents reported higher vocational or academic education, 47% had completed secondary school, and 2% reported elementary school or less. Nineteen percent of the respondents had been living in their neighborhood for less than 5 years, 34% for 5 to 15 years, 21% for 16 to 25 years, and 26.9% for longer than 25 years. As illustrated in Figure 5.1, participants' residential locations were well spread across the Netherlands.


**Figure 5.1**

Map of residential locations of the participants, based on 4 and 6 position postal codes (*N* = 224). Source: BatchGeo

### *5.2.2 Measures*

GSA was measured using 14 items encompassing four dimensions of place dependence (4 items), affective attachment (3 items), place identity (3 items), and social bonding (4 items) (see Table 5.1 for an overview). NA was measured using the 11-item version of the place attachment instrument developed by Williams and Vaske (2003), which comprises dimensions of place dependence

(5 items, sample item "My neighborhood is the best place for what I like to do") and place identity (6 items, sample item "I feel very attached to my neighborhood"). The social dimension of NA was measured with a 9-item social cohesion scale which is part of the standard toolkit for monitoring liveability in neighborhoods in the Netherlands (Bolt & Torrance, 2005; Dekker, 2007). Sample items are "I have a lot of contact with the other residents" and "I live in a nice neighborhood with a lot of togetherness". Affective attachment was not independently measured at the neighborhood level to avoid the questionnaire becoming too repetitive and lengthy. CN was measured with the 14-item CNS developed by Mayer and Frantz (2004). Sample items are "I often feel a kinship with animals and plants", and "I feel as though I belong to the Earth as equally as it belongs to me". All responses were given on a 5-point scale, ranging from "strongly disagree" to "strongly agree".

**Table 5.1**

Overview of items of the Green Space Attachment Scale.

| **Green Space Attachment Scale** |
|---|
| **Place dependence** |
| PD1 I enjoy visiting green spaces in my own neighborhood more than visiting any other green spaces |
| PD2 I get more satisfaction out of visiting green space in my own neighborhood than I get from visiting green spaces elsewhere |
| PD3 I prefer the green space in my own neighborhood over other green spaces for the recreational activities that I enjoy most |
| PD4 I wouldn't substitute any other green spaces for the green spaces in my own neighborhood |
| **Affective attachment** |
| AA1The green spaces in my neighborhood mean a lot to me |
| AA2 I am very attached to the green spaces in my living environment |
| AA3 I feel a strong sense of belonging to green spaces in my living environment |
| **Place identity** |
| PI1 I feel that green spaces in my living environment are part of me |
| PI2 I identify strongly with the green space in my living environment |
| PI3 Visiting green spaces in my living environment says a lot about who I am |
| **Social Bonding** |
| SB1 The time spent in the green spaces in my neighborhood allows me to bond with my family and friends |
| SB2 I have a lot of fond memories of past experiences with family in green spaces in my living environment |

| |
|---|
| SB3 Visiting green space in the neighborhood allows me to spend time with my friends and family |
| SB4 I associate special people in my life with green space in my living environment |

The quantity of neighborhood green spaces was calculated based on the postal code of the respondents as the percentage of green spaces in each respondent's neighborhood environment, using the GIS database set of Top 10 NL. Because there was no fixed format for the postal code in the survey, only 182 respondents reported a valid six-position postal code. Other respondents only reported the four numbers of their postal code, which represents a larger area than the neighborhood, and thus could not be used in the quantity calculations. The neighborhood environment of each respondent was delineated as a circle with a radius of 1.5 km (10-15 min walking) around the center of his/her postal code area. All public vegetated places such as urban parks, forests, agriculture areas were defined as 'green space'. In addition to the quantity of green space, additional information on the visiting frequency was obtained by the question "how often do you visit your neighborhood green spaces?" (1 = never, 5 = daily).

The perceived quality of neighborhood green spaces was measured by six questions adapted from previous studies regarding green space maintenance, amenities, facilities, natural qualities, incivilities, and accessibility (Arnberger & Eder, 2012; Gidlow et al., 2016). Sample items are "The green spaces in my neighborhood are well maintained" and "The green spaces in my neighborhood have enough facilities for play and recreation (e.g. playgrounds, soccer fields, walking trails)". Participants could indicate their agreement with the statements on a 5-point scale ranging from "strongly disagree" to "strongly agree.

### *5.2.3 Analysis*

Confirmatory factor analysis (CFA) was used to examine whether the second-order factor of GSA with four sub-dimensions (place dependence, affective attachment, place identity, and social bonding) was confirmed by the survey data. This CFA was conducted in LISREL 8.8 using maximum likelihood estimation method. SPSS (version 23.0) was used to calculate reliabilities of the scales (Cronbach's alpha) and Pearson's correlations between GSA and its sub-dimensions with other variables measured in the study.

## 5.3 Results

### *5.3.1 Reliability analysis*

As shown in the last row of Table 5.2 the GSA scale showed good reliability, with Cronbach's alpha > .82 for the overall scale as well as the subscales. All the other scales used in this study also showed sufficient reliability, with Cronbach's alpha > .74 (see last column of Table 5.2).

### *5.3.2 Confirmatory factor analysis*

The results of CFA of the second-order GSA model using maximum likelihood method are presented in Figure 5.2. All standard factor loadings ranged from 0.69 to 0.94, and were statistically significant ($p < .001$). The model fit indices of CFA showed that the examined model had an acceptable fit: $\chi 2\ (73) = 207.75$, $p < .01$, RMSEA = 0.090, SRMR = 0.056, CFI = 0.98, PGFI = 0.61, PNFI = 0.77.

The examination of the model construct validity was accomplished by convergent and discriminant validity. Since all the factor loadings of the second-order model were above the 0.5 threshold and statistically significant ($p < .001$), it confirmed the convergent validity of the model. Discriminant validity could be assessed by the correlations between the first-order GSA dimensions. Correlations less than 0.85 indicate discriminant validity likely exists between the first-order constructs (Lee, Segal, Kimberlin, Smith, & Weiler, 2014), while correlations higher than 0.85 show constructs might measure the same thing (Campbell & Fiske, 1959). In the second-order model, the correlations between the first-order dimensions ranged from 0.67 to 0.83, supporting discriminant validity. The moderate-high correlations also provide evidence for the second-order factor GSA, as theoretically the first-order dimensions should be correlated. This test confirmed that the sub-dimensions of GSA were not perfectly correlated and brought distinct values to GSA.

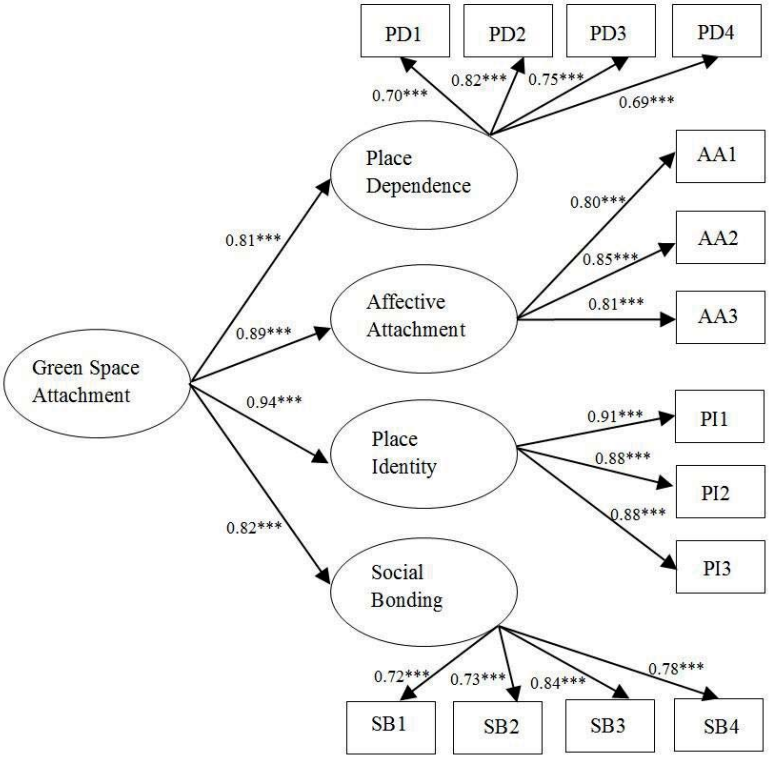


**Figure 5.2**

Standardized results of the confirmatory factor analysis, * $p < .05$, ** $p < .01$, *** $p < .001$. Note: PD1-PD4, AA1-AA3, PI1-PI3 and SB1-SB4 are indicators of the four sub-dimensions of green space attachment (See Table 5.2 for explanations of the abbreviations). Numbers represent the factor loadings of indicators.

### *5.3.3 Relationships between green space attachment, neighborhood attachment and connectedness to nature*

As shown in Table 5.2, overall GSA and overall NA were significantly correlated, sharing 27% of their variances. Overall GSA was also highly significantly correlated with the three sub-dimensions of NA. The four sub-dimensions of GSA (place dependence, place identity, affective attachment and social bonding) were significantly associated with overall NA and its three sub-dimensions with a shared variance of at least 16%. These findings show residents may experience GSA similarly to NA with moderate substantial overlap.

Overall GSA was also significantly related to CN with 9% of their variances shared. At the subscale level, all dimensions of GSA were significantly correlated with CN, but, as expected, relationships were strongest for the more affective dimensions, place identity, attachment, and social bonding. In general, these results indicate that GSA shares some similarities with CN in a statistically significant and theoretically meaningful way.

**Table 5.2**

Correlations of Green Space Attachment (GSA) and its sub-dimensions with Neighborhood Attachment (NA) and its sub-dimensions, Connectedness to Nature (CN), and quantity, quality and visiting frequency of neighborhood green space. Reliabilities (Cronbach's alpha) are provided for each (sub)scale.

| | GSA | | | | | |
|---|---|---|---|---|---|---|
| | Total | Place dependence | Place identity | Affective attachment | Social bonding | Cronbach's Alpha |
| NA-total | .523*** | .467*** | .442*** | .510*** | .395*** | .93 |
| NA-identity | .522*** | .441*** | .480*** | .515*** | .379*** | .91 |
| NA-dependence | .499*** | .516*** | .409*** | .438*** | .367*** | .82 |
| NA-social cohesion | .362*** | .299*** | .281*** | .380*** | .294*** | .86 |
| CN | .292*** | .140* | .340*** | .260*** | .267*** | .85 |
| Quantity green spaces | -.102 | -.147* | -.012 | -.099 | -.090 | - |
| Quality green spaces | .292*** | .282*** | .185** | .368*** | .187** | .74 |
| Visiting frequency | .371*** | .248*** | .385*** | .317*** | .310*** | - |
| Cronbach's Alpha | .94 | .82 | .92 | .86 | .85 | |

* $p < .05$, ** $p < .01$, *** $p < .001$

### *5.3.4 Relations of green space attachment with the quantity and quality of neighborhood green spaces*

Correlations were also computed to examine the sensitivity of GSA to the quantity, quality and visiting frequency of neighborhood green spaces. The results, as shown in Table 2, reveal that, against our expectations, GSA was generally negatively, though mostly non-significantly, correlated with the quantity of green space. For the GSA dimension of place dependence, this negative correlation was even significant at the .05 level. A possible explanation for these unexpected results could be that in the context of Netherlands, extremely high percentages of green space often indicate the provision of grassland and agriculture land which may probably provide limited functions to meet residents' goals and facilitate their activities.

Consistent with the expectations, GSA and its sub-dimensions were generally positively correlated with the quality of green spaces, as well as with the visiting frequency of green spaces. This further validates GSA as a measure sensitive to variation in green space quality and exposure.

### *5.3.5 Relations among neighborhood attachment, connectedness to nature, green space quantity, green space quality, and visiting frequency*

Table 5.3 shows the interrelations among NA, CN, as well as the quantity, quality and visiting frequency of neighborhood green spaces. Like GSA, NA was significantly correlated with the quality of green spaces, as well as with visiting frequency. CN was also positively correlated with visiting frequency. However, GSA was more strongly correlated with visiting frequency than NA and CN, which supports the usefulness of distinguishing GSA from NA and CN. The quantity of neighborhood green spaces was not meaningfully related to any of the other variables.

**Table 5.3**

Correlations among neighborhood attachment (NA), connectedness to nature (CN), the quantity of neighborhood green space (Quantity GS), the quality of neighborhood green space (Quality GS), and visiting frequency.

| | CN | Quantity GS | Quality GS | Visiting frequency |
|---|---|---|---|---|
| NA | .045 | .000 | .300*** | .267*** |
| CN | - | .115 | .054 | .170** |
| Quantity GS | | - | .044 | .014 |
| Quality GS | | | - | -.010 |

* $p < .1$, ** $p < .05$, *** $p < .01$

## 5.4 Discussion

The study aimed to assess the reliability and validity of GSA as a specific measure of place attachment which captures people's attachment to the green spaces in their neighborhood. Using an online survey sample, the results provide evidence that the second-order GSA with four sub-dimensions (place dependence, affective attachment, place identity and social bonding) fits the sample data well, confirming Hypothesis 1. The good reliabilities of GSA and its sub-dimensions further demonstrate the usefulness of this second-order construct for examining attachment to neighborhood green spaces. These results support findings by Zhang et al. (2015) indicating that GSA constitutes a reliable measure with a good internal validity.

Hypothesis 2 and Hypothesis 3 examined the convergent and divergent validity of GSA with NA and CN, respectively. We expected that residents may experience GSA similarly to NA and CN, due to GSA, theoretically, sharing commonalties with the other two constructs. However, the correlations between them may be not perfect, because GSA captures different aspects of people's relationships with their neighborhood and with nature in general than the other two constructs. Consistent with our predictions, the correlations between GSA and NA/CN were generally significant but not so large as to implicate similarity. Particularly, the shared variance between GSA and CN was only 9%. This low variance could be due to that connectedness to nature scale developed by Mayer and Frantz (2004) examines people's beliefs about their connection to nature instead of their emotional connection to nature (Perrin & Benassi, 2009). Overall, these findings confirm that GSA is distinct from NA and CNS, indicating GSA could bring new values to study the human-environment relationship.

Hypothesis 4 examined whether GSA would be sensitive to the quantity, quality and visiting frequency of green spaces. GSA was significantly related to quality of green spaces and visiting frequency, with the strongest correlations for the

affective dimensions of GSA. These findings further support the validity of GSA in particular with respect to the affective dimensions of the scale.

Percentage of neighborhood green spaces was generally found to be unrelated to GSA, as well as to NA, CN and other variables in the study. Similar null findings were reported in a previous case study conducted in Australia, which revealed that neither the percentage of green space within suburbs nor the proximity to nearest green space was statistically significantly associated with residential place attachment (Kimpton, Wickes, & Corcoran, 2014). Therefore, these findings may implicate that the quantity of green space is not an essential determinant of GSA, NA and CN. However, methodological issues may also play a role. Data on quantity of green space were incomplete due to missing information on the six-position postal code, which may have reduced the power to detect significant relationships. Moreover, the definition of neighborhood used to estimate the quantity of green space (a circle with a radius of 1.5 km around the center of the respondents' postal code area) might differ from the respondents' own perception of the green space supply in their neighborhood environment.

There are some limitations to this study. A first limitation is the use of an online survey. Although online surveys are more suitable than on-site surveys for obtaining data on a large variety of green spaces (Williams & Vaske, 2003) online collection of data may have caused bias by excluding residents who do not have internet access. Second, the reliance on self-report data may have led to inaccurate assessments. Third, given the correlational nature of this study, no causal relationships can be derived. Fourth, measurement of the objective quantity of neighborhood green spaces was hampered by limitations in the availability of postal code information and by issues regarding the definition of neighborhood.

Future studies could use (additional) data collection methods, like face-to-face interviews or written questionnaires, to reach a wider population. To overcome the limitations of self-report measures, future studies could employ more implicit measures for measuring people-environment relationships such as the implicit association test (Schultz, Shriver, Tabanico, & Khazian, 2004). Establishment of causal relations could be facilitated by employing longitudinal designs, in which residents' attachment to green space is monitored with simultaneous assessment of other behavioral and perceptual indicators. It might also be of interest for future studies to apply different ways of measuring objective quantity of green

spaces such as the Normalized Difference Vegetation Index (Dadvand et al., 2012) or using other pre-defined boundaries of neighborhood environment.

Another avenue would be to examine the predictive value of GSA for diverse individually and societally relevant outcomes, such as pro-environmental behaviors (e.g., Vaske & Kobrin, 2001), participation in green space design and management (Buijs et al, 2016), or health and well-being indicators (Scannell & Gifford, 2017a). Additional work could also employ more experimental designs to estimate the effects of GSA on health and well-being. For example, participants may be asked to visualize green spaces they are more or less attached to, which may shed light on how manipulating GSA can causally affect health and well-being (Scannell & Gifford, 2017b).

## 5.5 Conclusions

This study explores whether the concept of place attachment is applicable in the context of neighborhood green spaces. The findings of this paper support the reliability and validity of a second-order GSA to estimate the emotional bonds between residents and their neighborhood green spaces. GSA correlated with other constructs that are theoretical related and was sensitive to variations in green space characteristics. The findings highlight that GSA shares some commonalties with NA and CN, but brings distinctive values to people-environment research. Compared to the quantity of green space, the quality of green spaces might be a more important predictor of people's affective bond with their living environment in general, and green spaces in particular.

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