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The Restorative Value of the Urban Environment: A Systematic Review of the Existing Literature

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ABSTRACT

BACKGROUND: Stress poses a major issue in our modern society, making restoration an important research focus. Restoration likelihood has mostly been observed in nature, which was compared with urban environments that have little restorative potential, eg, industrial areas. However, many people reside in and need to find restoration in cities. The main aim of this review is to summarize research that has focused on investigating restoration possibilities in urban environments and the environmental elements interacting with the restoration likelihood of an urban environment.

METHOD: This review focuses on studies addressing the topic of restoration possibilities in urban settings in built and human-made natural urban environments. The studies were searched via Google Scholar, PsycINFO, PsycARTICLES, and PSYNDEX. All studies concerned with restoration in urban environments were included. However, studies concerned with nonoriginal data, solely investigating effects of natural environments or treating urban environments as a control for restoration in nature, were excluded from the review. Overall, 39 studies corresponded to the criteria and were included.

RESULTS: Natural elements in urban environments have a restorative potential and can increase the restorativeness of urban settings. Furthermore, built urban environments vary in their restorative potential, but promising results have been uncovered as well. Architectural elements, cultural, and leisure areas had a restorative value, whereas the findings on streets and residential areas differ. In sum, many urban locations can have restorative effects, but these effects may be influenced by factors such as cultural background, age, social components, and individual dispositions.

DISCUSSION: Certain urban environments hold a restorative potential. However, the literature on restoration in urban environments is still quite scarce and therefore has been of little practical use. Even though applying the findings to real-life environments is desirable, it might prove difficult, considering the overall sparse evidence. More research on the predictors of restoration likelihood (eg, social factors), generational and cultural differences, and comparisons between natural and urban environments is recommended.

KEYWORDS: Restoration, perceived restorativeness, urban environments, built environments, urban nature

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Introduction

Stress has been identified as a major health risk in industrialized societies and is directly and indirectly responsible for immense costs to health systems and the economy.[1] Consequently, strategies for avoiding stress—eg, improved working conditions and promoting a healthier lifestyle—have received increasing interest in many countries and companies. However, given the many potentially competing interests—eg, short-term vs long-term profits, public health expenditure vs taxes, working more for higher income vs leisure activities—it remains unclear to what extent and when such prevention-focused efforts will be successful. For the time being, identifying effective ways to *recover* from stress remains at least an equally important task.

On one hand, environmental factors such as noise can have a massively negative impact on physiological and psychological well-being.[2] On the other hand, there is widespread agreement that certain features of the environment may also increase resilience or foster restoration.

Joye and van den Berg[3(p58)] define restoration as "the experience of a psychological and/or physiological recovery process that is triggered by particular environments and environmental configurations." Most research on restoration likelihood suggests that natural environments hold a much higher restoration potential than urban environments.[4,5] Explanations for these findings typically take an evolutionary point of view and range from the absence of information-processing in nature and a reduction in (physiological) arousal to being away from one's everyday life and the recovery of attention.[6,7]

Urbanization poses new challenges: currently, more people reside in cities than in rural regions, and many lead stressful lives.[8] Natural, rural environments are often not feasible options

for city dwellers seeking recovery. Therefore, it is necessary to identify restoration possibilities in their everyday lives, eg, after work or school. In this review, we address the question, if and where restoration can be found in urban environments by summarizing the results of studies concerned with this question.

Concepts and Theories

Although this article focuses on the empirical evidence regarding urban restoration, some theoretical background is needed in order to understand the approaches taken in some of the studies. There are 2 major theories in restoration research: Attention Restoration Theory and Psycho-Evolutionary Theory of Stress Reduction.[5,7] Attention Restoration Theory conceptualizes restoration as a recovery from mental fatigue fostered by an absence of directed attention. According to Kaplan and Kaplan, 4 environmental qualities can facilitate involuntary attention: (1) fascination, describing the environment's ability to hold involuntary attention; (2) being away, referring to the feeling of being freed of directed attention and everyday life; (3) extent, as in a rich and coherent environment that creates a world of its own; and (4) compatibility, referring to the fit between the environment and a person's intentions.[7,9]

In contrast, Ulrich[6] and Ulrich et al[5] conceptualized stress, not attention fatigue, as the source for need for restoration. The Psycho-Evolutionary Theory of Stress Reduction claims that emotions, rather than cognitions, have an impact on restoration.[5,6]

Both theoretical approaches, however, have certain limitations and are disputed in the field of environmental psychology.[10] For example, Ulrich et al[5] criticized the lack of emotional components in Attention Restoration Theory and its strong focus on rather complex cognitive appraisal mechanisms. In a way, Stress Reduction Theory mirrors Attention Restoration Theory's deficit: the latter's focus on emotional states and stress relief goes along only marginally with the cognitive processes being addressed. Moreover, the theories' stances on basic psychological insights, such as the distinction between cognitive, behavioral, emotional and physiological levels of consideration, and their possible decoupling remain rather ambiguous. Most importantly, concerning the scope of this review, both Attention Restoration Theory and Stress Reduction Theory largely disregard and partly challenge the restorative potential of urban environments.[5,9] Despite their different perspectives, both Attention Restoration Theory and Stress Reduction Theory presume that humans have been shaped by their interaction with natural environments in the course of evolution. This idea is accompanied by a general skepticism concerning the restorative value of nonnatural, human-made environments. This conceptual fixation on natural environments may have partly inhibited unbiased and rigorous comparisons to urban environments.

For a detailed description of the major theories, namely, Attention Restoration Theory[7,9] and Psycho-Evolutionary Theory of Stress Reduction,[5,6] please refer to the original articles or to the work by Staats[11] for an overview.

Survey Methodology

Research questions

In this review, we aim to answer the following research questions:

1. Do urban environments have a restorative potential?
2. Which urban environments are perceived as restorative?
3. Which (environmental) elements interact with the restorative potential of a place?

Literature search

To answer these questions, we searched for articles concerned with restoration in urban environments. (Unfortunately, no review protocol is available.). The articles reviewed were researched via Google Scholar, PsycINFO, PsycARTICLES, and PSYNDEX. The following terms were used for this search: "architecture," "built environment," "environmental planning," "health," "perceived restorativeness," "recreation areas," "restoration," "restoration likelihood," "restoration possibilities," and "urban environment." The *Journal of Environmental Psychology* as well as *Environment and Behavior* were investigated issue by issue for additional articles concerning the topics reviewed individually. Furthermore, we visited the websites of those researchers, whose studies had been of interest for the review to find further studies, conference presentations, etc. If we found a review concerned with restoration in general, we checked which articles the authors had reviewed and if any of them met our inclusion criteria. Because we found few studies concerned with the relationship between restoration likelihood and built urban features, we expanded our search to human-made natural elements in urban contexts. Therefore, we included the terms "urban greening," "urban green environments," "urban green spaces," "urban forestry," "urban parks" and the terms for the 4 restorative qualities proposed by Kaplan[9] "being away," "compatibility," "extent," and "fascination". The literature search ended in September 2018.

Inclusion and exclusion criteria

All studies on restoration possibilities in urban environments and, in particular, urban features holding a restoration potential that were found during the search were included in this review, regardless of method, publication status, and sample size. Reason for this decision was the overall sparse literature on restoration in urban environments. Studies concerning nature in urban environments were included if the environment was human-made, including city parks and city greening. For a study to be considered, the outcome criterium had to be the (perceived) restorativeness of a place in an urban environment.

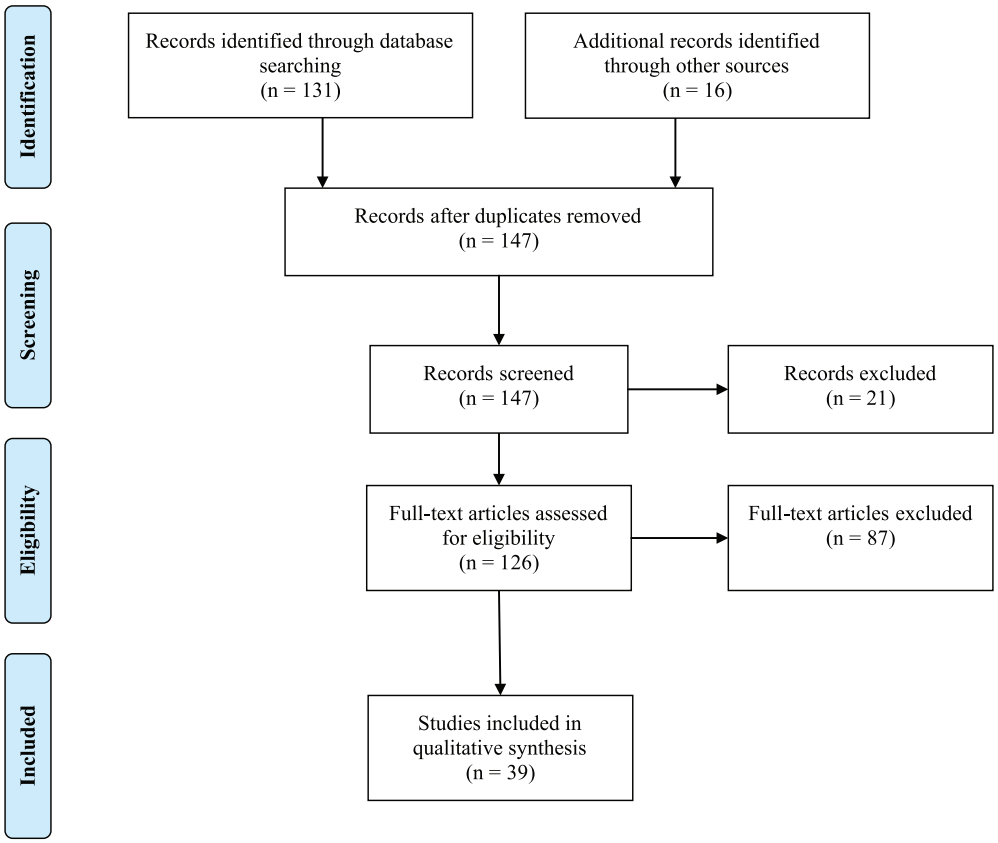

Figure 1. PRISMA flow diagram.

Unfortunately, only studies published in English could be considered. Therefore, it is possible that studies published in other languages were missed. Furthermore, the threat of publication bias is also present. However, we made an effort to find unpublished manuscripts or conference papers by scanning publication lists of authors we cited. Studies using a different restoration concept than psychological restoration, such as restoration of fish or plant population, were excluded after initial screening (21 studies). Studies that only addressed the restorative effects of nature, comparing nature to urban settings or solely investigating preferences for urban locations, were not taken into consideration. Articles focusing on rural environments, forests, green areas near cities, or other nonurban components or articles concerned with nonoriginal data (eg, reviews), or methodological papers were excluded after further reading as well (87 studies). We provide a table of the reviewed studies with each study's topic, the sample size, the study's design, the results, and country of conduction in Appendix 1. In total, 39 studies were included in the review. For a detailed breakdown of the literature research and the review criteria, see the PRISMA flow diagram in Figure 1 and the PRISMA checklist provided in the supplementary materials.[12]

Empirical Research on Urban Components

In the studies identified for this review, 2 broad categories of urban components with restorative value can be differentiated: natural elements in urban environments and aspects of the built environment itself.

The restorative effects of natural elements in the urban environment

Research on psychological restoration has focused on specific aspects of nature as opportunities for restoration and, as far as empirical findings are available; they suggest that natural environments provide better restoration than urban environments. Thus, it is not surprising that most studies agree that natural and naturalistic elements in an urban context—such as trees in gardens, grass patches and flowers growing along streets, or parks—exert restorative effects, as well.[8,13–34]

Perceived restoration in parks and botanical gardens is high, as stated for example by Staats et al[8] and Carrus et al,[13] and the restorative effect of playgrounds and school campuses can be increased by the presence of natural elements, as was found in studies by Bagot et al[32] and Mejía-Castillo et al.[27] Even relatively small patches of greenery make a difference: Hernández and Hidalgo[14] showed that ratings on the restoration likelihood of various urban environments, eg, streets, buildings, or even industrial zones, increased if natural elements were present. Similar findings were reported by Lindal and Hartig[15] using computer-generated streetscapes. Even flowering meadow green roofs,[16] views of nature from windows, indoor plants, gardens, and proximity to green spaces in an urban neighborhood can have positive effects on cognitive and affective components of restorative experiences.[17–19] A qualitative study from Norway by Nordh et al[20] indicated that cemeteries can have restorative effects as well, possibly due to the fact that

cemeteries in Northern Europe are usually well-maintained and park like green areas in the cities.

In line with Attention Restoration Theory[7,9] and Psycho-Evolutionary Theory of Stress Reduction,[5,6] the above findings point to a general restorative effect of natural and naturalistic elements in urban environments. However, many details remain unclear. For instance, Tenngart Ivarsson and Hagerhall[19] found that 2 well-tended, attractive gardens can be rated quite differently in respect to their perceived restorativeness. There is also one study by Galindo and Hidalgo[35] in which natural elements did not contribute to restoration likelihood in urban spaces. Consequently, in recent years, several studies have focused on identifying the specific factors underlying the restorative effect.

Nordh et al[21] discovered that the restorative potential of parks was mediated by 2 of the 4 restorative qualities postulated by the Attention Restoration Theory,[9] being away and fascination. Grass, amount of trees and bushes, as well as park size predicted restoration likelihood. In the already mentioned study by Lindal and Hartig,[15] similar effects were found with computer-generated images: being away mediated the effect of grass and number of flowers on restoration likelihood, and fascination mediated the effect of tree arrangement, and presence of flowers on restoration likelihood. A study using an eye-tracking paradigm by Nordh et al[22] showed which features in photos of urban parks participants focused on for rating restoration likelihood. The participants looked at trees, benches, and bushes. However, no relationship between the natural elements of the park and restoration likelihood could be found, except for a correlation with grass. In another study by Tyrväinen et al[23] participants took a walk in 3 different urban locations, a constructed park, an urban woodland, and a built urban environment (city center) in Helsinki, Finland. They rated the perceived restorativeness highest for the woodland, but physiological measures of stress relief showed no difference between the 3 settings.

Nordh and Østby[24] asked participants to rate the restoration potential of parks with different features. Participants tended to rate parks with many natural features like grass and water as most restorative and parks with many disturbances (eg, traffic) and little vegetation as least restorative. Participants used parks to philosophize and for social activities. Similar results with a Chinese sample were contributed by Wang et al.[25]

Nordh[33] compared 3 different ways of measuring restoration in urban parks: ratings of environments based on quantified photos, eye-tracking, and choice-based conjoint analysis. With all 3 methods, she found that participants were able to distinguish between different elements of parks or were able to imagine the park setting. All 3 methods were able to provide insights into the restorative potential of parks.

Hipp et al[26] conducted an online study on campus green spaces. Perceived restorativeness of the campus correlated with perceived campus greenness. Furthermore, perceived restorativeness mediated the relationship between perceived greenness and perceived quality of life, lending support to the restoration concept. However, the researchers themselves state that their findings might be hard to generalize to nonstudent populations. Similar results with school green spaces were contributed by Mejía-Castillo et al.[27] They found schools with a medium to large amount of green spaces to be more restorative, more fascinating, more likely to have extent and to create a sense of being away than schools without green spaces.

Jiang et al[30] found tree cover density in an urban neighborhood to have an effect on stress recovery for male participants, but not for female participants. For the male participants, recovery increased with tree cover density in the lower density range, then stagnated with medium levels, and increased again but slower with high density levels. In a second study, Jiang et al[31] found the relationship between self-reported stress recovery and tree cover density to be linear, regardless of age, gender, and stress level.

Grahn and Stigsdotter[34] asked participants in their study, which elements of nature they preferred and found that a combination of different aspects—refuge, nature, and diversity of species—could increase restoration in urban settings. Furthermore, they found that a low presence of social stimuli could also contribute to a restorative experience. Scopelliti et al[28] came to similar results, as they found that people engaging in environmental in contrast to social activities experienced more restoration. Moreover, in their study, the urban green area with the highest biodiversity received the highest rating on perceived restorativeness. In another study from that group, Carrus et al[29] asked residents of 4 Italian cities about their restorative experiences in 4 different urban locations, which varied in location (urban vs peri-urban) and biodiversity (low vs high): an urban square with trees, an urban park, a pinewood forest plantation, and a protected reserve. The peri-urban locations as well as the locations higher in biodiversity were perceived as more restorative than the urban locations or the locations with lower biodiversity, respectively. Furthermore, high biodiversity showed a stronger link to perceived restorativeness for urban compared with peri-urban environments.

Taken together, even little amounts of vegetation in urban environments seem to be sufficient for a restorative experience, with only 1 study producing negative results. Trees, flowers, and grass patches could be integrated into cities easily to enhance their restorativeness. However, the factors underlying the observed restorative effects are far from clear. Although theoretical approaches emphasize a special role of "naturalness" from an evolutionary perspective, this claim has not been substantiated empirically yet. Especially, if adding greenery is not a feasible option or limited by practical considerations, which elements of the built environment may serve the restoration process?

Built urban environments can be restorative as well

With the strong theoretical focus on natural environments (see above), the restorative potential of everyday urban environments has seldom been taken into account. In many studies,

built environments mainly served as a baseline or control condition (see previous section), but there is also some evidence that at least certain types of built environments can be restorative themselves.

Scopelliti and Giuliani[36] asked participants to name places that they visit to have a restorative experience. Surprisingly, they did not find a difference between natural and urban environments. Rather, the participants tended to name places associated with certain leisure activities, such as listening to music at home, going to the movies, a park, or a museum, or spending an evening at a restaurant. The participants' answers highlight the notion that activities have a very high restorative potential, with the environment and the activity probably interacting. For example, social activities were rated to be restorative and easier to achieve in urban environments.

This already demonstrates 2 main findings present in most of the studies discussed below: (1) in principle, built environments can have restorative effects similar to those of natural environments, and (2) social aspects play an important role.

Hernández and Hidalgo[14] asked participants to judge the perceived restorativeness of photos showing streetscapes, buildings, and industrial zones. Streetscapes yielded the highest scores, especially those with natural elements present. In 2 other studies with an explorative approach, Galindo and Hidalgo[35] and Hidalgo et al[37] asked participants to name places that they found most and least attractive in their hometowns and categorized them into 4 categories: cultural-historical places, recreational places, panoramic places, and housing areas. Participants liked cultural-historical places, recreational areas, and panoramic places, ie, places in the city with an expansive view, best, rated them as the most restorative, and restoration significantly predicted perceived attractiveness, creating a link between a place's restorative and aesthetic value. The cultural-historical and the recreational places were rated as most restorative. These results for cultural-historical environments were replicated in another study.[38] Interestingly, participants judged residential areas to be among the least liked and least restorative, but, as the authors noted themselves, this may have been partly due to the high crime rate in some of the neighborhoods.[35,37]

Fornara and Troffa[38] recruited participants as they were spending leisure time in 4 different urban settings: an urban park, a shopping mall, a historical site, and a panoramic site. Participants were asked to rate the sites according to the environmental qualities proposed in Attention Restoration Theory. The researchers concluded that the historical site was perceived to be as restorative as the urban park on all restorative qualities and can therefore be considered a restorative urban environment. Furthermore, they found the panoramic promenade in their study to be less restorative compared with the cultural-historical site and the urban park. The panoramic promenade in their study did not hold any historical elements, differing from the panoramic view used in the study by Galindo and Hidalgo,[35] possibly explaining the result.

Staats et al[8] investigated the restorative value of parks, shopping malls, busy streets, and cafés by asking participants to imagine being in one of those places. The participants rated being in parks to be more restorative than sitting in a café, which was rated to be more restorative than shopping at a mall. However, all 3 settings were rated as rather restorative, whereas walking along a busy street was evaluated to be the least restorative.

Mejía-Castillo et al[27] asked students to name their favorite places for restoration in their school. In addition to the schools' green spaces, students rated cafeterias as a possible place for restoration. Cafeterias scored highest for facilitating a feeling of being away and green spaces for the other environmental qualities proposed by Kaplan.[9]

In line with the above findings on cultural-historical places, museums and churches provide restoration as well, at least for some people. In a study by Kaplan et al,[39] experienced visitors found the visit more restorative compared with individuals who had not visited a museum since their childhood. Interestingly, inexperienced visitors found the art on display to be even more fascinating than did frequent visitors, but they did not show as much cognitive involvement. In a study by Packer and Bond,[40] natural environments received the highest restoration ratings, but people who had previously visited art galleries rated their restorative potential higher than people, who had previously visited a botanic garden, a history museum, or an aquarium; furthermore, frequent visitors found the art gallery even more restorative than occasional visitors. Moreover, when asked concerning their motives for visiting churches, people also mentioned their restorative aspects: In line with Attention Restoration Theory, Herzog et al[41] identified, among others, the factors beauty—summarizing extent and fascination—and being away. Similar results were reported by Ouellette et al[42] for visits to monasteries.

Some studies had a closer look at age and gender differences: As would be expected, Bagot et al[32] found that playgrounds have a higher restorative value for younger than for older children. Two studies by Rosenbaum and colleagues[43,44] indicate that adolescents valued the restorative potential of servicescapes, such as video arcades and coffee shops, whereas elderly participants found restoration in a special café offering senior activities in their neighborhood. Age differences were also present in the study by Fornara and Troffa,[38] already mentioned above. Participants age 50 and over rated the restorative qualities consistently higher than younger participants; however, in the study by Scopelliti and Giuliani,[36] only minor age differences were present. In the study by Mejía-Castillo et al,[27] males rated fascination, being away and overall restorativeness higher than females, suggesting possible gender differences. Furthermore, age correlated positively with fascination, being away, and extent, suggesting age effects and raising the question of developmental patterns in restorative experiences.

The studies having a closer look at age and gender differences show that noteworthy interindividual differences exist, and that effects of the environment potentially interact with personality traits, emotional states, expectations, and intentions. For instance, research by Finlay et al[45,46] showed that even casinos hold restorative potential, especially for nonrisk gamblers, but these findings can probably not be transferred to the general public. In one of the studies by Staats et al,[47] participants were asked to imagine being either attentionally fatigued or not, being in social company or alone, and further being in an urban park, at home, in the city center, or transit. Participants rated their preference for being in an urban park higher than being in any other of the 3 urban settings when in a state of attentional fatigue. Moreover, their preference for parks increased when fatigued compared with not fatigued, and it decreased for all other settings. In addition, their preference for social company decreased with attentional fatigue and increased when the participants imagined being not fatigued in all 4 settings. In another study by Staats et al,[8] interestingly, restoration need did not have an effect on the rated restorativeness of the settings under investigation, but the authors found differences between their Dutch, Swedish, and American samples, which warrant a closer look in future studies. Another interesting result was that a "sense of belonging" to a city, as investigated in the study by Hidalgo et al,[37] influenced the rated restorative value, whereas the years of living in a city did not. Furthermore, Galindo and Hidalgo[35] found that the presence of leisure facilities as well as the attribution of being a "meeting place" correlated with restoration likelihood.

The results presented above indicate that the social, recreational, cultural, and spiritual functions of urban environments strongly determine their potential for restorativeness. However, by strongly focusing on these social aspects, these studies tell us little about the effects of the built environment itself. But some studies have focused on the effects of architectural details.

Using sets of computer-generated images, Lindal and Hartig[48] showed that higher levels of architectural variation and lower building height were judged to provide a higher restoration likelihood, which was highly correlated with a general preference rating. Furthermore, the effects of architectural features on restoration likelihood were partly mediated by the qualities of fascination and being away proposed by Kaplan.[9] By contrast, increased building height led to higher ratings of perceived enclosure, which in turn was negatively correlated with restoration likelihood. These results indicate that architectural features of buildings and streetscapes have effects on restoration likelihood. In another study, Lindal and Hartig[15] used those pictures which had the highest and the lowest restoration potential and included trees, grass, and flowers. The restoration likelihood was low to moderate for all pictures, but tended to be higher if trees and flowers were present. Moreover, being away as well as fascination mediated the effect of number of trees on restoration likelihood. However, only being away mediated the effect of grass, and number of flowers on restoration likelihood, and only fascination mediated the effect of tree arrangement, and presence of flowers on restoration likelihood. Architecture and vegetation had a significant influence on restoration likelihood, their interaction, however, was not significant. Surprisingly, the effect size for architecture was much larger than for vegetation indicating that architecture had a bigger influence than vegetation.

Tabrizian et al[49] examined how aspects such as permeability and spatial arrangement interacted with the environmental setting. An increase in permeability increased perceived restoration of an urban plaza, whereas in a park an increase in enclosure decreased perceived restoration. Furthermore, the effect of enclosure on restoration was mediated by safety. In another study, Galindo and Hidalgo[35] found luminosity, openness, and congruence to correlate with perceived restorativeness.

San Juan et al[50] compared 2 open public squares, which were either high in natural elements and high in enclosure or low in natural elements and low in enclosure. They found that both squares decreased tension-anxiety, anger-hostility, fatigue, vigor, and stress, and increased happiness from pre- to posttest. However, the square high in natural elements and high in enclosure showed higher values for restoration compared with the square low in natural elements and low in enclosure, but visitors to the latter showed a higher decrease in stress.

Summary and Discussion of the Findings

Summary of the results

We collected and compared studies concerned with urban environments in the previous section. Summing up the results and answering research question 1, we found that different types of urban environments may indeed have a restorative value.

To answer research question 2, we took a closer look into the types of urban environments that are perceived as restorative. We found that natural urban as well as built urban spaces can have a restorative value. Most of the studies reviewed were concerned with restoration in urban nature, all of which yielded positive results suggesting that green spaces in cities provide a good possibility for restorative experiences. Hernández and Hidalgo[14] even discovered that the mean value for restoration likelihood increased if natural elements were present, independent of urban scene evaluated. Restorative potential has been uncovered for parks,[21,22,24,25] botanical gardens,[13] cemeteries,[20] and urban woodland.[23] But even smaller green spaces such as trees, grass, flowering meadow green roofs, or flowers growing along streets or in a residential area can help to relieve mental fatigue.[15-18] Furthermore, green spaces in schools or on campuses are perceived as restorative.[26,27]

Built urban spaces also posed a restorative capacity. All built urban environments reviewed here had a restorative value. However, there were differences in their restorativeness with historical places showing the highest restorativeness.[35,37] Places associated with recreational activities such as cafés and

Table 1. Key areas of recommendations for future research.

Predictors	Favorite places/personal meaning of places Social factors Sensory impressions
Cultural and generational differences	Cultural differences in restoration likelihood Restoration in children, adolescents and elders Generational differences Development of restoration over the life span
Comparisons between natural and urban environments	Comparison of restorative urban with natural settings

museums showed less restorative potential according to some studies,[8,35,37,40] but were also visited for restorative purposes by some individuals.[36]

Research question 3 was concerned with the environmental elements interacting with the restoration likelihood of a place. Lindal and Hartig[15] found that architectural elements had an effect on restoration as well, which was even bigger than the effect of vegetation on restoration. This finding suggests that, at least in urban settings dominated by constructed elements (in contrast to natural elements), architectural characteristics such as lower building height and higher levels of variation in the building façade play an important part in the restoration process. The finding of architectural variation as an influence factor of a place's restoration likelihood might partly explain other findings showing that historical buildings, often rich in façade elements, are perceived as restorative.[35,37,38]

Other environmental attributes that had an effect on restoration potential were enclosure,[48,49] biodiversity,[28,29] aesthetic value attributed to the place by the participant,[35] the individual's sense of belonging to a city,[37] amount of disturbances such as traffic,[24] openness, luminosity, congruence,[35] and state of mental fatigue,[47] all of which moderated the restorative value of a place. Moreover, recreational areas offer a variety of leisure activities and studies on different leisure areas have produced promising results. These include, among others, cafés, restaurants, playgrounds, museums, spiritual places, and even casinos.[8,32,36,39,40-43,45]

In conclusion, there is a growing body of research on restoration possibilities in urban environments, which provides insights into the restorative value of different urban places.

Discussion of the empirical research on restoration

There are some limitations regarding the available empirical research concerning restoration possibilities in urban environments. First, despite its relevance, the total number of studies concerned with this research topic is relatively small. This is surprising because one might assume that restoration likelihood in urban areas should be an interesting and valuable subject for researchers from many different disciplines. Unfortunately, the findings so far have been of little practical use. Their application to concrete environmental settings is difficult, as research has generally focused on identifying already present urban environments with restorative value rather than on finding out how to construct them.

One important point of criticism is that the existing studies often conceptualize urban settings in strong contrast to natural environments.[4,5,51,52] The urban environments used in some studies have mainly consisted of industrial and residential areas as well as streets in business districts, ie, particularly those with the lowest restoration likelihood found in other studies.[8,35,37] A confounding variable may be the cultural expectation we have regarding cities and nature. Cities are assumed to be hectic and crowded, nature to be calm and friendly. However, just as there are restorative urban areas, some natural environments are probably nonrestorative. In fact, some studies provide evidence that urban places can be equally or even more restorative than natural environments.[36,37,53–55] Aesthetic attributes affect the restorative quality of a place, and the restorative value of attractive urban areas is quite high.[37]

From a methodological point of view, most studies that we reviewed conducted group comparisons or were concerned with correlative relations. They may offer interesting insights and are an excellent starting point, but further statistical analyses dealing with causal relations were only performed in a few studies.[48] Nevertheless, most of the existing studies are of high quality and allow for the generalization of their findings, even if an insight into causal, moderating, or mediating relationships is desirable in future research.

Recommendations for future research

The research on restoration in general and on restoration likelihood in urban environments in particular offers many prospects for further research drawing on those mechanisms already uncovered. For an overview of the recommendations, see Table 1.

Predictors of restoration likelihood. Influences on restoration have not yet been fully investigated. For example, which psychological constructs (eg, personality traits) predict restoration likelihood? What sensory impressions influence the restoration process? And what is the role of social components for restoration?

Some possible influences on restorative experiences come to mind, and some researchers have already begun investigating

them. For example, Ratcliffe and Korpela[56] found that place attachment and place memory can impart high restorative value. Scopelliti and Giuliani[36] state more specifically that the restorative meaning of a place stems from the values a person attributes to experiences that he or she had there, what he or she did there, with whom, and how much the activity was enjoyed. They place a high value on the social component of restoration, and the results of their study indicate that social factors are indeed of importance, especially for adults. Activities with a partner or with family are more restorative for adults than they are for elderly people or young adults, whereas younger people profit most from spending time with friends. This highlights possible age differences in restoration likelihood. Indeed, social factors other than spending time with friends or family come to mind. Crowding is one of them and might even be a contributing factor as to why some perceive cities as being less restorative than nature. Noise produced by humans leads to depletion of cognitive abilities through the use of selective attention and thus hinders restoration.[57]

Furthermore, the time a person is able to spend on restoration is of importance as well. Scopelliti and Giuliani[36] discovered that people tend to spend more time at home on single week days and more time in built or natural environments on weekends and vacations. Age is also predictive of the restoration likelihood of a place. Younger people tend to search out built or natural environments when they are in need for restoration, adults natural environments, and elderly people home environments. This could be confounded with the difficulty of reaching a natural environment for impaired elderly urban citizens.

The restoration concept is primarily based on visual aspects; the theories and studies have had little to say about other sensory impressions. Factors contributing to the restorative value of an environment may include singing birds,[58] the smell of flowers, or even the rather unpleasant smell of some cities if a person connects those with nice memories, building on Scopelliti and Giuliani.[36] Very little work has been conducted on this topic, and we recommend future research on it.

Relaxation techniques used in clinical psychology—including mindfulness—and restoration, have stress-reducing and recovery effects, respectively. Mindfulness is a stress-reducing concept used in psychotherapy and may also influence restoration likelihood.[59] Mindfulness describes an effort to capture the present moment and cultivate awareness of oneself and one's surroundings and consists of active coping mechanisms that help to generate relief from stress. Kabat-Zinn[60,61] specifically states that mindfulness can help us experience our environment with all of our senses. From what we have discussed so far, environments can contribute to a restorative experience and may interplay with relaxation techniques and mindfulness.

Cultural and generational differences. Research on restoration has concentrated on Western cultures, specifically European and US-American citizens, with only a few recent studies conducted with East Asian participants.[25] Although many different populations have been studied, including Icelandic, Swedish, and Spanish samples, among others, the absence of samples from many other cultures is striking. Staats et al[8] compared Swedish, Dutch, and American citizens regarding their estimated restoration likelihood in the 4 different aforementioned settings. Although the 3 cultures were all Western societies, the researchers found major differences, which, according to the researchers, could be attributable to numerous factors, eg, differences in population density (Netherlands: high, Sweden: medium, United States: low). Small differences were also present in the Italian and Spanish sample in the study by Hidalgo et al.[37] Staats et al[8] found that country of residence moderated the evaluation of the 4 settings but did not influence restoration likelihood itself. Furthermore, the interaction effect of social company and country of residence was significant for the park and the street setting. Moreover, the interaction between mental fatigue and country of residence also had an intermediate effect. However, it is unclear, as the researchers stated themselves, whether the cultural differences found may be attributable to country of residence or rather to city size. Studies on other cultures may produce relevant results as well.

Furthermore, few studies have addressed restoration in children and adolescents. However, as far as we know from the existing studies, children find different environments to be restorative than do adults.[32] Research on restorative environments for children is an important field. Adults can search out restorative places according to their own will, whereas children do not have this freedom and move in a much smaller circle predefined by their parents, teachers, or other adults. More research is desirable to highlight the development of preferred restorative environments over the life span.[62]

We also need research on the restorative value of environments for the elderly. This population group faces a similar problem as children. Due to physical impairments, the mobility of many elderly decreases. However, it is also important for them to have restoration possibilities nearby. Differences between this age group and adults have already been uncovered.[36]

Urban and natural environments compared. Much potential lies in the investigation of existing urban environments to find more restorative locations. Some have already been uncovered, but more studies are desirable to replicate and extend these findings. Researchers may like to determine more about what cultural and panoramic places are especially restorative and under which conditions. It is likely that the Colosseum in Rome is more recreational on a calm summer evening than on a chilly winter day or more recuperative with fewer tourists than with crowds of noisy visitors. Assumptions such as these have to be examined, however. Research on buildings and

residential streets as potential restorative environments has produced mixed results.[37,48] Further research is needed to discover what other influences predict the restorativeness of these areas. Confounding variables may be crime rate, maintenance, complexity, and novelty of building form and façade, as well as building height.[63]

Finally, many studies have compared natural environments to the least restorative urban locations, namely, streets and buildings in business districts and industrial zones.[64] Studies comparing restorative urban settings, such as cultural areas, to natural ones still need to be conducted, as this has seldom been investigated. Stigsdotter et al[55] took a first step in this direction by comparing the restorative effect of a walk in the historical part of Copenhagen to a walk in a forest in an arboretum. They discovered that there were no differences on psychophysiological measures, such as heart rate variability and blood pressure, after the walk in the 2 environments. However, they uncovered differences in perceived restorativeness between the 2 environments advantaging the forest. Karmanov and Hamel[54] also compared a restorative natural environment (Amstelland) to a restorative urban environment (Eastern Docklands in Amsterdam). Perceived restoration did not differ after watching videos of the 2 settings. However, the natural environment showed a higher restorative potential for depression but not for anger and anxiety. These interesting results warrant a closer look into the differences between restorative urban and natural environments. For example, are natural environments more restorative under every condition? What about the prospect of meeting dangerous animals, which may not be present in most parts of Europe but certainly are in many other parts of the world?

Many open questions remain. Research on restoration and especially restoration in cities is a promising field with yet many more interesting phenomena to be discovered.

Conclusions

Urban environments can have a restorative potential. However, much research has concentrated on urban locations with very little restorative value. Nonetheless and especially during the past 2 decades, many researchers have reported promising findings. Certain urban locations, including cafés, museums, cultural places, and even some residential streets, have a high potential for restoration. Whether further research on cities' restoration potential can change the negative connotations of cities as noisy, hazardous environments remains to be seen.

Studies on this reviewed topic are few, but they provide generalizable results, which can help to generate new research questions. Many questions are still unanswered, and it will be a long time before we will be able to respond to them adequately. What is certain is that restoration is not only limited to nature but also includes some urban environments, irrespective of these being located in a small town or a large city.

Author Contributions

AMW and JT conceived of the presented idea. AMW conducted the literature research and selection, and drafted the manuscript. AMW and JT commented on and revised the manuscript. Both authors read and approved the final version of the manuscript.

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Appendix 1

Table A1. Main results of the articles reviewed in alphabetical order.

ARTICLE	TOPIC	LOCATION	SAMPLE	DESIGN AND QUESTIONNAIRE	RESULT
Bagot et al[32]	Vegetation and restoration in urban settings	Australia	550 children	Correlational PRCS-C[a]	Vegetation predicts perceived restoration likelihood of a playground
Baron and Rosenbaum[43]	Restoration in video arcades and coffee shops	USA	Study 1: 172 teenagers Study 2: 437 undergraduates	Correlational PRS[b]	Video arcades as well as coffee shops are restorative for adolescents
Carrus et al[13]	Restoration in botanical gardens	Italy	127 from 4 Italian cities	Field experiment PRS, Italian version[c]	Perceived restoration in botanical gardens was high
Carrus et al[29]	Restoration in urban green spaces	Italy	568 from 4 Italian cities	Field experiment PRS, Italian version	Biodiversity has a stronger link to perceived restoration in urban compared to peri-urban environments
Finlay et al[45]	Restoration in casinos	USA	22 people, who had gambled in 6 casinos	Natural experiment McKechnie[65] and Kaplan and Kaplan[7] scales	Casinos have restorative value, especially for nonrisk gamblers
Finlay et al[46]	Restoration in casinos	USA	484 people, who like to gamble	Correlational McKechnie[65] scale	Casinos have a restorative value
Fornara and Troffa[38]	Restoration potential of different urban environments	Italy	197	Correlational PRS, Italian version	Historical environments have the same restorative potential as urban parks
Galindo and Hidalgo[35]	Restoration likelihood in different urban environments	Spain	132	Correlational PRS, Spanish version[d]	Aesthetic value of an urban place correlates with restoration likelihood
Grahn and Stigsdotter	Restorative aspects of nature	Sweden	953	Correlational Self-estimations of health	Refuge, diversity in species, nature, and absence of social stimuli could increase restoration likelihood of urban environments
Hernández and Hidalgo[14]	Vegetation and restoration in urban settings	Spain	214 university students	Correlational PRS, Spanish version	Natural elements in urban environments have a restorative value
Herzog et al[41]	Restoration in spiritual places	USA	781 undergraduates	Correlational Adaptation of Ouellette et al[42] scale	Christian spiritual places have a restorative value
Hipp et al[26]	Vegetation and restoration in urban settings	USA and Scotland	570 students from 3 universities	Field experiment PRS	Vegetation on campus increases restorative value
Hidalgo et al[37]	Restoration and preference	Spain Italy	Study 1: 58 Study 2: 98	Correlational PRS, Spanish and Italian versions	Preferred places are rated to be more restorative, and restorative places are preferred
Jiang et al[30]	Effect of tree cover density on stress recovery	USA	158	Experiment Cortisol and skin conductance levels	Tree cover density increased stress recovery for male participants in a U-shaped curve, but not for female participants
Jiang et al[31]	Effect of tree cover density on stress recovery	USA	158	Experiment VAS[66]	The association between tree cover density and stress recovery is linear

(Continued)

Table A1. (Continued)

ARTICLE	TOPIC	LOCATION	SAMPLE	DESIGN AND QUESTIONNAIRE	RESULT
Kaplan et al[39]	Restoration likelihood in cultural places	USA	Study 1: focus groups with 8 to 12 members Study 2: 124	Natural experiment A survey	Museums hold ART's 4 restorative qualities and are restorative
Kuo[17]	Green areas in poverty stricken neighborhoods	USA	145 female residents	Field experiment Digit Span Backwards test[67]	Residents of buildings with nearby green areas showed less mental fatigue compared with residents of buildings with no nearby green areas
Kuo and Sullivan[18]	Green areas in poverty stricken neighborhoods	USA	145 female residents	Field experiment Digit Span Backwards test[67]	Residents of buildings with nearby green areas showed less mental fatigue and aggression compared with residents of buildings with no nearby green areas
Lee et al[16]	Vegetation and restoration in urban settings	Australia	150	Experiment PRS	Flowering meadow green roofs are restorative
Lindal and Hartig[48]	Restoration likelihood of residential areas	Iceland	263	Experiment Some items of the PRS	Being away and fascination enhance restoration likelihood in residential streetscapes
Lindal and Hartig[15]	Restoration likelihood of residential areas	Iceland	188	Experiment Some items of the PRS	Vegetation on residential streetscapes enhances restoration likelihood. However, architectural elements had a larger effect on restoration than vegetation did
Mejía-Castillo et al[27]	Restoration likelihood in schools	Mexico	706 high school students	Correlational EPREE[e]	Leisure areas with green spaces are suited best for a restorative experience in schools
Nordh[33]	Methods to measure restoration	Study 1 and 2: Sweden Study 3: Norway	Study 1: 51 university students Study 2: 33 university students Study 3: 154	Correlational Study 1: PRS Study 2: One question assessing restoration Study 3: One question assessing restoration	All 3 methods are able to provide insights into the restorative value of parks
Nordh et al[20]	Restoration in cemeteries	Norway	59 visitors to a cemetery in Oslo	Qualitative Semistandardized interview	Visitors' description of their use of the cemetery corresponded with a restorative environment
Nordh et al[22]	Restoration likelihood in urban spaces	Sweden	33	Correlational One question assessing restoration	Grass and restoration likelihood have a positive relation. The relations to the other components (eg, benches) were nonsignificant
Nordh et al[21]	Restoration in parks	Sweden	52	Correlational, PRS	Fascination and being away mediate restoration likelihood in parks. Grass, trees, bushes, and park size predicted restorativeness
Nordh and Østby[24]	Vegetation and restoration in urban settings	Norway	58 university students	Correlational One question assessing restoration	Green spaces in parks benefit restorative experiences

Table A1. (Continued)

ARTICLE	TOPIC	LOCATION	SAMPLE	DESIGN AND QUESTIONNAIRE	RESULT
Ouellette et al[42]	Restoration in monasteries	Canada	521 visitors to a Benedictine monastery	Correlational Survey developed for the study	Monasteries hold restorative potential, but more experienced visitors name beauty and spirituality as their reasons for their visit
Packer and Bond[40]	Restorative values of different urban environments	Australia	596 visitors to one of 4 urban sites: an arts museum, a history museum, an aquarium, or a botanic garden	Field experiment Restorative Components Scale[68] Modified version of the Attention Recovery and Reflection Scale[69] Restored Mental State Scale[40]	Visitors to an art gallery find it restorating. However, the national parks and beaches received highest restoration rating from the overall sample
Rosenbaum and Sweeney[44]	Restorative value of a café	USA	90 senior citizens	Correlational SRSS[f]	Cafés are restorative for elderly citizens
San Juan et al[50]	Restorative potential of urban squares	Spain	46	Experiment Spanish adaptation of PRS	The urban square higher in vegetation was perceived as more restorative, but the urban square lower in vegetation decreased stress further than the other square
Scopelliti et al[28]	Biodiversity, affective, and social components	Italy	124	Field experiment, PRS	High levels of biodiversity correlate with restoration potential of a place. Affective components mediated this relationship.
Scopelliti and Giuliani[36]	Restoration likelihood in natural vs urban environments	Italy	67	Correlational PRS	Urban and natural environments are equally restorative.
Staats et al[8]	Restoration likelihood in different Western societies	USA Netherlands Sweden	USA: 316 Netherlands: 80 Sweden: 100	Field experiment PRS	Cultural differences in restorative urban environments
Staats et al[47]	Restoration in different urban environments	Netherlands	70	Correlational PRS	Attentional fatigue moderates preference for a more restorative environment, here an urban park
Tabrizian et al[49]	Green space enclosure and restorativeness	USA	87	Experiment Modified version of PRS	Enclosure positively affects perceived restorativeness of an urban plaza
Tenngart Ivarsson and Hagerhall[19]	Restorativeness of gardens, usefulness of PRS	Sweden	74	Field experiment Swedish version of PRS by Hartig	Scenes can include elements that differ in perceived restorativeness. The PRS is a useful tool for measuring perceived restorativeness
Tyrväinen et al[23]	Restoration in different urban settings	Finland	77	Field experiment PRS ROS[g]	Perceived restorativeness was rated highest for the woodland, but physiological measures of stress relief showed no difference between the settings
Wang et al[25]	Vegetation and restoration in urban settings	China	140	Experiment PRS	Parks are restorative, which is supported by psychophysiological measures

[a]PRCS-C = Perceived Restorative Components Scale for children.[70,71]
[b]PRS = Perceived Restorativeness Scale.[72]
[c]Italian version of the PRS.[73]
[d]Spanish version of the PRS.[74]
[e]EPREE = Spanish acronym for Scale of Restorative Potential of School Spaces (unpublished, validated by Mejía-Castillo et al[27]).
[f]SRSS = Short-Version Revised Perceived Restorativeness Scale.[75,76]
[g]ROS = Restoration Outcome Scale.[77]