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Traffic-related exposures, constrained restoration, and health in the residential context ☆

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ABSTRACT

Traffic-related exposures may undermine the restorative character of the home, and this may in turn undermine health and residential satisfaction. We addressed this possibility with data for adults residing in a large valley near Innsbruck, Austria ($N=572$). We joined objective measures of traffic-related sound and air pollutants with reports from door-to-door surveys concerning perceived disturbance from traffic-related exposures, restorative qualities of the living environment, self-perceived health and residential satisfaction. We analyzed these data with successive tests of nested structural equation models, with and without the restorative quality variables. The results suggest that the negative impact of traffic-related exposures on self-perceived health and satisfaction with the living environment involves the constraint of restorative qualities of the living environment, over and above the share traditionally attributed to such exposures viewed as stressors. We discuss theoretical and practical implications of the distinction between environmental stressors and constraints on restoration.

1. Introduction

Sound, exhaust and other emissions from road traffic have been implicated in atherosclerosis, myocardial infarction, stroke, cardiovascular mortality, and overall mortality, among other manifestations of ill health (e.g., Selander et al., 2009; Sørensen et al., 2011). It is important that decision makers and the public know about the severe consequences of traffic-related exposures. It is also important that the objective physical and chemical aspects of those exposures are accurately represented in efforts to estimate their consequences. Yet, a focus only on the severe outcomes of traffic-related exposures would neglect their more prevalent effects, and measurement only of the objective aspects of exposures would neglect their psychosocial significance and the broader social ecological context in which effects are realized. Reference to subjective disturbance or annoyance from traffic-related exposures in a residential context can help to explain how they can impair physical functioning, the quality of sleep, psychological well-being, self-perceived health, and health-related quality of life for years without inducing severe illness or death (cf. Balfour and Kaplan, 2002; Cummins et al., 2005, Dratva et al., 2010; Gundersen et al., 2013; Lercher and Kofler, 1996; Riedel et al., 2015; Roswall et al., 2015; Stafford and Marmot, 2003; Urban and Máca, 2013). In line with this understanding, the World Health Organization has included subjective annoyance in its noise impact assessment package (Fritschi et al., 2011), and many countries have legislatively mandated integrated environmental impact assessments that consider how environmental conditions affect not only physical health but also social, economic, cultural and psychological well-being (e.g., Briggs, 2008; Kwiatkowski and Ooi, 2003; Morgan, 2011; Sexton, 2012).

In referring here to perceived disturbance by traffic in the residential context, we treat vehicular sounds and exhaust as negatively evaluated conditions that can fuel chronic stress and thus diminish life quality and compromise health. This approach is consistent with a large literature that views disturbance and annoyance as outcomes that are important both in and of themselves

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and as mediators of the effects of traffic-related exposures on other decrements in health and well-being (e.g., Babisch et al., 2003; Claeson et al., 2013; Fyhri and Klæboe, 2009; Job, 1996; Lercher et al., 1995; Miedema, 2007; Ndrepepa and Twardella, 2011; Nivison and Endresen, 1993; Stenlund et al., 2009; Urban and Máca, 2013). As a novel contribution here, we explicitly distinguish different pathways through which disturbance by traffic-related exposures can undermine health and well-being. Specifically, we address the possibility that traffic-related exposures have negative effects both as environmental stressors and as constraints on restoration.

Stress becomes chronic in part because physical and psychosocial demands from the environment persistently tax the individual's coping resources, and in part because environmental circumstances constrain possibilities for the individual to adequately restore the various resources that have been depleted. Depletion of coping resources as a contributor to chronic stress has received the most attention in research concerned with psychosocial processes engaged by adverse environmental exposures, treating them as stressors. The constraint of restoration has more recently been distinguished as a contributor to chronic stress that may be attributed to environmental conditions that undermine opportunities for restoration (Hartig et al., 2007a; von Lindern, 2015). Some environmental conditions may constrain restoration without making adaptive demands, as when inclement weather leads people to choose indoor activities that serve needed restoration less well than outdoor activities that might have been chosen given better weather (Hartig and Catalano, 2013). Other environmental conditions may contribute to chronic stress both by taxing adaptive resources and by hindering their subsequent renewal, as when regular telework at home leads to longer hours of paid work and a reduced ability to psychologically distance oneself from work during leisure time (Hartig et al., 2007b).

The extent to which an environmental exposure will function both as an environmental stressor and a constraint on restoration is dependent on the context in which it is encountered. In the residential context, people ordinarily carry out a variety of activities, and performance of some of these may be hindered by traffic-related conditions. People ordinarily try to meet some of their recurrent needs for psychological restoration in the residential context (Hartig et al., 2003), and activities dedicated to restoration, such as sleeping and relaxing after the work day, may be particularly sensitive to exposures ordinarily considered as stressors. For example, when in-home activity involved concentration, Öhrström et al. (2006) found that the percentage of urban residents reporting traffic-related disturbance increased from roughly 4% to 22% as the sound level measured at the most exposed side of the dwelling increased from 43 to 68 $dB_{LAeq,24\ h}$. When activity was dedicated to relaxation, however, the percentage of residents disturbed increased from roughly 5% to 35% with the same increase in sound level. From our perspective, the difference between the two slopes relating sound level to disturbance reflects on the distinction between noise as a stressor and noise as a constraint of restoration.

The restoration perspective as a complement to the stress perspective (Hartig et al., 2008; von Lindern et al., 2016) has been elaborated with a view to theories that specify restorative qualities of person-environment transactions. One of these, attention restoration theory (ART; Kaplan and Kaplan, 1989; Kaplan, 1995) is particularly concerned with restoration of a depleted capacity to direct attention. The theory posits that willfully directing attention is necessary for the performance of a wide range of activities, and that directing attention requires inhibiting distractions. Because it requires effort to inhibit distractions, the capacity to direct attention can become fatigued. When the attentional resource is depleted and directed attention fatigue impairs performance, an individual may become more vulnerable to stress (Kaplan, 1995). The account of restorative quality provided by ART can therefore aid understanding of how environmental conditions can contribute to chronic stress by constraining the restoration of adaptive resources such as directed attention capacity.

ART describes restorative quality in terms of psychological distance from routine mental contents and demands on directed attention (being away), the engagement of effortless attention by interesting stimuli and processes such as exploration and problem solving (fascination), the scope for involvement with and coherence perceived in the environment (extent), and the match between what the individual wants to do, can do, and must do in the environment (compatibility). Although brought together in ART, some of these constructs have long-established counterparts in different literatures, notably the escape concept in research on outdoor recreation and leisure (cf. Knopf et al., 1987) and the person-environment fit and congruence concepts in the stress literature (e.g., Moser, 2009; Stokols, 1979). The fascination construct has particular significance in ART because reliance on effortless attention is assumed to allow for rest of a neurocognitive mechanism on which directed attention is thought to depend; however, other theorizing about restorative environments similarly refers to the engagement of non-vigilant attention by pleasant aspects of the environment, though in a process of recovery from acute psychophysiological stress (Ulrich, 1983; cf. Fredrickson and Levenson, 1998; Gladwell et al., 2012). It follows that research on restorative quality can refer to being away, fascination, extent and compatibility with the understanding that they have broad generality; they may apply to the recovery of other depleted adaptive resources in addition to the capacity to direct attention.

1.1. The present study

In the present study, we address the potential effects of traffic-related exposures in the residential context on self-perceived health and residential satisfaction. A novel feature of the study is the treatment of noise and air pollution both as stressors and as constraints on restoration. We join objective measures of traffic-related exposures with a subjective measure of disturbance and residents' perceptions of restorative quality to obtain a more holistic assessment of traffic impacts. We hypothesize that disturbance by traffic exposures will negatively impact residential satisfaction and health both directly, reflecting stressful qualities of the sound and air quality conditions, and indirectly, by constraining restorative qualities of the living environment.

Fig. 1 displays the hypothesized conceptual model. In the empirical work, we test two nested models, starting from the complete model and then closing off the paths from restorative quality to health and residential satisfaction. Comparison of the fit indices and variance explained will give an indication of the degree to which inclusion of the restorative quality construct contributes to understanding of the effects of traffic-related exposures on residential satisfaction and health, over and above the contribution of the traditional stress model.

Much of the previous research on noise annoyance has focused on traffic-related exposures in natural areas during recreational visits or in densely populated urban residential contexts (e.g., Öhrström et al., 2006). The present case brings these two research strands together, in that the particular study area is neither urban nor rural in character, but rather comprises peri-urban settlements situated in a region of renowned scenic beauty that attracts many tourists. Residents in these areas may particularly value the relative quiet, and so may be particularly disturbed by the traffic-related exposures they experience (cf. Shepherd et al., 2013; Lercher, 1998). This possibility, among others, encourages the consideration of resident sensitivity to disturbance in our model