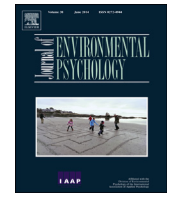
Journal of Environmental Psychology 40 (2014) 187–197

Contents lists available at ScienceDirect

Journal of Environmental Psychology

journal homepage: www.elsevier.com/locate/jep



The impact of the classroom built environment on student perceptions and learning

Gwen C. Marchand [a,*], Nicholas M. Nardi [a,1], Douglas Reynolds [b,2], Stoil Pamoukov [b,2]

[a] University of Nevada Las Vegas, Department of Educational Psychology and Higher Education, 4505 S. Maryland Parkway, Box 453003, Las Vegas, NV, 89154, USA

[b] University of Nevada Las Vegas, Center for Mechanical & Environmental Systems Technology, Thomas T. Beam College of Engineering, 4505 S. Maryland Parkway, Las Vegas, NV, 89154, USA

A R T I C L E I N F O

Article history:
Available online 5 July 2014

Keywords:
Reading comprehension
Listening comprehension
Environmental factors
Student performance

A B S T R A C T

The aim of this 2 × 2 experimental study was to investigate whether the combined environmental factors of light, sound, and temperature in a classroom built environment set to comfortable levels or just outside the comfort zone (OCZ) impacted undergraduate student learning, mood, and perceptions of environmental influence on performance during listening and reading tasks. Results indicated that participants in the OCZ listening condition had lower scores on a comprehension test than those in the normal listening condition, but that no difference was detected between conditions for the reading modality. Students in the OCZ condition reported more negative affect and believed that the sound and temperature of the room had a more negative impact on their performance than those in the normal condition. Participants in the reading conditions were more likely to attribute poor performance to the sound levels in the room than students in the listening condition.

1. Introduction

The bioecological model of human development proposes that individual learning and psychological functioning are influenced by multiple, nested layers of the context. Although not typically the focus of the model (e.g., Bronfenbrenner & Morris, 2006), the built environment can be considered a context for human development (Evans, 2003). Chaos or sub-optimal conditions in the built environment may interfere with the ability of individuals in school, work, or home environments to adequately process new information in a manner that will allow that information to be learned and retained (Maxwell, 2010). Effects of the built environment have been explored in relation to a wide range of human functioning, including cognitive processes (e.g., Hygge & Knez, 2001), affect (e.g., Loewen & Suedfeld, 1992), and mental health (Evans, 2003). The present study is focused on learning tasks typical in a classroom situation and psychological outcomes.

Higgins, Hall, Wall, Woolner, and McCaughey (2005) refer to temperature, lighting and acoustics as the "physical basics" of the built indoor environment. In real world learning and workplace environments it is unlikely that only one element in the built indoor environment would constitute a substandard setting but a negative environment may instead reflect more of a composite of multiple elements. For instance, the National Center for Education Statistics (U.S. Department of Education, 2000) asked schools to rank how satisfactory or unsatisfactory six different environmental conditions were: lighting, heating, ventilation, indoor air quality, acoustics and physical security of the building. The survey revealed that an average of 2.6 environmental conditions was reported unsatisfactory among the 43% of schools that reported at least one unsatisfactory condition. In addition, 8% of schools rated all 6 environmental conditions unsatisfactory (U.S. Department of Education, 2000).

The three elements of temperature, lighting, and acoustics are rarely addressed together in the same study (Higgins et al., 2005; Hygge & Knez, 2001). Researchers tend to focus on one element in the environment or a combination of two environmental elements in an effort to isolate the impact of each component and also to develop and test theory as to the processes underlying the mechanism by which each element influences cognitive and psychological factors (e.g., Sörqvist, Stenfelt, & Rönnberg, 2012). The bulk of research has focused on the individual negative impact that noise (Clark et al., 2006; Halin, Marsh, Hellmen, Hellström, & Sörqvist, 2014; Hygge, Evans, & Bullinger, 2002; Jones, 1990;

* Corresponding author. Tel.: +1 702 895 4303.
E-mail address: Gwen.marchand@unlv.edu (G.C. Marchand).
[1] Tel.: +1 702 895 4303.
[2] Tel.: +1 702 895 3807.

http://dx.doi.org/10.1016/j.jenvp.2014.06.009
0272-4944/

Kjellberg, Ljung, & Hallman, 2008; Seabi, Goldschagg, & Cockcroft, 2010; Sörqvist, 2010; Sörqvist, Halin, & Hygge, 2010; Stansfeld et al., 2005), temperature (Wargocki & Wyon, 2007; Zeiler & Boxem, 2009), and lighting (Barkmann, Wessolowski, & Schulte-Markwort, 2012; Dunn, Krimsky, Murray, & Quinn, 1985; Knez, 1995) have on learning and psychological outcomes. To the best of our knowledge there is only one study that has explored these three environmental factors and their influence on student performance. Hygge and Knez (2001) examined the interaction between lighting, temperature, and noise on attention, problem solving and affect. They discovered an interaction between noise and heat, as well as light and noise on cognitive performance on reading tasks.

Although it is important to understand the unique effect of different environmental factors on student learning, a more ecologically valid approach to examining the classroom environment may be to consider multiple factors in combination to create a composite representing the built environment in order to better understand the overall influence on human learning (Bronfenbrenner & Crouter, 1983; Bronfenbrenner & Morris, 2006; Maxwell, 2010). Further, recent research has called for laboratory-based studies to include tasks similar to those experienced by individuals in real-world situations, such as complex reading comprehension tasks, when studying the impact of built environment (Halin et al., 2014; Oswald, Tremblay, & Jones, 2000; Sörqvist et al., 2010). Thus, the purpose of the present study was to examine the effects of a simulated classroom environment with sound, temperature, and lighting parameters within a normal range for comfort and an environment with conditions set just beyond the limits of a normal comfort zone (OCZ) on student comprehension, mood, and perceptions of the environment following a moderately difficult reading or listening task.

1.1. Complex cognitive tasks

Research on the effects of the built environment frequently use a variety of memory and learning tasks as outcome measures (see Beaman, 2005 for a review on noise). When considering how the physical environment impacts learning, compelling contributions have been made by researchers studying the relationships amongst sound, working memory, and attention. Researchers have investigated task complexity and difficulty (Halin et al., 2014), type of sound (e.g. speech and non-speech; Oswald et al., 2000; Sörqvist, 2010), intensity of sound (Loewen & Suedfeld, 1992), and timing of environmental stimuli (Hughes, Hurlstone, Marsh, Vachon, & Jones, 2013), among other factors (Beaman, 2005; Sörqvist et al., 2012). Findings have emerged to suggest that the effects of noise on cognitive processes are nuanced and complex.

One such nuance is the nature of the cognitive task (Beaman, 2005), as the tasks in sound studies range from memory for word lists to reading comprehension tasks. In the classroom environment, students are faced with multiple tasks, including reading for comprehension and listening for comprehension. For example students may be asked to read quietly to themselves or students may listen to lecture. Reading and listening comprehension are constructive processes "involving an interaction between incoming discourse (text or speech) and the reader or listener's prior knowledge" (Royer, 2001, p. 30). Comprehension occurs when a reader or listener can remember the meaning of what was heard or read. For individuals to be able to construct meaning, text must be efficiently processed on multiple levels; organized from microstructure, the sentence structure used to represent the meaning of the text; to macrostructure, the higher-order organization of the text into larger sections; to the situation model, or the meaning of the text interpreted with respect to prior knowledge, goals, and other individual characteristics (Kintsch, 2004). The ultimate goal associated with classroom learning is typically focused on the level of the situation model, or whether the text was understood and well integrated with an individual's background knowledge.

The most consistent negative effects for task-irrelevant sound on reading comprehension in late adolescent and undergraduate populations have centered on task-irrelevant speech (Oswald et al., 2000; Sörqvist, 2010; Sörqvist et al., 2010). Other types of background noise, particularly noise that is consistent, may not be sufficiently distracting to disrupt attentional processes associated with learning new information, but at the same time, may be slightly more negative than silence (Oswald et al., 2000; Sörqvist, 2010). The effects of noise, particularly task-irrelevant speech, may be qualified by individual differences in working memory capacity (Sörqvist & Rönnberg, 2012) as well as task difficulty. For instance, recent research has found that task difficulty buffered the effect of irrelevant background speech on memory for prose reading tasks (Halin et al., 2014). The authors explained their findings by suggesting that more difficult tasks lend themselves to a more concentrated locus-of-attention that protects against the interfering stimuli of irrelevant speech. In other words, when individuals concentrate their attention on processing a difficult task, environmental distractors lose their ability to capture attention. Although these findings are specific to task-irrelevant speech, it is conceivable that the general mechanism might be applied to other environmental conditions. Thus, it is likely that given a relatively difficult task, such as reading a dense text, that requires concerted attention environment should have minimal impact.

Research on the effects of noise on listening comprehension are less common, but one study found that broadband noise interfered with student memory for lecture, even when speech perception was not a factor (Ljung, Sörqvist, Kjellberg, & Green, 2009). Drawing on theories of cognitive load, the authors suggested that when students have to concentrate harder to hear speech in a noisy environment, cognitive resources that could be allocated to processing the meaning of the speech are directed toward listening. Over time, this type of interference could lead to reductions in the retention of the new information. Yet, other research found that noise did not interfere with listening comprehension for adults, although it did interfere with younger children (Klatte, Lachmann, & Meis, 2010).

Comparatively less research has focused specifically on the effects of temperature or illumination on reading or listening comprehension, particularly with late adolescent or adult populations. Research with school-aged children has linked warmer temperatures to reduced performance on language-based tasks (Wargocki & Wyon, 2006, 2007). Lower levels of lighting have been associated with decreased cognitive performance and academic performance (Dunn et al., 1985; Hathaway, 1995; Hygge & Knez, 2001).

Findings from studies that include multiple environmental elements tend to report a range of effects from the different combinations of factors. Hygge and Knez (2001), the only study located to investigate three environmental factors, found that individuals performed better on long-term recall tasks when noise levels were lower at higher temperature points, but performed about the same when the temperature was low.

1.2. Mood and perceptions of the environment

The effects of the built environment on psychological states, such as mood, and individual perceptions of the environmental impact on learning, have received less attention in the empirical literature associated with simulated or naturalistic classroom environments with late adolescent or undergraduate populations.