Journal of Environmental Psychology 31 (2011) 137–146

Contents lists available at ScienceDirect

Journal of Environmental Psychology

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

Measuring knowledge of indoor environmental hazards

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ARTICLE INFO

Article history:
Available online 3 September 2010

Keywords:
Indoor environment
Science literacy
Knowledge
Scale development
Environmental risk
Environmental hazard

ABSTRACT

People spend most of their time indoors, where air pollution levels rival and often exceed those outdoors for a number of important pollutants. Yet, little is known about people's knowledge of indoor environmental hazards. The purpose of the current study was to construct a measure of indoor environmental knowledge. A set of 78 true/false items were developed with input from a panel of experts. The set of items was truncated with traditional item analyses, resulting in a reliable set of 21 items ($\alpha = .79$). Concurrent validity was established by a significant correlation between the indoor environmental knowledge (IEK) scale and an established measure of science literacy ($r = 0.44$, $p < .001$). Schema theory guided the assumption that the two measures should be related. Convergent validity was established by the significant regression of science literacy, formal education in science and math, and status as an engineering student on IEK scale score, accounting for 25% of the variance in the IEK scale score. Future research avenues are proposed and limitations are discussed.

1. Introduction

The term "environmental hazard" might evoke imagery of severe weather events, water pollution, nuclear reactor accidents, and other phenomena that originate *outdoors*. Some *indoor* environmental hazards (e.g., radon, asbestos, second-hand smoke) might be considered similarly as being hazardous to humans; however, people tend not to think of the indoor environment as posing the same kind of risk. At least two studies have found that the public is generally unconcerned about health risks posed by indoor air (Dingle & Lalla, 2002; Moschandreas & Chang, 1994); and one researcher found that people perceive outdoor air to be riskier than indoor air and several indoor pollutants (viz., candles, dust, and air fresheners; Rosenthal, 2009). Such disregard of indoor environmental risk is troublesome, as the public spends roughly 90% of their time indoors (Klepeis, Tsang, & Behar, 1996; Ott, 1989), where environmental pollution levels rival and often exceed those found outdoors (CARB, 2005; Ott & Roberts, 1998). For example, typical indoor formaldehyde concentrations can be as much as 20-times higher than typical outdoor concentrations (Hodgson, Beal, & McIlvaine, 2002). Formaldehyde is a suspected human carcinogen (HSDB, 2009). Consequently, health care professionals and risk managers should be interested in reducing human exposure to the myriad indoor environmental hazards; however, such efforts can only be hampered by limited public understanding of the hazards and related health risks.

At least some of the difficulty with motivating public interest in and behavior toward improving indoor environmental quality has been attributed to uncertainties about the outcomes of such improvements and to limited communication of research findings (Fisk, 2000, p. 558). To put it another way, relatively ubiquitous ignorance of indoor environmental risk and risk mitigation strategies inhibits public concern (i.e., "what you don't see can't hurt you"), which diminishes motivation to engage in risk mitigation and avoidance behavior (Bruhn, 1997; Gerrard, Gibbons, Benthin, & Hessling, 1996). Indeed, much of the literature on behavioral intention has linked outcome certainty with motivation to act (see Fishbein & Ajzen, 1975; Rogers, 1975; Tversky & Kahneman, 1992); the corollary is that uncertainty produces amotivation. In order to motivate public interest in indoor environmental quality and relevant protective health behaviors, risk communicators might focus on improving public awareness and understanding of indoor environmental risk. Specifically, practitioners might seek to improve understanding of the indoor environment as a component of science and health literacy. To that end, the purpose of the current study is to develop a measure of indoor environmental knowledge for assessing the effectiveness of public outreach efforts and for use in complex behavioral models. Certainly, public outreach efforts that aim to build public awareness and knowledge of the indoor environment might gauge their effectiveness with such a knowledge measure (e.g., Cavill & Bauman, 2004); and several studies implicate knowledge as a partial determinant of risk

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0272-4944/$ – see front matter
doi:10.1016/j.jenvp.2010.08.003

avoidance behavior (Fransson & Garling, 1999; Hiller Connell, 2010; Jones, Abraham, Harris, Schulz, & Chrispin, 2001; Van Duyn et al., 2001).

Traditional approaches to developing measures of knowledge examine statistical properties of scale items individually and in relation to a larger set of scale items, which can produce reliable scales that distinguish between relevant groups of people (e.g., high- and low-literacy). However, if researchers do not take care in developing and interpreting scale items, the resulting scales invariably lack external validity. In order to minimize this limitation, the current study will use schema theory as the basis of construct validation. Based on schema theory, certain aspects of indoor environmental knowledge should be rooted in broader cognitive structures containing general science and health knowledge. If, indeed, science literacy undergirds knowledge of the indoor environment, then existing scales of science literacy can serve as a guide for the development of an indoor environmental knowledge scale. Traditional statistical methodologies will be employed concurrently to isolate and assess good scale items.

2. Theory

2.1. Knowledge and behavior

That knowledge and behavior are related should not be a point of dispute; though, the extent of this relationship can vary tremendously across contexts, types of knowledge, and individual differences; and in some situations, knowledge might not exert an appreciable effect on behavior. In a meta-analysis, Hines, Hungerford, and Tomera (1987) identified, among other key variables, knowledge of issues and knowledge of action strategies as significant correlates of responsible environmental behavior. Across the 17 studies in their analysis, the mean correlation between knowledge and behavior was 0.30. Similarly, Mobley, Vagias, and DeWard (2010) found that people's intentions to pursue environmentally responsible behavior increased after learning about environmental issues. Conversely, Schahn and Holzer (1990) found that ecological knowledge did not predict environmentally responsible behavior directly. However, they did find that concrete knowledge (partitioned from abstract knowledge) moderated the relationship between intentions and behavior. According to the theory of planned behavior (Ajzen, 1991, 2005), behavioral control mediates the relationship between intention and behavior; and so it would seem that knowledge is related to behavioral control. That is, the more people know about an issue, they more capable they are to act on it. Rimal (2000) found that the relationship between self-efficacy (which is conceptually similar to perceived behavioral control) and healthy dieting was greatest in subjects with high dietary knowledge. However, the antecedents of behavior contain myriad complexities.

Several well-established behavioral models account for such variables as attitudes, norms, self-efficacy, affect, self-identity, personal relevance, and past behavior (e.g., protection motivation theory, Rogers, 1975; theory of planned behavior, Ajzen, 1991; extended parallel process model, Witte, 1992, 1994). Researchers have examined how knowledge plays into such models, and have found that knowledge can contribute significantly to people's intentions and behaviors. Jones et al. (2001) found that, in addition to norms, self-efficacy, perceived threat, and importance, knowledge of skin cancer and of sun protection predicted people's intentions to use sun screen. Although the effect of knowledge on behavioral intentions was weak, it was comparable to the effects of norms and perceived threat. Similarly, studies of risk information seeking and processing have found that the difference between what people know and what they perceive they need to know predicts information seeking intentions beyond what attitudes, affect, norms, and perceived behavioral control predict (Griffin, Dunwoody, & Neuwirth, 1999; Kahlor, 2007). In this case, (the perception of) having more knowledge might inhibit information seeking behavior. However, in accordance with the heuristic-systematic model (Chen & Chaiken, 1999), people will seek information when they feel that their current knowledge is insufficient in order to make an important judgment or decision (e.g., whether or not to engage in risk avoidance behavior). Thus, people who perceive that they are sufficiently knowledgeable about an environmental risk are also likely to perceive themselves as capable of avoiding it, which returns to the notion of knowledge as a component of self-efficacy.

The following sections explore the concept of indoor environmental knowledge in terms of health literacy and science literacy, the cognitive structure of science and health knowledge, and the cognitive and behavioral implications thereof. The purpose of these sections is to relate indoor environmental knowledge to general science knowledge and science literacy, which is helpful in assessing the construct validity of the scale focal to this study.

2.2. Health literacy

The current study is interested in measuring a knowledge construct that is specific to a narrowly-defined domain, but which consists of several components (e.g., sources, health effects, physical properties and government regulation of indoor environmental pollution). Although some of the components are not explicitly health related, the study employs a cognitive framework rooted in Zarcadoolas, Pleasant, and Greer's (2005) definition of health literacy.

According to their definition,

> …a health literate person is able to use health concepts and information generatively – applying information to novel situations […and] participate in the ongoing public and private dialogues about health, medicine, scientific knowledge and cultural beliefs. Health literacy evolves over one's life and […] is impacted by health status as well as demographic, sociopolitical, psychological, and cultural factors (p. 196).

Basically, health literacy is the expression of a collection of knowledge whose arrangement and use is specific to the information task at hand, and which facilitates informed decision making (see also Murcia, 2009). Furthermore, health literacy grows dynamically with relevant life experiences. In similar terms, the process of becoming health literate can be described as a kind of schema development.

2.3. Schema theory

According to schema theory (for an overview, see Brewer & Nakamura, 1984) knowledge is stored in categorizations ("schemas") of varying generality that people use to make sense of novel situations. As people experience more of the same kind of situation or encounter more of the same kind of information, their relevant schemas will take on greater detail and will be used thereafter for making sense of increasingly complex situations or information (see Case, 1985). For example, lay knowledge of chemical reactions might reflect a general understanding that reactions require two or more chemicals and that one or more new chemicals will emerge as the product. Such knowledge would be organized into some kind of "chemistry" schema. Likewise, expert knowledge will also be organized into a chemistry schema; however, this schema will contain greater detail, or fewer generalities, and will have more precise application to unique chemistry phenomena. When presented with