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Social aspects of working in underground spaces

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ABSTRACT

With growing population in urban areas, the problem of lacking space is becoming more prominent. Thus, the development of underground space has increasingly gained attention as a viable solution. Social aspects, such as social behavior and attitudes toward underground spaces could act as both facilitators and inhibitors toward the adoption of underground spaces. Here we review, present and discuss the major social parameters associated with working in underground spaces. Our research overview identified three major themes that pervade existing literature: attitudes and perception; social behavior; and the impact of environmental attributes of underground spaces. Yet, we also notice that the social and cultural elements associated with underground spaces have remained largely unexplored, with previous research being of more of a qualitative character and, to some extent, outdated. We thus subsequently identified the major unexplored themes and present an organized, systematic research program for a more holistic and quantifiable understanding of the interaction between social behavior and underground spaces. We end by discussing how this research program can be integrated with other disciplines, including engineering, design and health.

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1. Introduction

A central characteristic of cities is the high level of social interactions; in modern cities, additional factors such as higher density, urbanicity and the increasingly complex social network have transformed social life to a multi-dimensional phenomenon of critical importance for the welfare of citizens. Indeed, previous research has shed light on the effect of various social factors on people's everyday performance and health, suggesting that social well-being is an important aspect that needs to be taken into account for the successful operation of a community (Bauman, 2013; Beck and Camiller, 2000; Costa et al., 2006; Ilmarinen, 2006; Kuoppala et al., 2008). Therefore, pioneering a novel urban environment would require an extensive analysis on social impact of working in such environment.

With the current and projected growth in population, both the deterioration of the environment associated with the over-exploitation of natural resources as well as the quality of life in urban areas are of concern. According to The Population Division of the UN Department of Economic and Social Affairs in March 2004, it was reported that most of the growth of the world's

population between 2000 and 2030 is expected to be immersed by the urban areas and that the proportion of the world's population living in urban areas is expected to reach 61% by 2030, having more urban than rural residents (Godard, 2004). Such a dramatic growth is posing challenges to individual countries as well as to the world as a whole. Thus, it is crucial that further developments take place for creating sustainable urban environments.

In fact, the concept of underground urban area is not new. There are already several large underground spaces for different uses all over the world including the City Hall Link in Singapore, underground shopping streets in Japan, and the underground city network RÉSO in Montréal. However, there is a lack of a comprehensive review on the impact of underground spaces on various social facets, such as social perception, behavior and culture. Thus, the present review attempts to provide a critical overview of the current literature on social phenomena of underground environment and suggest how various measures could be employed to understand and improve the conditions of future underground spaces. The paper is constructed as follows: in the first part we examine the attitudes and perception associated with underground environment; the second part elaborates on the social behavior associated with underground environment; whereas the third part examines the impact of architectural attributes related to underground environment. We end up by offering

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an overview of potential research questions that need to be examined by future researchers.

2. Attitudes and perception associated with underground environment

When we enter a new environment, we immediately form an impression of the place and through this process, we implicitly decide whether we feel positive about the place. Such ‘snap’ processes are characteristic of many aesthetic or value judgments – including human faces and products – that humans constantly make; due to limited cognitive resources such judgments are often imperfect and based on cognitive biases (Christopoulos et al., 2011; Günaydin et al., 2012; Krpan and Schnall, 2014; Lee and Schnall, 2014; Schnall et al., 2008). In this section, we discuss people’s general attitude toward underground spaces and how such environment shapes individuals’ perception of themselves and the space during the stage of impression formation. The section begins by reviewing common mental conceptions people have about underground spaces. Then, the mental constructs most closely related to confined space – such as perceived sense of control – are discussed in relation to underground environment. Lastly, we discuss how such environment might influence the way individuals identify themselves.

2.1. Attitude and psychological imagery: positive and negative aspects

Psychological imagery is defined as mental pictures or vivid descriptions and metaphors to represent ideas (Galton, 1907). For example, when we try to remember a phone number by repeating in our head we might simultaneously visualize the numbers being written on a chalk board. There is significant evidence supporting the idea that underground space is associated with negative attitude and imagery (Carmody, 1992). The mental images could be aided by different cultural sources, such as literature and religion. For example, in many Western societies, the religion of Christianity has historically been associated with underground spaces depicting the subterranean environment as “equated with evil” (Lesser, 1987). Yet, underground spaces have also some positive aspects for the very same religion, as early Christians used to gather in catacombs (Jewish catacombs also exist). Similarly, East Asian traditions, such as Taoism, Buddhism, and some Chinese folklore, hold the concept of ‘diyu’ [地狱], or an underground world serving as a place to prepare spirits of the deceased for reincarnation. It is also where punishments against spirits are carried out for all their wrongdoings during their time on earth. As such ‘diyu’, literally translated as ‘earth prison’, bears the connotation of being trapped for inevitable punishment. Further, being underground may activate the concept of burial and result in the impression that people in underground spaces are isolated from the world out there (Hane et al., 1991; Hollon et al., 1980; Sommer, 1974; Wada and Sakugawa, 1990).

Other common associations people have with underground are death, lifelessness, loss of association with nature and a static place (Hane et al., 1991). Indeed, one of the reasons why people have negative impressions on underground space is the lack of stimulation such place offers (Hane et al., 1991). Further, implications arise from here that such place is dark and damp, thus, people judge underground environment to be unhealthy.

Fear, uneasiness and timidity are prevailing adjectives that people choose for describing underground spaces (Hane et al., 1991; Ringstad, 1994). These associations could arise from specific characteristics of underground space that people are predisposed to be distressed by and avoid. Entrapment, enclosed spaces, darkness, crowds and getting lost are prevalent phobic stimuli that could

easily be affiliated with subterranean spaces. Thus, prominence of negative imagery could partly be understood as a reaction to several factors of underground environment that people are naturally prepared to fear and avoid (Ringstad, 1994).

While underground environment activates negative imagery, it has been reported that some positive imagery is also associated with underground spaces. Underground space may result in the feeling of security and safety by providing a shelter against extreme conditions in above ground (Mohirra, 2012).¹ Further, the work by Hane et al. (1991) demonstrates that culture might influence people’s perception of underground space: Americans chose the word “comfort” as an adjective for describing underground environment in a higher degree than Japanese. This suggests that the content of the associations could vary across cultures and conditions that underground space can offer as compared with above ground environments (Carmody, 1992).

Studies that had directly looked at people working in underground spaces offer insights into how actual experience maybe an important factor in the formation of psychological imagery. For example, it was reported that a group that was working in an underground space was more willing to work in an underground space compared to a group that never had such an experience (Carmody and Sterling, 1990). Further, unsatisfied workers in the former group preferred an improvement to the actual underground space they worked rather than moving to an above ground space, whereas unsatisfied workers in the latter group were reluctant to go underground in general. Moreover, people with no experience in underground environment declared a problem of ‘lighting and brightness’, whilst people who had an experience were generally satisfied with these aspects (Hane et al., 1991). In short, learned associations through experiences are also one of the crucial factors that influence people’s psychological imagery of underground space. This might indicate that the social beliefs and representations toward underground spaces are the most critical inhibitory factor: *people might be generally averse toward underground spaces but, once the space is actually experienced, attitudes might change.* Thus, *introducing the underground spaces seems to be a problem akin to the problems that all innovations face (public typically resists major innovations; Rogers, 2010)* and thus similar approaches could be adopted to ensure proper dissemination of underground uses.

2.2. Perceived control and safety perception

Underground environment is a confined type of space, of which people have (or believe to have) less control over. If any incident, such as fire or explosion, takes place, it would be much more difficult to escape as there is no direct access to the outdoor environment. One of many concerns regarding underground environment is people’s perceived control (Ringstad, 1994). Perceived control can be defined as the belief that one can determine one’s own states and behavior, influence one’s environment and bring desired outcomes (Smith et al., 1984; Wallston et al., 1987). Lack of perceived control from underground space can result in a variety of symptoms ranging from formation of negative perception to claustrophobia (Ringstad, 1994).

There are several environmental cues that seem to underlie reduced perceived control in an underground facility. For example, way-finding is (or is perceived to be) more difficult as the number of escape routes is somewhat limited, the space tends to be darker, technological aspects of an underground facility may be unfamiliar and people inexperienced with underground environment may experience a lack of confidence due to this unfamiliarity

¹ For a recent cultural example, the book “The Hunger Games: Mockingjay” by Suzanne Collins (2010) depicts the underground space as a safe environment that protects victims of dictatorship.

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