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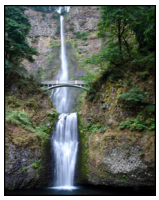

Office versus leisure environments: Effects of surroundings on concentration

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ABSTRACT

Mobile workers perform tasks that require high concentration not only in their traditional office but also within environments that are typically related to leisure (e.g., in a park or in the living room). Because research has shown that surroundings affect cognitive processing, we assume that concentration is different in office versus in leisure environments. We hypothesize that a typical office activates an associated (work-related) schema which in turn positively influences processes that are normally conducted within the environment (e.g., show high concentration in work-related activities in the office). In two studies, we assessed participants' objective and subjective work-related concentration twice, each time once within an office and once within a leisure environment. In study 1 (laboratory), we manipulated environments by means of virtual realities. In study 2 (field experiment), participants were tested within their self-elected, real-life environments. In both studies, results indicated higher work-related concentration when surrounded by an office compared to a leisure environment.

1. Office versus leisure environments: effects of surroundings on concentration

Nowadays, work is no longer completed exclusively in the typical office but has also become mobile and may occur within changing environments (Bailey & Kurland, 2002; Chen & Nath, 2005; Hislop & Axtell, 2007; Moskaliuk, Burmeister, Landkammer, Renner, & Cress, 2017; Su & Mark, 2008; Vartiainen & Hyrkkänen, 2010). The evolution of modern information and communication technologies altered work practices completely in the last decades (e.g., Halford, 2005; Messenger & Gschwind, 2015). Many employees can work independently both in terms of time and space, because all they need can be found through mobile devices such as smartphones, tablets, or netbooks. Mobile work entails many benefits because it saves time and money. For example, employees save commuting time while employers save office spaces; mobile work offers autonomy and flexibility, and enables global cooperation (e.g., Demerouti, Ders, ten Bummelhuis, & Bakker, 2014; Hill, Ferris, & Märtinson, 2003; Hill, Miller, Weiner, & Colihan, 1998; Kurland & Bailey, 1999). However, mobile work also has some downsides. Employers have fewer possibilities to supervise or control their employees whereas employees might suffer from blurring boundaries between work and private life (e.g., Anderson & Rainie, 2008; Anderson & Rainie, 2014a, 2014b; Bailey & Kurland, 2002; Davis, 2002; Renner, 2014; Vartiainen & Hyrkkänen, 2010). Although mobile work is already common practice, it is still unclear in which way working within different environments affects cognition and work performance. Research regarding environmental effects on work performance often concentrates on typical work places (e.g., the office on company premises) to derive design recommendations to enhance performance, but it seldom investigates the effects of untypical, leisure-related environments (e.g., exterior areas such as gardens or private retreats such as the homely living room) although unfavorable surroundings also belong to the everyday working life of mobile workers. The studies presented here therefore investigate whether work-related cognitive performance differs within typical work-related (office) and typical leisure-related environments (garden scenery or at home). We combine the methods of a laboratory (study 1) and a field (study 2) experiment to ensure ecological validity. In study 1, we manipulate environments in the laboratory by means of virtual realities (a virtual office vs. a virtual garden) in a highly standardized and controlled manner. In study 2, we test participants either in their real office environment or in their self-elected leisure environment.

1.1. Cognitive performance and schema activation

Most mobile workers can be considered knowledge workers, whose work is mainly cognitive in nature (e.g., to collect, analyze, and evaluate information, to generate and use knowledge, to plan, or to decide) and requires concentration (Davis, 2002; Drucker, 1999; Ramirez & Nembhard, 2004). In the reported studies, we assess concentration in a

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work-related activity as an indicator of cognitive performance. To capture an integrative picture of concentration performance, we combine objective (a standardized work-related concentration test) and subjective measurements (ratings). Hill et al. (2003) show that participants rated their own subjective performance higher while doing mobile work (not in the actual office) compared to work in the office but objective measurements did not support these subjective estimates. Hill et al. (2003) suggest that participants perceive the benefits of working mobile as being so valuable that it distorts participants' own evaluations of their actual performance. Therefore, the combination of objective and subjective measurements seems to be the appropriate strategy.

That the environment can affect cognitive performance seems to be generally accepted and in addition, a wide range of specific environmental elements have been identified that influence or shape cognitive processing (e.g., Slepian, Weisbuch, Rutchick, Newman, & Ambady, 2010; Smith & Vela, 2001; Vischer, 2008). These include, for example, windows (Aries, Veitch, & Newsham, 2010; Stone & Irvine, 1994; Tennessen & Cimprich, 1995), colors (Elliot, Maier, Moller, Friedman, & Meinhardt, 2007; McCoy & Evans, 2002; Mehta & Zhu, 2009; Stone & English, 1998; Stone, 2001), and light (Chellappa et al., 2011; Hygge & Knez, 2001; Lehrl et al., 2007; Steidle & Werth, 2013; Steidle, Werth, & Hanke, 2011). Therefore, it seems obvious to assume that mobile workers (i.e., those who work within different environments) do not show the same work-related concentration when surrounded by elements of a typical office (e.g., artificial light, solid wall colors, or practical office furniture) compared to elements of leisure environments (e.g., natural sun light and lush green plants in a garden or comfortable sofas in a cozy living room).

From a theoretical side, cognitive schema theories can help to explain potential differences in concentration within different environments. Cognitive schemas represent our knowledge about the world, elements, and stimuli (Fiske, 2000). Schemas are developed through learning and prior experiences and include expectancies, attitudes, rules and norms that help us to orient ourselves in the world and to choose adequate behaviors across different situations (Cohen & Ebbesen, 1979; Fiske & Linville, 1980; Fiske, 2000; Wirtz, 2013). Cognitive schemas organize knowledge into networks of information. They guide how new information is processed and can trigger related actions, and actions can in turn form new schemas (Fiske & Linville, 1980), for example in terms of behavior scripts (e.g., Abelson, 1976, 1981; Barsalou & Sewell, 1985).

Barsalou offers another approach by means of the situated concept theory (e.g., 1982). Barsalou states that concepts about entities in the world are not only collections of cognitive knowledge but are formed within and stored together with their background situations (Barsalou, 1999, 2002, 2003; Yeh & Barsalou, 2006). This assumption is in line with the wide field of embodiment or grounded cognition research, which proposes that body, brain, and the environment interact to enable intelligent behavior (e.g., Barsalou, 2010; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005; Prinz & Barsalou, 2000). In life, some situations are experienced repeatedly in combination with certain artefacts, people or actions and occur within certain environments. After some time, this knowledge becomes entrenched and supports the selection of adequate behavior as related associations come to mind automatically when situations arise (e.g., Barsalou, 2005, 2016; Yeh & Barsalou, 2006).

Relying on both approaches, we assume that people have learned throughout their working lives that they must show work-related behavior as soon as they are in an office environment. Speaking in terms of entrenched situated conceptualizations (e.g., Barsalou, 2005) people might have incorporated knowledge of and behavior in typical work situations in office environments. When being in the office they are expected to behave professionally, to not disturb others and to avoid distractions. The primary goal is to be productive, to show effort and to produce highly concentrated work. This situational knowledge is consolidated over time and activated by a typical office environment. In terms of cognitive schemas, people hold associations of work-related knowledge, activities, and behavior and typical work environments. Through prior experiences they have formed a 'work-related schema' including all expectancies, typical behavior, and attitudes towards work that can be activated by associated environments (e.g., typical work surroundings such as an office). In contrast, typical leisure environments (e.g., a park or a cozy living room) should activate a 'leisure-related schema' (e.g., show leisure behavior such as relaxing and going easy on cognitive resources) as people are used to avoiding strain and other unpleasant activities in leisure environments. Bridging both approaches results in the hypothesis that concentration is enhanced in office environments compared to leisure environments.

2. General method

2.1. Design and procedure

In two experiments, we varied the factor *environment* by means of a within-subjects design. We used the same design and measures in both experiments but assessed a different participant sample and varied the method of manipulation of environments. In each experiment, participants completed a concentration test and a subjective rating at two different times, once within a work-related environment and the other time within a leisure-related environment. A priori power analyses suggested a sample size of $N = 109$. Tests and instructions were presented in German. Data was recorded anonymously and participants signed informed consent statements beforehand. In both studies, participants received covered instructions that disguised the actual investigation purpose before starting the experiment ("the aim of this experiment is to investigate the impact of the work environment on mental states"). At the end of the study, participants were told the purpose of the study and assigned a generated personal code to guarantee anonymity.

2.2. Assessment of concentration

2.2.1. Objective work-related concentration

We assessed concentration by means of an adapted, shortened version of the *Psychomeda Konzentrationstest* (KONT-P; Satow, 2011). This standardized concentration task was adapted to typical requirements in work activities. The KONT-P measures performance in *calculating* (e.g., 1 + 2 + 1 + 2 + 2 = , solve simple equations) and *counting* subtests (e.g., 1 2 1 1 1 2 2 1 1 2 1 1, count the digit 1). For each subtest, we used 5 items (compared to 7 items in the original version of the KONT-P) consisting each of 7 equations (rows). Both subtests were presented in a randomized manner and participants had 20 s per item to solve as many equations as possible. Concentration was assessed in terms of *accuracy* (number of correctly solved equations), *speed* (number of equations solved at all), and *efficiency* (ratio between solved equations and correctly solved equations) for each subtest and for the overall test. *Accuracy increase* (difference between accuracy in the first solved items and later solved ones) and *speed increase* (difference between speed in the first solved items and later solved ones) was calculated for the overall test. Higher scores indicate higher performance in concentration. We used two parallel versions of the KONT-P for the first and the second measurements (as offered by Satow, 2011).

2.2.2. Subjective concentration

In addition to the objective measurement of work-related concentration, we asked participants to rate how they subjectively perceived their own concentration capacity during the experiment. In study 1 and 2, participants rated satisfaction with their own performance on the concentration test using a 6 point Likert-scale: "How satisfied are you with your own performance in the test?" (Higher values indicate higher satisfaction). In study 2, we further specified