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Noise and Cognitive Flexibility: Exploring the Moderating Roles of Eastern and Western Perspectives of Mindfulness, and the Mediating Mechanisms of Arousal and Cognitive Processing

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”To my mother, my role model, this is my way of thanking you for sparking my passion for the academic world. To my brother, my best friend, thank you for always reminding me of the little things that are easily taken for granted. To my wife, my beacon of light in the storm, thank you for your unconditional love and support.” - Lewend Mayiwar

“To Valdimar and Evey, the loves of my life. To my mother. And to one special dance. Thank you.” - Arna Helgadottir

Content

Abstract

Using a between-subject experimental design, the current thesis takes an exploratory approach in examining the effects of open-office noise on cognitive flexibility. In attempts of gaining a holistic understanding of this relationship, we investigated the mediating effects of arousal and cognitive processing, as well as the moderating roles of Eastern and Western trait mindfulness. Three central models were employed in order to see whether a) arousal and cognitive processing would comparably mediate the relationship (parallel mediation), b) if arousal and cognitive processing would mediate sequentially (serial mediation), and c) if arousal and cognitive processing would behave differently with the inclusion of Eastern or Western trait mindfulness as a moderator (moderated mediation). Although parallel and serial mediation analyses did not reveal any significant findings, we found a significant moderated mediation model with Western mindfulness. Practical implications and limitations are discussed.

Introduction

The growing popularity of open-office workspaces has sparked an interest in the effects of open-office noise on cognitive performance. The adoption of this type of design is commonly based on the assumption that it facilitates collaboration and creativity where people, information, and ideas flow together. Yet, concerns have been raised with regards to the effects of such offices on cognitive outcomes. For example, Roper and Juneja (2008) explain that the central issue within these kind of offices is "the sustainability of two extremely contrasting requirements, concentration and collaboration, in the same workspace and work environment at a given time'' (p. 91). The present thesis investigates the noise produced by such offices and how it impacts performance in tasks that require cognitive flexibility. The detrimental effect of open-office noise is often explained by the limited capacity of human information processing (Salamé & Baddeley, 1982). More specifically, distractions that are produced by competing background noise in open offices tax cognitive resources and thus decrease task performance (Banbury, Macken, Tremblay, & Jones, 2001; Jones, 1990; Sörqvist, Nöstl, & Halin, 2012). For example, irrelevant speech-based noise (i.e., noise produced by irrelevant conversations in the office) impairs performance in proofreading (e.g., Smith-Jackson and Klein, 2009; Venetjoki, Kaarlela-Tuomaala, Keskinen, & Hongisto, 2006), serial recall (for a review, see Jones & Morris, 1992), mental arithmetic (e.g., Banbury and Berry, 1998; Schlittmeier, Hellbrück, Thaden, & Vorländer, 2008), reading comprehension (REFS), operation span, and tasks activating prior knowledge from long-term memory (Haka et al., 2009). Yet, to date, there appears to be no studies that have explicitly investigated the effect of open-office noise on cognitive flexibility. This is surprising considering the vast majority of organizations that emphasize the importance of facilitating creativity in spite of the prevalence of open-office workspaces. Kristiansen et al. (2008) point out that there is a shortage of research on the combined effect of office-noise and complex cognitive tasks on psychophysiological outcomes. On a similar line, Hillier, Alexander, and Beversdorf (2006) state that ''the effects of stress on more complex aspects of cognition, such as cognitive flexibility and creativity, need to be further refined'' (p. 228). These authors' concerns point to the importance of investigating the link between open-office noise on cognitive flexibility. As such, our selection of cognitive flexibility as the dependent variable is based on the following reasons: it seems fair to assume that an open workspace might place a higher demand on cognitive flexibility due to the more complex and dynamic nature of such workspaces (e.g., more interactions, interruptions, etc.); it is intrinsically linked to attentional processes (Cañas, Quesada, Antolí, & Fajardo, 2003; Moore & Malinowski, 2009); it is a central element in Western mindfulness (Langer, 1989); and as Roemer and Orsillo (2006) have argued, there is a lack of research that examines the effect of mindfulness on cognitive flexibility.

To better understand the link between open-office noise and cognitive flexibility, the present thesis seeks to advance current research on this effect by taking a rather exploratory approach examining three possible models; parallel, serial, and moderated mediation. With the parallel mediation model, we seek to examine how cognitive processing and arousal might mediate the relationship between open-office noise and cognitive flexibility. We then seek to explore how these two mediators may act sequentially - that is to say, what the indirect relationship of noise on cognitive flexibility is through arousal and cognitive processing. Finally, in a moderated mediation model, we examine whether the indirect effects of open-office noise on cognitive flexibility through arousal and cognitive processing are moderated by Eastern trait mindfulness (hereafter referred to as Eastern mindfulness), Western trait mindfulness (hereafter referred to as Western mindfulness), and mind-wandering.

These are interesting and relevant variables as they are conceptually closely linked to attentional processes in particular, and have recently become increasingly popular variables in Judgment and Decision Making (JDM) research. Here, we draw a distinction between Eastern and Western mindfulness as these represent two different and important conceptualizations of the mindfulness construct – a distinction that remains overlooked in the literature. Although previous studies have examined how each of these two perspectives of mindfulness relate to task performance, to the best of our knowledge, no study has directly compared these two constructs. In addition, the moderating role of mind-wandering, a construct that is typically treated as the polar opposite of mindfulness (Mrazek, Phillips, Franklin, Broadway, & Schooler, 2013), is explored due to mixed findings that have recently emerged regarding the relationship between mindfulness and task performance.

Theoretical Framework & Hypotheses

Cognitive flexibility

Cognitive flexibility is a core executive function (EF). EF refers to a family of top-down mental processes involving concentration and attention triggered by situations where a reliance on intuition is either ill-advised or impossible, (Burgess & Simons, 2005; Diamond, 2013) that facilitates our ability to adapt our decision-making to new situations and contexts. Dajani and Uddini (2015) explain that cognitive flexibility can be difficult to assess due to the many different ways in which it has been described. Among others, these descriptions include attentional flexibility (Vilgis, Silk, & Vance, 2015), attention switching (Casey et al., 2004), and attentional set-shifting (Owen, Roberts, Polkey, Sahakian, & Robbins, 1991). Similarly, operationalizations of cognitive flexibility differ based on the task employed to assess the construct.

To avoid ambiguities, we adopt Diamond's (2013) description of cognitive flexibility consisting of two sub-components; shifting between mental sets and idea production. Mental shifting involves an awareness of changes within the environment and the ability to change perspectives accordingly in order to better handle situation-specific demands (Martin & Rubin, 1995; Moore and Malinowski, 2009). For instance, one of the most widely used tasks in the assessment of the mental shifting component of cognitive flexibility is the Wisconsin Card Sorting Task (WCST) (Diamond, 2013). This task, which is described in further detail in the methods section, measures how well participants learn new rules and abandon old rules in their decision-making. Performance in this task is measured by looking at the number of errors made, in particular, preservative errors (the ongoing repetition of an error).

The latter aspect of cognitive flexibility, idea production, involves changing the way of thinking about something, like coming up with a new way of solving a problem when an older way of tackling the problem has proved ineffective (Diamond, 2013). Idea production has indeed been strongly linked to creativity (Silvia, Beaty, & Nusbaum, 2013). The idea production aspect of cognitive flexibility requires ‘’thinking outside the box’’ to generate novel ideas and is commonly assessed with the verbal fluency task. In this task, participants might be asked to come up with uncommon uses for an object (design fluency), words beginning with a specific letter (letter fluency), words that belong to a certain category such as types of animals (semantic fluency), and even alternating between letter and semantic fluency.

Open-office noise as a source of distraction

Before exploring the literature on the effects of open-office noise on cognitive flexibility, it is useful to distinguish between the terms "distraction'' and "interruption''. Speier (1996) defines distraction as "a provocative stimulus that directs attention away from an ongoing activity" and interruption ''as a severe attentional distraction that can place greater demands on cognitive processing resources than available capacity can handle" (p. 32). Speier (1996) continues to explain that whether it is a distraction or an interruption that causes a break from an ongoing task, both result in capacity overload, which in turn leads to cognitive disruption. Specifically, capacity overload causes the individual to make priorities, take cognitive shortcuts, ignore certain stimuli, and tasks (Baron, Baron, & Miller, 1973; Glass & Singer, 1972).

Distraction is a prevalent phenomenon in our surroundings and is caused by many factors. Sources of distraction include such things as background noise, temperature, new organizational policies, and bad lighting. While some distractions are internally generated, others are generated by the surrounding environment. According to the literature, out of all the examined distractions occurring around humans, sound distractions produced by open offices have consistently been found to increase stress, and consequently reduce task performance (Moore, 1977; Baron, Moore, & Sanders, 1978; Sanders & Baron, 1975; Sanders, 1981).

There can be many different types of noise in open offices that distract workers. According to the literature, intelligible irrelevant speech noise constitutes one of the strongest sources of distraction and stress in open-offices (Szalma & Hancock, 2011; Berti & Schroger, 2001; Heerwagen, Kampschroer, Powell, & Loftness, 2004; Banbury & Berry, 1998; Nemecek & Grandjean, 1973). Intelligible irrelevant speech refers to the type of noise caused by colleagues talking in the background while the individual exposed to the sound is performing a non-auditory task. This type of noise, which is the focus of the present thesis, is very common in open-plan offices (Jahncke, Hongisto, & Virjonen, 2013).

Effects of open-office noise on cognitive performance

With the ubiquitous emphasis on collaboration and creativity by organizations that in turn places a heavy demand on cognitive flexibility, it is surprising that, at least to our knowledge, no studies have examined the effect of open-office noise on cognitive flexibility specifically. Nevertheless, many studies have investigated the effect of open-office noise (speech and non-speech) on cognitive performance. A look at these studies can help reveal the effects of open-office noise on cognitive flexibility. The most widely studied effect within this area of research is that of irrelevant speech-based noise on serial recall performance, which was first discovered by Colle and Welsh (1976). A number of studies have replicated this effect using simple recall tasks (Colle, 1980; Miles, Jones, & Madden, 1991; Salamé & Baddeley, 1982, 1989; Haka et al., 2009). Recall tasks are known to serve as indicators of working memory (WM), or more simply known as short-term memory (Baddeley, 2010). In studies examining the irrelevant-speech effect, participants perform a short-term visual serial recall task while at the same time exposed to an auditory distraction in which participants are asked to ignore (because the sound is irrelevant to the task at hand). One proposed mechanism by which noise impairs performance is a disruption to the material stored in the articulatory loop component. This short-term mechanism of storing information rehearses information in an auditory manner (also known as inner speech) (Szalma & Hancock, 2011). Miyake et al. (2000) demonstrated that working memory, while different from other types of executive function, is linked to set shifting and inhibition. Similarly, Lehto (1996) showed that working memory tasks are correlated with the WCST and other set shifting tasks. Furthermore, Roper and Juneja (2008) explain that although memory recall tasks remain the most frequently used, ‘’almost all tasks involve memory and seriation (placing in serial order) at some instance during the task performance’’ (p. 97). Indeed, irrelevant speech noise has also been found to impair performance in tasks activating prior knowledge from long-term memory (Haka et al., 2009) such as the verbal fluency test (e.g., Unsworth, Spillers, & Brewer, 2011).

H1: Open-office noise will be negatively related to performance on the set shifting and the idea production aspects of cognitive flexibility.

Defining arousal and cognitive processing

Before exploring the literature on how arousal and cognitive processing may mediate the proposed hypotheses above, we begin by defining arousal and cognitive processing separately.

Arousal

Definitions of arousal appear to vary in terms of how narrow or broad they are (Russell, 2003). Broad definitions tend to describe arousal in term of individuals' subjective experience of arousal. Arousal in this view is commonly defined as a state of alertness or activation (Thayer, 1967). On the other hand, narrow definitions are more concerned with physiological aspects of arousal. For instance, scientists have measured arousal using various indicators of peripheral autonomic activity, such as blood pressure, pupil dilation, heart rate, or electrodermal response (Russell, 2003). Adopting Russell's (2003) definition, arousal here is defined as "a state of readiness for action or energy expenditure at one extreme versus need for sleep or rest at the other'' (p. 156). More importantly, our view of arousal in the present thesis takes into account both the physiological and subjective dimensions. This provides a more holistic view of arousal.

Cognitive processing

A large body of research has concentrated on dual-process theories of cognitive processing (e.g., Epstein, 1994; Kahneman, 2003; Mukherjee, 2010; Stanovich & West, 2000), where two dominant and separate systems of cognitive processing have been proposed. One of the most well-known dual-process theories is Kahneman's famous System 1 and System 2 of cognitive processing (Kahneman, 2003). System 1 refers to the intuitive mode of cognitive processing, where heuristics (or mental shortcuts) are used in quick and effortless decision-making. System 2 involves more effortful, slower, and deliberate type of processing. Such dual-process models, in contrast to unitary models, provide a more holistic and descriptive understanding of decision-making in different contexts (Mukherjee, 2010). Bakken, Hæerem, Hodgkinson, and Sinclair (2016) state that "both systems operate in parallel and compete for control of cognition and behaviour". Moreover, although the dominant perspective has treated intuition as a source of fallacy in decision-making, this notion has been increasingly criticized and challenged, particularly by the work of Gert Gigerenzer. To elaborate, analytical cognitive processing does not necessarily translate into positive performance of cognitive tasks. Gigerenzer (2008) famously went against the prevalent notion of the harmful effects of intuitive decision-making on decision-making outcomes, which was largely spurred by Kahneman and Tversky's seminal work on heuristics and decision-making. Gigerenzer introduced what he calls the ecological validity of heuristics, and argued that the appropriateness of heuristics depends on the situation and context in which they are applied in. Adopting a dual-process model allows for the exploration of both intuitive and analytical modes of cognitive processing.

The mediating effects of arousal and cognitive processing

Although sound levels in offices are relatively low (Kjellberg & Landström, 1994), surprisingly, psychological arousal during the performance of cognitive tasks is higher in office noise conditions than in quiet conditions (Loewen & Suedfeld, 1992). Noise has also been shown to trigger stress-related effects as a result of emotional irritation and annoyance that produce physiological responses (Hillier et al., 2006). Two of the most well-known and classical notions that link arousal to performance are the Yerkes-Dodson law (Yerkes & Dodson, 1908) and Easterbrook's (1959) hypothesis. The Yerkes-Dodson law asserts that ''the quality of performance on any task is an inverted U-shaped function of arousal, and that the range over which performance improves with increasing arousal varies with task complexity (as cited in Kahneman, 1973, p. 33). One particularly interesting domain in which this law has been applied in is the effects of background noise on human performance. Paraphrasing Kahneman (1973), although people are generally able to shield themselves from noise distraction, exposure to noise during longer periods can impair performance in a variety of ways. Continuous exposure to noise increases arousal level, the influence on performance as a result of the increased arousal depends on the nature of the task. Along a very similar line of thinking is Easterbrook's (1959) hypothesis, which predicts that a higher level of arousal limits the individual's use of cues as guidance for action. In Easterbrook's hypothesis, it is argued that low arousal is associated with low selectivity, in which case cues are encoded without filtering out irrelevant ones. As arousal increases, selectivity increases as well, leading to an improvement in performance as a result of filtering out irrelevant cues. However, increases in arousal from this level impairs performance, since arousal at this point narrows the individual's selective attention to such an extent that relevant cues also become filtered out.

The physiological stress reactions produced by noise (Evans & Johnson, 2000) influence our decision-making by impacting mechanisms such as strategy use, adjustment from automated responses, feedback processing, and reward and punishment sensitivity (Starcke & Brand, 2012). Moreover, the kind of attention to detail and identification of relevant cues highlighted in the paragraph above are critical aspects of analytical processing (Bakken et al., 2016). A plausible assumption is therefore that higher levels of arousal will increase intuitive processing and decrease analytical processing. For instance, there is evidence demonstrating that although noise increases the speed of decisions, it reduces the accuracy of them, thus leading to more errors (Hillier et al., 2006). This outcome of noise is often attributed to higher arousal (Hillier et al., 2006). Indeed, stress has been linked to an over-reliance on automatic cognitive processing and a decreased reliance on controlled processing (Masicampo & Baumeister, 2008). Moreover, high arousal also limits participants' memory to a restricted amount of information (Hanoch & Vitouch, 2004). For instance, Corson and Verrier (2007) discovered that higher levels of arousal increased the recollection of false memories. Likewise, Porter, Spencer, and Birt (2003) showed that high arousal caused participants to ignore the presence of misinformation and also reported fewer central details from the tasks they performed. Such findings are likely to be a result of a reduction in analytical processing (e.g., less attention to relevant cues) and an increase in intuitive processing (e.g., recalling false memories).

Research on stress also lends credence to our hypothesized role of arousal and cognitive processing. Although stress and arousal are not interchangeable terms, these two variables are highly interrelated. Boucsein (2012) defines stress as "a state of high general arousal and negatively tuned but unspecific emotion, which appears as a consequence of stressors (i.e., stress-inducing stimuli or situations) acting upon individuals" (p. 381). As such, arousal is a key element of stress. Also worth noting is that the link between stress and physiological arousal is independent of whether the felt stress is negative or positive (Boucsein, 2012). Research on the negative effects of stress on task performance is well-established (Keinan, 1987; Starcke, Wolf, Markowitsch, & Brand, 2008), where reduced attention span and executive functioning caused by stressors have been highlighted as underlying mechanisms for deploying maladaptive strategy.

Kassam, Koslov, and Mendes (2009) observed that limited cognitive resources decrease adjustment under stressful conditions. More specifically, they observed that participants failed to suppress their prepotent automatic response, consequently, failing to make controlled rational adjustments. Neurologically speaking, stressful conditions cause the amygdala to trigger stress pathways, which in turn produces high levels of dopamine and noradrenaline. In such situations, the prefrontal cortex switches from thoughtful 'top-down' control that is based on what is relevant for the primary task, to 'bottom-up' processing (Arnsten, 2009). In other words, the prefrontal cortex switches to more rapid and reflexive responses, which leads to an impairment in working memory and reasoning abilities (Pham, 2007). Furthermore, this change in how the brain processes information can also be thought of as switching from what Lieberman (2007) calls the C-system (reflective system) to the X-system (reflexive system). Indeed, these two systems strongly overlap with analytical and intuitive processing, respectively (Lieberman, 2007).

Finally, apart from the parallel (comparable) multiple mediating effects of arousal and cognitive processing, a more interesting and plausible relationship that can be inferred from the findings above is serial mediation between arousal and cognitive processing. This leads us to the following hypotheses:

H2: Open-office noise will be positively related to arousal.

H3: Open-office noise will be positively related to intuitive processing and negatively related to analytical processing.

The above literature on the relationship between cognitive processing and task performance indeed suggest that rather than basing our assumptions on the conventional notion of analytical processing being superior to intuitive processing with regards to task performance, one might also expect intuitive processing to be positively related to task performance. Similarly, based on optimal level of arousal assumption posited by the Yerkes-Dodson law, the direction of the relationship between arousal and task performance may depend on the proximity to the optimal level of arousal.

H4: Intuitive processing will be negatively related to a) the mental shifting aspect and b) the idea production of cognitive flexibility.

H5: Arousal will be negatively related to a) the mental shifting aspect and b) the idea production aspect of cognitive flexibility.

Parallel mediation hypotheses
H6: Arousal will mediate the relationship between open-office noise and a) the mental shifting aspect and b) the idea production aspect of cognitive flexibility.

H7: Intuitive processing will mediate the relationship between open-office noise and a) the mental shifting aspect and b) the idea production aspect of cognitive flexibility.

Serial mediation hypotheses
H8: Open-office noise will indirectly influence a) the mental shifting aspect and b) the idea production aspect of cognitive flexibility through causally multiple mediators of physiological arousal and intuitive processing.

A moderated mediation model with Eastern versus Western perspectives of mindfulness

Owing to the extant evidence pointing to the positive effects of mindfulness on psychological and physiological outcomes, particularly in reducing stress (for a review see Gu, Strauss, Bond, & Cavanagh, 2015), only recently has mindfulness become recognized as an important variable in the field of judgement and decision making (JDM). Studies examining the role of mindfulness in decision-making contexts have ended up with contrary findings. On the one hand, studies have found a positive relationship between mindfulness and cognitive performance in tasks involving, among others, working memory (Jha, Krompinger, & Baime, 2007; Heeren, Van Broeck, & Philippot, 2009; Zeidan, Johnson, Diamond, David, & Goolkasian, 2010), attention (Jha, Stanley, Kiyonaga, Wong, & Gelfand, 2010), inhibitory control (Allen et al., 2012), creativity (Colzato, Szappora, & Hommel, 2012). In contrast, recent findings suggest that mindfulness may impair cognitive performance in certain task domains, such as learning in implicit cognitive tasks (Stillman, Feldman, Wambach, Howard, & Howard, 2014; Whitmarsh, Uddén, Barendregt, & Petersson, 2013) and creativity (Zedelius & Schooler, 2015). Similarly, authors have found that mind-wandering (here defined as engaging in task-unrelated thoughts) improves cognitive functions that are responsible for creativity. Several common problems seem to lend themselves to these mixed findings. The most apparent issue relates to the different ways in which mindfulness is conceptualized. This is rather unsurprising considering the many mindfulness scales that have been developed within such a short period. Two fundamental perspectives dominate the mindfulness literature; these are Eastern and Western perspectives of mindfulness (for a summary of these two perspectives, see Weick & Putnam, 2006). Although these perspectives share their similarities, they also share notable differences. The Eastern perspective, which is closely associated with meditative calmness, has indeed dominated the literature, commonly measured with the Mindfulness Attention Awareness Scale (MAAS; Brown & Ryan, 2003). Eastern mindfulness is usually described as a way of becoming more in touch with one's intuition (Dane, 2010; Dane & Pratt, 2009). On the other hand, the Western perspective, which is largely seen in the work of Ellen Langer (1989), is less concerned with meditative properties and more focused on cognitive functions. Langer's notion of individual mindfulness has also largely inspired Weick and Sutcliffe's (2001) well-known concept of organizational mindfulness, with their particular emphasis on high reliability organizations (HROs). Ray, Baker, and Plowman (2011) observe that ''the notion of organizational mindfulness emerged in the organizational science literature in regard to automatic and non-automatic information processing'' (p. 189). Where mindfulness entails a more aware and deliberate type of information processing, its polar opposite, mindlessness, entails a reliance on previously established categorizations and automatic processing. Similarly, Langer (1989) defines individual mindfulness as a state of alertness and active awareness (a description that seems to strongly converge with arousal), continuous creation and refinement of categories, openness to new information, and awareness of multiple perspectives. Most notable is the ability to hold multiple perspectives, or cognitive flexibility, which is the essence of Langerian mindfulness (Brown & Langer, 1990). Cognitive flexibility involves the ability to adapt cognitive processing strategies in order to better handle turbulent conditions, and has an intrinsic relationship with attentional processes (Cañas et al., 2003). Since mindfulness relies on the investment and reinvestment of attention on a moment-by-moment basis, mindfulness should demonstrate a positive relationship to cognitive flexibility, through its positive effect on analytical (non-habitual) processing (Moore & Malinowski, 2009; Ie, Haller, Langer, & Courvoisier, 2012). Furthermore, the large body of research showing the positive effects of mindfulness in reducing stress makes it interesting to investigate how mindfulness functions in relation to arousal. As such, an intriguing question that arises is how trait mindfulness (Eastern vs. Western) and the polar opposite of mindfulness mind-wandering might moderate the indirect effect of open-office noise on cognitive flexibility through arousal and cognitive processing. Indeed, due to conceptual differences between the Eastern and Western perspectives of mindfulness as discussed above, one might expect different moderating effects across the three focal moderators. However, due to the mixed findings regarding the effects of these variables on cognitive performance, we leave open the direction of the relationship these variables might moderate. More specifically, as discussed earlier, where most studies suggest a positive relationship between mindfulness and task performance, recent studies have found reversed findings within certain task domains. To test this moderated mediation model, we propose the following set of hypotheses:

H9: The indirect effect of open-office noise on cognitive flexibility (mental shifting aspect and idea production aspect) through arousal will be moderated by a) Eastern mindfulness, b) Western mindfulness, and c) mind-wandering.

H10: The indirect effect of open-office noise on cognitive flexibility (mental shifting aspect and idea production aspect) through intuitive processing will be moderated by a) Eastern mindfulness, b) Western mindfulness, and c) mind-wandering.

Method

The present study employs a between-subject experimental design with one experimental (noise) condition and a control (silent) condition. All materials have been retained in their original format and language (English). This study has been notified to the Norwegian Centre for Research Data (NSD) prior to collecting the data.

Participants and Design

We set sample size a priori to *N*=100. We did not conduct a priori power analysis (Cohen, 1988) but simply followed a common heuristic to conduct 50 participants per condition. This should provide more than 95% power to detect the effect sizes (i.e., of stress vs. no-stress condition on task performance), following *G*Power* (Faul, Erdfelder, Lang, & Buchner, 2007). The final sample consisted of 109 participants (31 men), after excluding 9 participants with missing values on central elements of the experiment. Age was indicated in categories. Most participants (*N*=53) were between 26 and 35 years old and almost all were younger than 56 years old. Participants were recruited through an online participation form that was shared on social media platforms and by hanging up flyers inside the University of Oslo and BI Norwegian Business School. Most of the participants were Master students (*N*=41). The participation form was entitled ''The Psychology of Decision Making'' with a brief and rather general description of the present study. This was done with the intention of refraining from explicating the purpose of the study. As an incentive to participate, they were told that four participants would be selected at random to receive a gift card worth 500 NOK, and that participants could choose to receive individual feedback on results from the experiment. Participants were randomly assigned to one of the two conditions.

Procedure

Each session comprised of a group of maximum five participants since we only had five devices to measure their physiological arousal. After entering the laboratory, participants were handed a consent form as well as a subject ID number and asked to take their seat. After expressing their agreement to participate, participants were connected to the Biogauge Sudologgers (Tronstad et al., 2008) to measure their physiological arousal. The participants' electrodermal responses (EDRs) were recorded at a sampling frequency of 1.1111 Hz (i.e., every 0.9 second). This measurement is described in further detail in the measures section below. Participants were then told to copy-paste a given link in the browser in order to get to the experiment. The experiment was designed on PsyToolkit (www.psytoolkit.org; Stoet, 2010, 2016), which is a free web-based service designed for setting up, running, and analysing online questionnaires and reaction-time (RT) experiments. Participants first responded to questionnaires measuring mindfulness and mind-wandering. Next, they were presented with a link to an external site where the sound file was uploaded, and were asked to wear their headsets, click play, and return to the previous page to continue the experiment with the sound on. The next phases of the experiment involved two experimental tasks; a questionnaire measuring cognitive processing; manipulation check; and demographic questions. Finally, participants were thoroughly debriefed and thanked for their contribution.

Manipulation

In order to induce stress, participants listened to an intelligible speech-based noise recording that was played on headphones (DT 770 PRO 80 OHM) while they were carrying out the experimental tasks. These sounds, that were purchased from www.soundsnap.com, have been recorded in realistic open-office workspaces. The following keywords were entered when searching for sounds on the website's library: ''conversation'', ''open office'', ''talking in office'', ''talking''. We limited our inclusion to recordings of open-offices that also included the sound of intelligible conversations. Other background noise of these recordings included the sound of printers printing paper, telephones ringing, doors opening and closing, among others. A total of 5 sound files were purchased, and later combined using GarageBand on a Macbook Air laptop. The individual sound files had an average duration of 2 minutes and 30 seconds. The combination and extension of these 5 sound files resulted in a total duration of 23 minutes and 9 seconds. These recordings were combined in such a way as to minimize the likelihood of participants noticing that the final sound file was made up of different sound files. The decibel (db) level of the final sound file was measured using the software Decibel Meter on a Macbook Air laptop, which indicated an average of 65 db - this level is classified as a typical conversation. We have focused on intelligible speech as the literature on noise and distraction points to this type of noise as the most significant source of distraction during task performance. Previous studies have also used sounds such as story-reading, however, the sound employed in the present thesis may provide stronger ecological validity as it creates a more (albeit artificial) realistic environment with greater proximity to real-life experiences in offices. Another important feature of the manipulation is the intermittence of the sound, which has been described as "externally-generated, randomly occurring, discrete event that breaks continuity of cognitive focus on a primary task" (Coraggio, 1990, p. 19). According to Jones (1993), reduction in performance is not caused by the intensity of the sound nor the informational content of the speech itself. Rather, the intermittency of the sound is believed to account for the largest part of the negative effect.

Measures

Physiological arousal

For the measurement of participants' physiological arousal, Biogauge Sudologgers were used (Tronstad et al., 2008). As mentioned above, these are sensors that measure skin conductance response (SCR) by applying a very small electric current (30 mV) to the skin beneath three measuring electrodes connected to palm and forearm of subjects' non-dominant hand. The skin is made up of electric properties that change on a time scale of seconds, and are closely linked to psychological processes. These changes in SCR are tied to changes in eccrine sweating and activity in the sympathetic part of the autonomic nervous system. Thus, more specifically, EDA measures tap into physiological processes related to sympathetic arousal (Figner & Murphy, 2011). Skin conductance is a popular tool in the field of judgment and decision making (JDM), and is often used to indicate affective and emotional states (Figner & Murphy, 2011). Indeed, this tool makes it possible to reveal otherwise hidden processes of the ways in which people make decisions and form judgments. For the purpose of clarity of terminology, although often used interchangeably, EDA and SCR do not refer to the same measurement. While EDA refers most generally to all kinds of electrical phenomena in the skin, skin conductance is one particular type of EDA that refers to the skin's ability to conduct electricity when an external direct current of constant voltage is applied to the skin (Figner & Murphy, 2011). Skin conductance is typically divided into tonic and phasic phenomena. The primary difference between these two relate to their time scale and their relationship to the evoking stimuli.

For the analysis of skin conductance activity, we used Ledalab 3.4.9 (www.ledalab.de), a software written in MATLAB. Continuous Decomposition Analysis (CDA) was performed in order to decompose the data into phasic and tonic components (Benedek & Kaernbach, 2010). The advantage of using CDA is its ability to control for baseline dependency, or participants' skin conductance level at the very beginning of the experiment. Without this type of control, SCR increases only to a certain level when starting at a high level. Specifically, as opposed to the classic "Trough-to-peak method'', CDA reduces the risk of underestimating EDR amplitudes due to superimposed EDRs (Benedek & Kaernbach, 2010). Adopting the procedure employed in Benedek and Kaernbach's (2010) article, the minimum amplitude criterion was set to 0.05 μS. Several time windows were selected based on their expected significance as demonstrated in prior theses (Løseth & Dahl, 2017; Borge & Hedenstad, 2016). These time windows included 10 seconds after the onset of the stimulus, 5 seconds before the end of stimulus, and average experience. EDR amplitudes are commonly used when assessing even-related EDA (Boucsein, 2012). As such, for our final analyses, we used the sum of EDR amplitudes (i.e., difference between the baseline and the highest SCR level) within the specific response windows.

Langer's Mindfulness Scale (LMS)

Western mindfulness was assessed using the LMS, a 21-item scale that includes four dimensions: novelty seeking, novelty producing, engagement, and flexibility (Bodner & Langer, 2001; Pirson, Langer, Bodner, & Zilcha-Mano, 2012). Participants rated the items using a 7-point scale between Strongly disagree (1) and Strongly agree (7). The LMS has both positively (e.g. "I like to investigate things") and negatively (e.g. "I seldom notice what other people are up to") scored items. The LMS has demonstrated good internal consistency (Haigh, Moore, Kashdan, & Fresco, 2010).

Mindfulness Awareness Attention Scale (MAAS)

Eastern mindfulness was assessed using the MAAS, a 15-item scale developed by Brown and Ryan (2003). It is a self-report measure which determines how well an individual can stay undistracted and attentive on an experience (MacKillop & Anderson, 2007; Mrazek et al., 2013). Participants rated the items using a 6-point scale between Almost Always (1) and Almost Never (6) [reverse-scored]. Items include "I could be experiencing some emotion and not be conscious of it until sometime later'' and "I rush through activities without being really attentive to them''. The MAAS is the most widely used measure of trait mindfulness, which has demonstrated strong psychometric properties. One item was modified in order to make it appropriate for the target population: the item "I drive places on 'automatic pilot' and then wonder why I went there was changed to "'I go places on 'automatic pilot' and then wonder why I went there.''

Mind-Wandering Questionnaire (MWQ)

The MWQ is a 5-item scale developed by Mrazek et al. (2013) that specifically measures trait levels of mind-wandering. Participants rated the items using a 6-point scale between Almost always disagree (1) and Almost never (6). It is a face-valid tool and has demonstrated high internal consistency and good homogeneity (Mrazek et al., 2013). This scale consists of items such as "while reading, I find I haven't been thinking about the text and must therefore read it again'' and "I mind-wander during lectures of presentation''. Although numerous studies have used low scores on the MAAS (Brown & Ryan, 2003) as a proxy for mind-wandering, such an approach has recently been subject to scrutiny (Mrazek et al., 2013). The MAAS seeks to capture the extent to which one is aware and attentive of events occurring in the present. At first glance, it may seem plausible to treat a low level of mindfulness as an indicator of mind-wandering. Indeed, studies have found that those who report high levels of mindfulness on the MAAS are less prone to mind-wandering when working with tasks (Mrazek et al., 2013). However, the use of the MAAS in capturing mind-wandering entails several limitations. The MAAS probes attention without a clearly defined primary task (e.g., "I find myself preoccupied with the future or the past.''). Paraphrasing Mrazek et al. (2013), such preoccupation cannot be defined as mind-wandering if it occurs in the absence of a primary task. In addition to measuring attention, the MAAS also seeks to measure awareness (e.g., "I do jobs or tasks automatically, without being aware of what I'm doing''). Yet, one can effectively perform a task while highly attentive, without metaawareness (Mrazek et al., 2013).

Cognitive Processing

Participants' cognitive processing during the two experimental tasks was measured in two ways: using the Cognitive Processing Questionnaire (CPQ) and using participants response time (RT) during each of the experimental tasks. A description of each method is provided below.

Cognitive Processing Questionnaire (CPQ). developed by Bakken, Hærem, Hodgkinson, and Sinclair (2016). This 22-item scale is made up of 5 dimensions: rational (5 items), control (6 items), urgency (4 items), affective (3 items), and knowing (4 items). The questionnaire contains items such as "I evaluated systematically all key uncertainties" and "I made the decision because it felt right to me". All items were rated on a scale from 1 (strongly disagree) to 5 (strongly agree). The Knowing, Affective, and Urgency subscales are expected to serve as indicators of an intuitive mode of information processing, while the Rational and Control subscales are expected to serve as indicators of analytical processing (Akinci & Sadler-Smith, 2013; Hodgkinson, Sadler-Smith, Sinclair, & Ashkanasy, 2009). These two higher-order constructs analytic and intuitive processing were used in final analyses. As this is a relatively newly developed scale, we sought to examine the extent to which the scale maintains its psychometric properties by assessing its internal consistency and running a confirmatory factor analysis. Descriptive statistics for the cognitive processing construct are presented in table 4.1. All scales had acceptable reliabilities of .70 and above, except the affective subscale which had a reliability of .65. A confirmatory factor analysis indicated that the model proposed by (Bakken, et al., 2016) provided a poor fit (X2 (205) = 395.28, RMSEA = 0.09, CFI = 0.79).

Table 1: Means, Standard Deviations, and Scale Intercorrelations Among the five CPQ Dimensions. Scale Reliabilities, Measured by Coefficient Alpha, are Shown in boldface on the Leading Diagonal. N = 109.

CPQ Dimension	Mean	SD	1	2	3	4	5
1. Rational	3.14	.86	**.85**				
2. Control	2.93	.71	.59**	**.77**			
3. Urgency	3.51	.82	-.37**	-.47**	**.82**		
4. Affective	3.45	.77	.02	.00	-.06	**.68**	
5. Knowing	3.35	.76	.39**	.15	-.11	.00	**.69**

Note. **p < .001 (two-tailed).

The correlations for the analytical dimension (Rational and Control) are in the expected directions. The subscales Rational and Control also show significant negative correlation with the Urgency subscale which is part of the intuitive dimension of cognitive processing, thus supporting Bakken et al.'s proposed differences between these modes of cognitive processing. However, none of the intuitive subscales (urgency, affective, knowing) demonstrate any significant correlations. Moreover, we found that Knowing correlated significantly with the

Rational dimension, but not with Affective and Urgency. Conceptually, Knowing is described as being part of the intuitive mode of processing, along with the dimensions Affective and Urgency. Bakken et al. (2016) also discovered that the Knowing subscale correlated with the analytic processing variables. Bakken and colleagues argue that what might explain this finding is that knowing (i.e., having sufficient information in a given task) is a state shared by intuitive and analytical processing. Due to this ambiguity, the Knowing subscale was excluded from further analyses.

Response time. According to the literature, response time (RT) should correlate positively with analytical processing and negatively with intuitive processing. According to Bakken et al. (2016), the subscales belonging to the intuitive mode of processing (Knowing, Affective, and Urgency) should be negatively related to RT, whereas the subscales belonging to the analytical mode (Rational and Control) should be positively related to RT. Based on this notion, participants' RTs during all experimental tasks were collected. RTs for the WCST were automatically provided in the data, which was then converted from milliseconds (ms) to seconds (sec). For the verbal fluency task (which consists of three sub-tasks), while there was no data for participants' RTs for these tasks, the RTs were calculated by dividing the number of words with the time they had in each of three sub-tasks (60 seconds). The results are presented using the following labels: RTs for three verbal fluency tasks are labeled "VFT1 RT'', ''VFT2 RT'', VFT3 RT'', and RT for the WCST is labeled ''WCST RT''.

Manipulation check. A subjective rating called the Self-Assessment Manikin (SAM) of physiological arousal level (Bradley & Lang, 1994) was used to check whether or not experimental participants felt more stressed than the control participants. Participants rated the affective dimensions of arousal on a 9-point Likert scale that includes graphic pictures representing different levels of arousal, ranging from ''calm'' to ''excited'' (see Appendix 7). In assessing the effectiveness of the distraction induction, we carried out a between-subjects t-test. Although subjective arousal was higher in the noise condition (M = 4.23, SD = 1.59), this was not significantly different from the silent condition (M = 4.15, SD = 1.65). Thus, it appears that the participants in the noise condition did not differ from the control group in terms of their subjective feeling of arousal. However, it should be mentioned that our manipulation check did not specifically ask specifically about the sound, but rather, how ''active'' or ''alert'' they felt while performing the tasks. A manipulation check targeted at the noise itself may have better served this purpose.

Control variables. Previous empirical evidence points to possible confounding effects of gender, where gender differences have been found in cognitive processing (e.g., Tranel, Damasio, Denburg, & Bechara, 2005; Gur et al., 1999) and arousal (e.g., Matthews, Gump, & Owens, 2001; Sauro, Jorgensen, & Pedlow, 2003; Steiner, Ryst, Berkowitz, Gschwendt, & Koopman, 2002; Wolf, Schommer, Hellhammer, McEwen, & Kirschbaum, 2001). Age and education were also controlled for. Thus, age, gender, and education were added as covariates.

Experimental Tasks

Two tasks were used in order to measure cognitive flexibility. WCST was used to measure the mental shifting aspect of cognitive flexibility. Verbal fluency was used to measure the idea production aspect of cognitive flexibility.

The Wisconsin Card Sorting Task (WCST). WCST is the oldest and most widely used test for measuring cognitive flexibility (Miyake et al., 2000; Diamond, 2013). Neurologically, it measures prefrontal cortex functioning in adults (Diamond, 2002). We used a computerized version of the WCST downloaded from www.psytoolkit.org. Against a dark black background were four key cards presented at the top of the screen (see Appendix 5). A response card was presented one at a time at the bottom left of the screen. Participants were required to match the series of response cards with any of the four key cards. The matching has to satisfy one of three possible rules; matching along dimensions of number (1,2,3,4), colour (red, green, blue, yellow), or shape (triangle, square, circle, star). Once a card had been selected, the participant would receive the message ''Correct!'' in green font with a smiling face for a correct response, and the message ''Wrong!'' in red font with a sad face for an incorrect response. In the original version of the task that was downloaded from ww.psytoolkit.org, a sound would play upon selection of a card (a cheerful sound for a correct response and an uncheerful sound for an incorrect response). However, this effect was removed from the script due to the concern of this sound confounding the effect of the treatment sound. The sorting rule changed once the participant had made 10 correct selections, and they were given a total of 64 trials. In the original version of the task, participants get a maximum of 10 seconds to choose a card, however, we reduced it to a maximum of 5 seconds. This was done because 10 seconds may reduce the effect of the noise treatment on task performance. The primary dependent measure in this task is the number of perseverative errors a person makes, which indicates a continued application of a card-sorting rule that is no longer appropriate instead of shifting to the use of a new rule (i.e., cognitive inflexibility); higher scores thus indicate worse performance. In order to ease the interpretation of the results, the number of preservative variables were re-coded such that higher scores on the recoded variable indicated better performance. This task took on average approximately 6 minutes to complete.

The Verbal Fluency Task (VFT). Verbal fluency task is usually used to measure idea production aspect of cognitive flexibility and creativity (Diamond, 2013). We adapted it to a computerized version by using PsyToolkit. During each trial, participants were instructed to generate (in writing) as many words as possible within one minute (Appendix 4). Participants were given the instruction to avoid generating names, places, or the same words with different endings. Each new trial was prompted by the participant pressing a button to continue after having been subjected to instructions. At that point, a white text box appears with a discreet timer at the bottom counting down from one minute. Once the minute was out, they would automatically get a new screen with a next task. First, letter fluency was evaluated in one trial: participants were instructed to generate as many words as possible beginning with the letter A. The second trial assessed category fluency where participants were asked to generate as many unusual uses for a cup that they could think of. The third trial, assessed the participants' ability to alternate between semantic category and phonemic criteria by producing combinations of a word starting with the letter M, followed by naming a type of vegetable. This family of tasks are also relevant for office work since they tap into processes involved in generating written texts and ideas. For all three tasks, fluency performance was scored in terms of the number of words produced in 1 minute. Each author of the present thesis scored these tasks separately and later compared and discussed the scores in order to ensure some degree of consistency.

Data analysis

All hypotheses were tested using a conditional process modelling program, PROCESS, that employs an ordinary least-squares path analytical framework to test direct and indirect effects (Hayes, 2012). Hayes' process model is convenient for the analysis of the current data as it allows the exploration parallel, serial, and moderated mediation models. Specifically, PROCESS Models 4 (parallel mediation), 6 (serial mediation), and 59 (moderated mediation) were chosen. This statistical method has several important benefits. First, a researcher can assess whether an overall effect of a set of mediators exists. Second, this statistical method reduces the probability of omitting other important mediating variables which may lead to parameter bias. Third, the strength of specific indirect effects can be assessed and compared against each other, which makes it possible to test for competing hypotheses. The indirect effects were examined with 5000 bootstrap samples and 95% bias-corrected confidence intervals. Mediation was determined by the significance of the overall indirect path from the independent variable (IV) to the dependent variable (DV) via the mediator (M) variable (MacKinnon, Fairchild, & Fritz, 2007). A specific effect is considered significant if zero falls outside the upper and lower bound of the bootstrap confidence interval (Preacher & Hayes, 2008). The overall models were evaluated using the $\chi 2$ test along with other fit indices. A Root Mean Square Error of Approximation (RMSEA) close to .06, a Comparative Fit Index (CFI) over .95, and a Standardized Root Mean Square Residual (SRMR) under .08 indicate close fitting models (Hu & Bentler, 1999).

Parallel mediation

PROCESS model 4 was employed to explore simultaneous mediation (Preacher & Hayes, 2008) by cognitive processing and arousal. Specifically, the model was used to determine whether open-office noise influences cognitive flexibility through the two proposed mediators. The *a* coefficients represent the effect of open-office noise on the mediators, and the *b* coefficients represent the effects of the mediators on cognitive flexibility partialling out the effect of open-office noise. The *c* path is the total effect of open-office noise on cognitive flexibility. The *c'* path is the direct effect, that is, the effect of open-office noise on cognitive flexibility controlled for the effect of the set of mediators. The specific indirect effect is the mediating effect of each proposed mediator, as represented by a1b1 (cognitive processing), a2b2 (arousal). Finally, the total indirect effect is the sum of both specific indirect effects. The overall moderated mediation model as illustrated in Figure 3 was broken into 2 submodels that differed only with respect to the two DVs of ''mental shifting'' and ''idea production''.

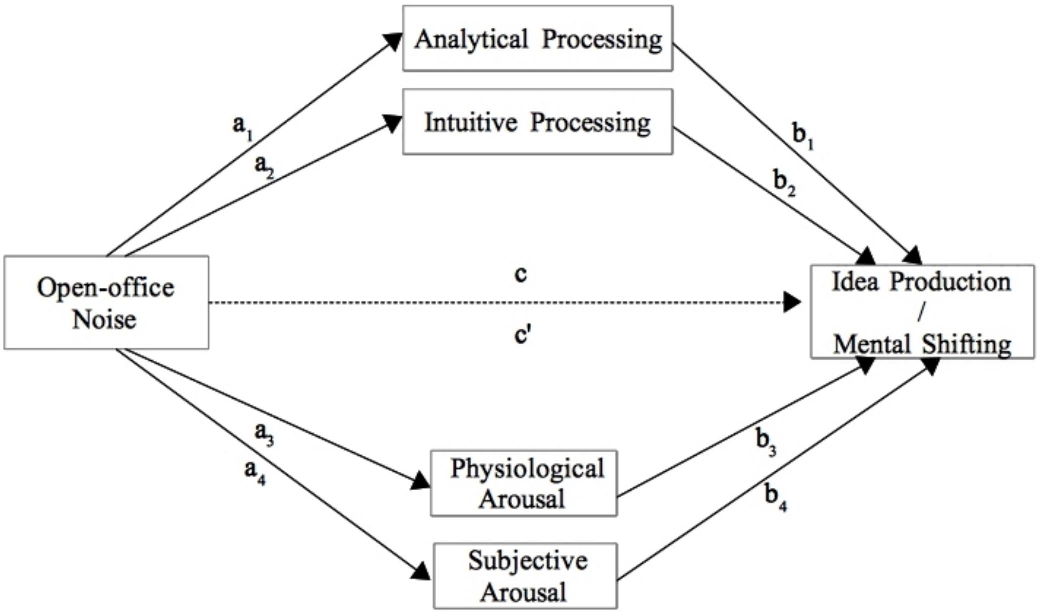

Figure 1. The Hypothesized Parallel Mediation Model.

Serial mediation

PROCESS Model 6 was employed to determine whether open-office noise influences cognitive flexibility through a serial chain of the two proposed mediators. Serial mediation assumes "a causal chain linking the mediators, with a specified direction of causal flow" (Hayes, 2012, p. 14). For example, open-office noise could increase arousal, which could increase intuitive processing, and thus decrease performance in the idea production and mental shifting aspects of cognitive flexibility (see Figure 2). The *a* coefficients represent the effect of open-office noise on the mediators, and the *b* coefficients represent the effects of the mediators on cognitive flexibility. The *c* path is the total effect of open-office noise on cognitive flexibility. The *c'* path is the direct effect, that is, the effect of open-office noise on cognitive flexibility controlled for the effect of the set of mediators. The specific indirect effect through only arousal (M1) is a1b1, the specific indirect effect through cognitive processing (M2) only is a2b2, and the specific indirect effect through both arousal and cognitive processing is a1d21b2 The specific indirect effect is the mediating effect of each proposed mediator, as represented by a1b1 (cognitive processing), a2b2 (arousal). Finally, the total indirect effect is the sum of both specific indirect effects. Note that the model illustrated in Figure 2 was run four times where either physiological or subjective arousal was entered as M1, and where either idea production or mental shifting was entered as the DV.

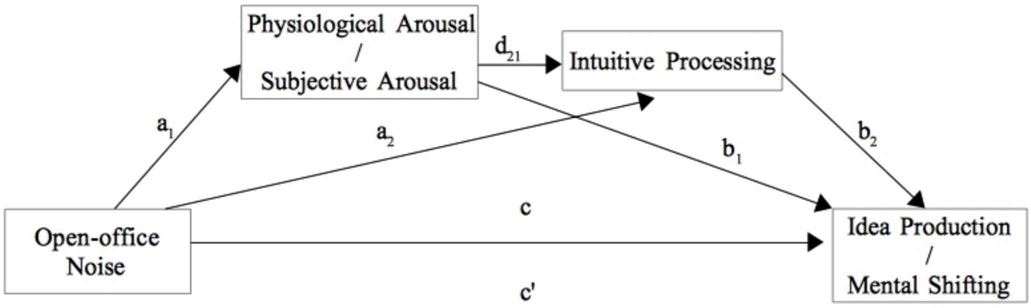

Figure 2. The Hypothesized Serial Mediation Model.

Moderated mediation

PROCESS Models 59 was employed to investigate how Eastern mindfulness, Western mindfulness, and mind-wandering might moderate the parallel and serial mediation models, respectively. Specifically, Model 59 quantifies how differences in X (noise vs. silent condition) map onto differences in Y (cognitive flexibility) indirectly through both M1 (cognitive processing) and M2 (arousal) depending on the value of W (Eastern mindfulness, Western mindfulness, or mind-wandering). Finally, the direct effect of open-office noise on cognitive flexibility is also moderated and therefore conditional. Figure 3 presents the hypothesized multiple mediation models. The overall moderated mediation model as illustrated in Figure 3 was broken into 6 submodels that differed only with respect to the three moderators ‘’Eastern Mindfulness’’, ‘’Western mindfulness’’, and ‘’mind-wandering’’, as well as the DVs ‘’mental shifting’’ and ‘’idea production’’.

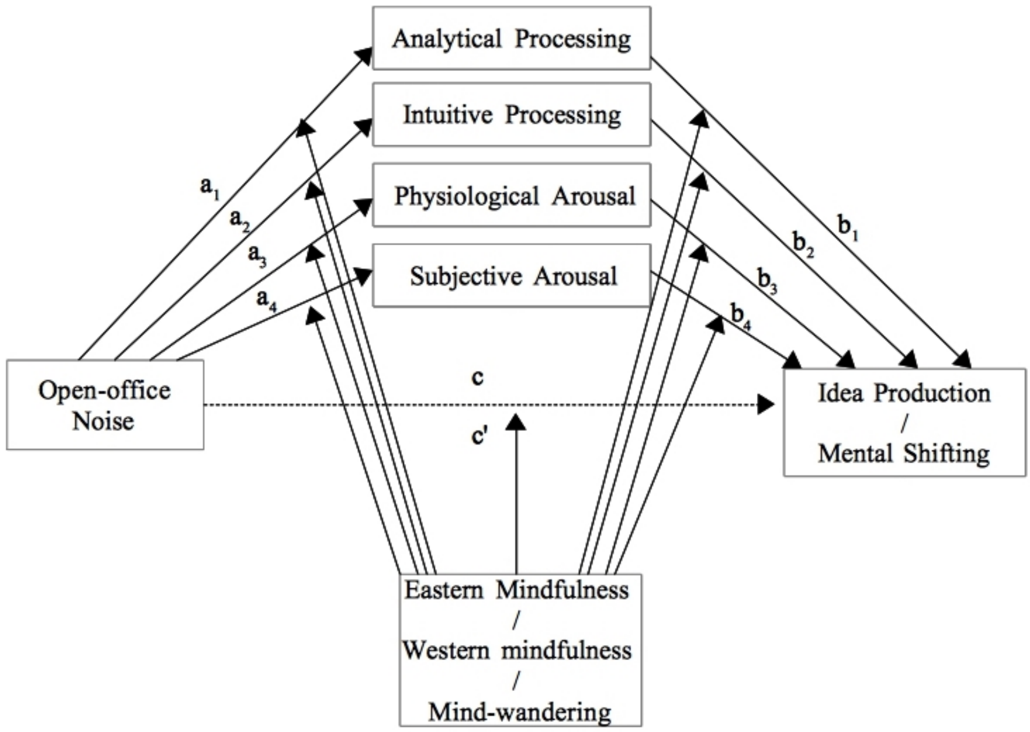

Figure 3. The Hypothesized Overall Moderated Mediation Model.

Results

Exploring the data

Using Mahalanobis distance (Tabachnick & Fidell, 2011), no outliers were detected in the data on any of the four dependent variables of verbal fluency task 1, 2 and 3, and the WCST. Linearity, normality, multicollinearity, homogeneity, and homoscedasticity assumptions were all met. As one might expect, due to the conceptual overlap between the Eastern and Western mindfulness measurements, these two variables were significantly correlated. Nevertheless, collinearity diagnostics revealed no issues (i.e., tolerance-level was above .9 and the VIF-value was below 2).

Descriptive statistics

An overview of correlations between all study variables is illustrated in Table 2. Response times (RTs) for each task (three subtasks of verbal fluency, and the WCST) were included in order to assess if RT predicted intuitive and analytical processing in expected directions. Theoretically, RT should be negatively related to intuitive processing and positively related to analytical processing. That is, individuals reporting higher levels of intuitive processing should have shorter RTs in the tasks, and those reporting higher levels of analytical processing should have longer RTs in the tasks. However, the results reveal that not only were these correlations insignificant, but also in opposite directions from what was expected. The two modes of cognitive processing intuitive and analytical were significantly and negatively related, supporting the notion of these as two independent systems (Bakken et al., 2016). Interestingly, mind-wandering has a significant and positive relationship with intuitive processing, indicating that participants with a general tendency to mind-wander were more intuitive in the performance of the experimental tasks. This relationship is backed by several studies (e.g., Zedelius & Schooler, 2015). Additionally, mind-wandering has a significantly positive relationship with subjective arousal, indicating that participants with a general tendency to mind-wander also reported higher levels of subjective (i.e., psychological) arousal during the experimental tasks. Based on the correlations between each time window of arousal with the rest of the study variables, we decided to proceed with the *10 seconds after onset of stimulus* window. Focusing on this specific window, physiological arousal demonstrated a significantly negative relationship with Eastern mindfulness. Indeed, theoretically, individuals reporting higher levels of Eastern mindfulness should be more calm and less affected by external stimuli (in this case, the sound intervention). Finally, the negative relationship between Eastern mindfulness and mind-wandering lends credence to Mrazek et al.'s (2013) definition and operationalization of these two constructs as polar opposites.

Table 2. Bivariate correlations of central study variables.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Intuitive	-																
2. Analytical	-.383**	-															
3. EMF	-.035	.099	-														
4. WMF	-.018	.097	.220*	-													
5. MW	.307**	-.093	-.546**	-.018	-												
6. Subjective Arousal	.210*	-.087	-.113	-.173	.298**	-											
7. Physiological Aro.	.112	.010	-.198*	-.062	.108	.057	-										
8. VFT1	.106	-.122	.002	.128	.019	-.039	.064	-									
9. VFT2	.100	-.037	-.039	.245**	-.023	-.117	.181	.478**	-								
10. VFT3	.044	-.129	.054	.165	-.053	-.077	.010	.502**	.368**	-							
11. VFT Total	.109	-.124	.006	.210*	-.014	-.087	.101	.895**	.733**	.738**	-						
12. VFT1 RT	.106	-.122	.002	.128	.019	-.039	.064	1.000**	.478**	.502**	.895**	-					
13. VFT2 RT	.100	-.037	-.039	.245**	-.023	-.117	.181	.478**	1.000**	.368**	.733**	.478**	-				
14. VFT3 RT	.044	-.129	.054	.165	-.053	-.077	.010	.502**	.368**	1.000**	.738**	.502**	.368**	-			
15. VFT Total RT	.109	-.124	.006	.210*	-.014	-.087	.101	.895**	.733**	.738**	1.000**	.895**	.733**	.738**	-		
16. WCST	-.126	.019	.086	.212*	-.110	-.080	-.175	.230*	.257**	.465**	.371**	.230*	.257**	.465**	.371**	-	
17. WCST RT	.152	-.110	-.003	-.230*	.081	.175	.095	-.174	-.308**	-.351**	-.319**	-.174	-.308**	-.351**	-.319**	-.475**	-
18. Group (0=Silent)	-.074	-.067	.009	.000	-.161	.053	.238*	.025	.155	-.066	.045	.025	.155	-.066	.045	.018	.020

Note. * $p < .05$. ** $p < .01$.

A one-way analysis of variance (ANOVA) was performed in order to evaluate the main effect of the experimental condition (silent versus noise) on cognitive flexibility (mental set shifting and idea production). Results indicated a non-significant difference at the $p < 0.05$ level in idea production scores (as measured by the three verbal fluency tasks) and mental set shifting scores (as measured by the WCST). Only the second subtask of verbal fluency indicated a near-significant difference ($p = .69$). From a theory standpoint, what is more interesting is whether or not there any indirect effects. It was hypothesized that cognitive processing and arousal should exhibit both parallel and serial mediation on the relationship between noise and cognitive flexibility. In addition, it was hypothesized that mindfulness (Eastern vs. Western) and mind-wandering would moderate the mediated effects.

Mediation

Based on the classical requirements of mediation by Baron and Kenny (1986), an association between X and Y must exist in order to estimate and test hypotheses about indirect effects. Nevertheless, modern approaches to mediation analysis, do not impose this requirement (Hayes, 2009; Hayes & Rockwood, 2017). Although finding a significant direct effect of X on Y is useful for gaining a better understanding of results, there are several cases in which mediation might exist despite such insignificance of the overall X to Y relationship (MacKinnon et al., 2007). Hayes' PROCESS macro for SPSS allows the analyst to test indirect effects with the use of bootstrapping, which is a non-parametric method that does not rely on any assumptions of the distribution of variables. Bootstrapping creates samples of unique data from the original data set and estimates indirect effects in each resampled data set (Shrout & Bolger, 2002), a process that is repeated many times (e.g., 5000 times). Furthermore, this method has been argued to be suitable for small to moderate sample sizes, as it is not based on large-sample theory (Preacher & Hayes, 2004). Thus, despite the insignificant direct effect of open-office noise on cognitive flexibility, we continued with the analyses of the mediating effects.

Two dependent variables (idea production and mental shifting) are included in our overall conceptual model, where each is meant to capture a specific component of cognitive flexibility. However, the idea production aspect was measured by three distinct subtasks of verbal fluency, where each subtask also measures a distinct feature. The first subtask measures phonemic fluency, the second subtask measures divergent thinking (i.e., creativity), and the third measures the ability to shift between phonemic and semantic criteria. The mental shifting aspect of cognitive flexibility was measured by one task, the WCST. Thus, in order to ease subsequent mediation analyses, we first computed a new variable where all three subtasks of verbal fluency are combined into one total score of verbal fluency. Thus, each specific PROCESS model was run twice across two dependent variables (DVs); the idea production aspect as measured by the total verbal fluency score, and the mental shifting aspect as measured by the WCST.

Parallel mediation

To test the parallel mediation model as depicted in Figure 2, cognitive flexibility was entered as the DV, open-office noise as the IV, age, gender (0=Male), and education as covariates, and arousal (physiological and subjective arousal) and cognitive processing (analytical and intuitive processing) as mediators. Hypothesis 1 predicted that open-office noise is negatively related with both the idea production and mental shifting aspects of cognitive flexibility. Hypothesis 2 predicted a positive relationship between these variables. As seen in Table 3 (path *c*), the results showed that open-office noise was positively but insignificantly related to the idea production aspect of cognitive flexibility ($b = .46$, $p > .05$), as well as the mental shifting aspect of cognitive flexibility ($b = .22$, $p > .05$). Hypothesis 1 and 2 are therefore not supported. This finding indicates that open-office noise has no significantly negative or positive relationship with cognitive flexibility. The results also demonstrate that the direct effect (path *c'*) of open-office noise on the idea production aspect of cognitive flexibility is not significant, and also increased ($b = .59$, $p > .05$) from the c path. That is, the effect of open-office noise on cognitive flexibility, when controlled for the effect of the mediators, was higher and not significant. These results are inconsistent with mediation.

Table 3. Regression Coefficients from the Multiple Mediation Analysis Predicting the Idea Production (VFT) and Mental Shifting (WCST) Aspects of Cognitive Flexibility.

	WCST				VFT			
	b	*SE*	R^2	*F*	*b*	*SE*	R^2	*F*
Control variables								
Gender	1.08	.68			4.93^{***}	1.33		
Age	-.09	.41			.83	.80		
Education	.36	.30			.68	.58		
Path a								
Analytical processing	-.07	.13			-.07	.13		
Intuitive processing								
	-.07	.11			-.07	.11		
Physiological arousal								
Subjective arousal	$.63^{**}$	.21			$.63^{**}$	.21		
Path b								
	.12	.31			.12	.31		
Analytical processing								
Intuitive processing								
Physiological arousal								
	.66	.52			-.22	1.02		
Subjective arousal								
Total effect of open-office noise (path c)	-.62	.65			1.27	1.28		
Direct effect of open-office noise (path c')								
	-.23	.31			.63	.60		
Model summary								
	-.18	.21			$-.81^{*}$	.40		
	.10	.64			.59	1.26		
	.23	.67			.37	1.32		
			.06	.80			$.17^{*}$	2.65

Note. * p < .05. ** p < .01. *** p < .001

The results in Table 3 also show that open-office noise only had a significant relationship with one of the mediating variables (path *a*). As predicted by Hypothesis 3, open-office noise was positively related to arousal ($b = .63$, $p < .01$). However, this effect was only found for physiological arousal, and not subjective arousal. Hypothesis 4 predicted that open-office would be positively related to intuitive processing and negatively related to analytical processing. Not only were these effects insignificant but the effect was negative and almost identical for both modes of processing ($b = -.07$, $p > .05$). Thus, Hypothesis 4 was not supported.

Moreover, as predicted by Hypothesis 6, arousal was significantly and negatively related to the idea production aspect of cognitive flexibility ($b = -.81$, $p < .05$). However, this effect was only found for subjective arousal, and not physiological arousal. This suggest that participants who believed that they felt aroused performed worse on the VFT. Thus, Hypothesis 6 was partially supported. Interestingly, Table 3 shows that physiological arousal was positively (but insignificantly) related to performance in the VFT ($b = .63$, $p > .05$), while subjective arousal was negatively related to performance in the VFT. Indeed, taken together, these diverging effects of physiological and psychological arousal seem to suggest some degree of inconsistency in how individuals subjectively assess their physiological state. Hypothesis 5 predicted that intuitive processing will be negatively related to both aspects of cognitive flexibility. Although the relationship between intuitive processing and the two aspects of cognitive flexibility were insignificant, the effect of intuitive processing was negative for the WCST ($b = -.62$, $p > .05$) and positive for the VFT ($b = 1.27$, $p > .05$). Thus, Hypothesis 5 was not supported.

Finally, looking at the specific indirect effects of arousal and intuitive processing, these two proposed mediating variables did not mediate the relationship between open-office noise on neither the idea production aspect nor the mental shifting aspect. With the WCST as the DV, all mediators were insignificant: analytical processing, $b = -.01$, $SE = .09$, 95% bootstrap confidence interval: -.19, .21, intuitive processing, $b = .03$, $SE = .09$, 95% bootstrap confidence interval: -.14, .24, physiological arousal, $b = -.30$, $SE = .17$, 95% bootstrap confidence interval: -.68, .03, subjective arousal, $b = -.02$, $SE = .09$, 95% bootstrap confidence interval: -.20, .17. Similarly, with the VFT as the DV, all mediators were insignificant: analytical processing, $b = .02$, $SE = .16$, 95%

bootstrap confidence interval: -.30, .41, intuitive processing, *b* = -.10, *SE* = .21, 95% bootstrap confidence interval: -.62, .21, physiological arousal, *b* = .16, *SE* = .25, 95% bootstrap confidence interval: -.25, .75, subjective arousal, *b* = -.10, *SE* = .29, 95% bootstrap confidence interval: -.74, .48.

Table 4a. Total Indirect Effect, Specific Indirect Effects, Contrasts, and their Corresponding Bootstrap Confidence Intervals of the Relationship Between Open-office Noise and the Idea Production Aspect of Cognitive Flexibility

			95% BCa CI	
	b	SE	Lower CI	Upper CI
Mediator				
Total	-.0174	.45	-.8836	.9322
Analytical processing	.0171	.16	-.3005	.4073
Intuitive processing	-.0979	.21	-.6234	.2086
Physiological arousal	.1599	.25	-.2504	.7505
Subjective arousal	-.0965	.38	-.7445	.4806
Contrasts				
Analytical vs. Intuitive	.1149	.25	-.3342	.7022
Analytical vs. Ph.Arousal	-.1428	.29	-.7861	.3761
Analytical vs. Sub.Arousal	.1135	.34	-.5349	.8731
Intuitive vs. Ph.Arousal	-.2577	.33	-1.0388	.2805
Intuitive vs. Sub.Arousal	-.0014	.38	-.8293	.7516
Ph.Arousal vs. Sub.Arousal	.2563	.38	-.4363	1.1284

Note. BCa CI = bias corrected and accelerated confidence intervals. Based on 5000 bootstrap samples.

Table 4b. Total Indirect Effect, Specific Indirect Effects, Contrasts, and their Corresponding Bootstrap Confidence Intervals of the Relationship Between Open-office Noise and the Mental Shifting Aspect of Cognitive Flexibility

			95% BCa CI	
	b	*SE*	Lower CI	Upper CI
Mediator				
Total	-.3031	.26	-.8167	.2190
Analytical processing	-.0115	.10	-.1895	.2141
Intuitive processing	-.0348	.09	-.1362	.2399
Physiological arousal	-.3036	.17	-.6757	.0249
Subjective arousal	-.0228	.09	-.1979	.1680
Contrasts				
Analytical vs. Intuitive	-.0464	.12	-.2820	.2554
Analytical vs. Ph.Arousal	.2921	.19	-.0501	.7109
Analytical vs. Sub.Arousal	.0113	.12	-.2474	.2721
Intuitive vs. Ph.Arousal	.3385	.18	-.0155	.6989
Intuitive vs. Sub.Arousal	.0576	.12	-.1961	.2853
Ph.Arousal vs. Sub.Arousal	-.2808	.18	-.6742	.0526

Note. BCa CI = bias corrected and accelerated confidence intervals. Based on 5000 bootstrap samples.

Taken together, these results suggest that first, the set of mediators did not mediate the effect of open-office noise on any of the two aspects of cognitive flexibility. Second, none of the proposed mediators were significant. Thus, Hypothesis 7 and Hypothesis 8 were not supported.

Serial mediation

To test the serial mediation model as depicted in Figure 2, the variables entered were identical to the parallel mediation model, except that only arousal (both physiological and subjective) and intuitive processing were entered as serial mediators.

In the first serial mediation model, idea production was entered as the DV. The proposed serial mediating effect of arousal and intuitive processing was insignificant (b = .03, SE = .05, 95% bootstrap confidence interval: -.04, .15). In the second serial mediation model, with mental shifting as the DV, results revealed no significant serial mediation (b = -.02, SE = .03, 95% bootstrap confidence interval: -.09, .01). An examination of the coefficients revealed that open-office noise was positively related to physiological arousal, physiological arousal was positively related to intuitive processing, and intuitive processing was positively related to idea production. The direction of the coefficients were the same with mental shifting as the DV, however, the coefficient of intuitive processing on mental shifting was negative. This seems to suggest that intuitive processing may be positively related to the idea production aspect but negatively related to mental shifting. Nevertheless, these results were insignificant, and thus, Hypothesis 9 was not supported. Finally, replacing physiological arousal with subjective arousal did not yield any meaningful differences.

Moderated mediation

Utilizing Lee and Jeon's (2014) steps, the following conditions were considered in testing moderated mediation: 1) if the effect of the independent variable on the mediator depends on the moderator, then the effect of mediator on the dependent variable must be significant, or if the effect of the mediator on the dependent variable depends on the moderator, then the effect of the independent variable on the mediator should be significant; 2) the conditional indirect effect of the independent variable on the dependent variable via the mediator depends on the presence of a certain range of the moderator. For moderated mediation to exist, meeting the second condition is crucial.

Only one moderation model (Western mindfulness) yielded significant moderated mediation. Moreover, moderated mediation was only found with mental shifting entered as the DV. The overall model was near the significance level $F(11, 97) = 1.71$, $p = .08$, $R^2 = .16$. Western mindfulness significantly moderated the effect of physiological arousal on mental shifting (see Figure 3). Moreover, the effect of the mediating variable physiological arousal on mental shifting depended on Western mindfulness, thus satisfying the first condition for moderated mediation analysis. As illustrated in Table 5, physiological arousal was a significantly negative mediator for individuals with moderate to high scores on the Western mindfulness scale (see Table 5), thus, satisfying the second condition for moderated mediation analysis. Importantly, the mediating effect of physiological arousal was negative, an effect known as inconsistent mediation or suppression (MacKinnon et al., 2007). Inconsistent mediation is said to exist when the direct and mediated effect (path *c'*) is greater than the total effect of X on Y (path *c*). In such cases, the direct and indirect effects cancel each other out in the overall relationship (e.g., a near-zero Perason's correlation). However, with the inclusion of a third inconsistent mediator variable in the regression, the direct effect becomes visible and also shows that the third variable mediates an opposite and inconsistent effect.

Our results also revealed some other interesting effects worth noting. First, Western mindfulness was positively related to the idea production aspect of cognitive flexibility ($b = 2.3209$, $p > .05$) and the mental shifting aspect of cognitive flexibility ($b = .9550$, $p < .05$). Second, Western mindfulness had a near-significant ($p = .082$) moderating effect on the relationship between open-office noise on analytical thinking. Conditional direct and indirect effects of open-office noise through proposed mediators at values of Western mindfulness is presented in Table 5 below. Tables for the remaining moderating variables Eastern mindfulness and mind-wandering are found in Appendix 8.

Table 5. Conditional direct and indirect effects of open-office noise through proposed mediators at values of Western mindfulness. Conditional effects of focal predictor are included only for significantly moderated relationships.

	Idea production				Mental shifting			
	b	*SE*	Lower *CI*	Upper *CI*	*b*	*SE*	Lower *CI*	Upper *CI*
Western mindfulness								
Conditional effects of focal predictor	N/A							
Low					.0920	.14	-.1925	.3765
Medium					-.2645	.09	-.4517	-.0773
High					-.6211	.21	-1.0371	-.2051
Conditional direct effect								
Low	-.3504	1.86	-4.0402	3.3393	.8101	.91	-.9894	2.6095
Medium	.5750	1.31	-2.0348	3.1849	.4103	.64	-.8624	1.6831
High	.6784	1.98	-2.4298	5.4308	.0106	.96	-1.9062	1.9273
Cond. Ind. effect: analytical								
Low	-.1247	.47	-1.2046	.8027	-.0813	.25	-.5733	.4995
Medium	.0200	.18	-.2881	.4662	-.0133	.10	-.1289	.3049
High	-.1127	.48	-.2383	.8520	.0720	.24	-.5210	.5008
Cond. Ind. effect: intuitive								
Low	.0573	.46	-1.0188	1.0005	-.0150	.18	-.4768	.3212
Moderate	-.1144	.24	-.7310	.2500	.0486	.10	-.1571	.2803
High	-.2071	.41	-1.240	.4428	.1435	.21	-.2445	.6341
Cond. Ind. effect:								
*ph.arous**	.4871	.74	-.7856	2.1917	.2056	.36	-.4052	1.0450
Low	.1303	.36	-.4679	.9717	-.4526	.23	-.9602	-.0471
Moderate	-.0782	.59	-1.0929	1.3410	-.7382	.51	-1.7999	.1688
High								
Cond. Ind. effect:								
sub.arou	-.1377	.64	-1.5044	1.2322	-.0338	.20	-.4669	.3826
Low	-.0929	.28	-.7207	.4552	-.0080	.07	-.1496	.1638
Moderate	-.0293	.29	-.6587	.5718	.0266	.14	-.2351	.3761
High								

Note. * p < .05.

Discussion

The aim of the present thesis was to study the impact of open-office noise on cognitive flexibility. A particular focus has been placed on exploring the mediating effects of arousal (both physiological and subjective) and cognitive processing, as well as the moderating effects of Eastern versus Western mindfulness, and mind-wandering.

Open-office noise and cognitive flexibility

Our first hypothesis predicted that open-office noise would impair cognitive flexibility. Cognitive flexibility was broken down into two of its core aspects, namely, idea production and mental shifting. These two aspects were measured with two different experimental tasks. Our findings did not reveal any detrimental effects of open-office noise on any of the two aspects of cognitive flexibility. This null-effect is not surprising considering the numerous studies that have failed to produce such effects of open-office noise. For instance, in a study by Jahncke, Hongisto, and Virjonen (2013), irrelevant speech did not reduce performance in verbal fluency (i.e., idea production). According to Jahncke et al. (2013), word fluency relies on retrieval of information from the long-term memory and does not involve rehearsal of to-be-remembered material. Most studies supporting the detrimental effect of noise on cognitive performance have used tasks that tap into WM, or short-term memory. Since the idea production, as indicated by verbal fluency, does not involve rehearsal of to-be-remembered material stored in the short-term memory, then indeed, noise such as irrelevant speech may not produce any harmful effects.

However, it is less clear why the noise manipulation did not impair performance in the mental shifting aspect, as this was captured with a task involving short-term memory. One possible explanation can be borrowed from Banbury and Berry's (1997) findings, where they observed that participants who were exposed to irrelevant background speech while performing tasks habituated to the sound after a short while. Additionally, the sound might have reduced boredom through its positive impact on physiological arousal, and thus, facilitated performance rather than restricting it (Wilkinson, Nicholls, Pattenden, Kilduff, & Milberg, 2008; Usher & Feingold, 2000). Indeed, as depicted by the Yerkes-Dodson law, such effects of noise may vary greatly depending on how close or far arousal is from the optimal level. Moreover, research has shown that continuous irrelevant sound, such as irrelevant speech, presents only a modest challenge to tasks involving memory testing (LeCompte, 1994). On a similar line, Hillier et al. (2006) argued against the generalizability of auditory stressors as distractors. Hillier and colleagues examined the effect of auditory stress (in their case, white noise) on cognitive flexibility and observed that auditory stress did not reduce performance in memory tasks. Indeed, some research on the neural mechanisms of memory in arousing situations show that arousal can even improve long-term memory of stimuli by modifying hippocampal consolidation (the process of encoding or storing) of those memories (Cahill, Babinsky, Markowitsch, & McGaugh, 1995; Hamann, Ely, Grafton, & Kilts, 1999; McGaugh, 1992; Packard & Teather, 1998).

Mediating effects of arousal and cognitive processing

The parallel and serial mediation analyses did not yield any significant results. Nevertheless, there were some interesting effects that are worth discussing. Previous research has identified open-office noise as a significant predictor of physiological and subjective arousal (Loewen & Suedfeld, 1992; Evans & Johnson, 2000). Our results regarding the effects of arousal are consistent with these findings. Specifically, open-office noise was found to increase physiological arousal in all three time windows (average, 10 seconds after the onset of the stimulus, and 5 seconds before the offset of the stimulus), but did not increase subjective arousal. At the same time, physiological arousal did not reduce performance in idea production or mental shifting, whereas subjective arousal was negatively related to performance on both of these aspects. Interestingly, this suggests that subjective arousal might be a more critical predictor of cognitive flexibility than physiological arousal. Furthermore, research has also shown that open-office noise triggers intuitive processing that in turn impairs cognitive task performance (Starcke & Brand, 2012; Masicampo & Baumeister, 2008; Hanoch & Vitouch, 2004). However, our findings are inconsistent with this idea as there was no significant effect on either intuitive or analytical processing. One plausible explanation is that the rise in physiological arousal as a result of the noise may not have reached a level where arousal begins to significantly alter cognitive processing mechanisms.

Moderated mediation

Two central moderators were included in this thesis that are conceptually relevant to the proposed relationship between open-office noise and cognitive flexibility. Here, the aim was to examine the distinctive moderating roles of Eastern and Western perspectives of mindfulness. Additionally, mind-wandering, which is the polar opposite of mindfulness, was included as a way of further validating the mindfulness construct. That is, if we were to observe a moderating effect of mindfulness, then mind-wandering should operate in the opposite direction. Findings only revealed Western mindfulness as a significant moderator of mediation. Specifically, the inconsistent mediating effect of physiological arousal on the relationship between open-office noise and the mental shifting aspect of cognitive flexibility became significant only for individuals who are mindful in the Western (Langerian) sense. Mindfulness in the Western sense (Weick & Putnam, 2001) is defined by Langer (1989) as a state of alertness and active awareness. Thus, individuals who are mindful in the Western sense may be better equipped to respond to stressful stimuli due to their openness to challenges and novelty. The relative effects of Eastern and Western mindfulness revealed in our findings are consistent with the idea that different aspects of mindfulness predict cognitive flexibility in different ways (Lebuda, Zabelina, & Karwowski, 2016; Baas, Nevicka, & Ten Velden, 2014). This notion of mindfulness as a multifaceted construct is an important one. Baas et al. (2014) highlight two central skills of mindfulness – observing and attending different stimuli (Observation) and focusing one's attention with full awareness (Act with awareness; AWA). In their study, Baas and colleagues found that while the Observation skill of mindfulness was significantly related to creativity, the AWA skill was not. The former skill is in fact strongly reflected in Langer's conceptualization of mindfulness. As such, the inconsistency of findings surrounding the mindfulness-performance link may be reduced by carefully considering the various conceptualizations and operationalizations of the mindful construct, and carefully defining the task domain.

Although no significant moderating effects of Eastern mindfulness were found, there were some interesting effects nonetheless. Mind-wandering was positively related to the intuitive processing dimension. This finding strengthens the construct validity of Bakken et al.'s (2016) proposed dimension of intuitive processing. In several recent studies examining the relationship between mindfulness and intuition, authors have found a negative relationship between mindfulness and intuitive decision-making (Remmers, Topolinski, & Michalak, 2015; Zedelius & Schooler, 2015). Future studies should aim at further investigating the comparative effects of mindfulness and mind-wandering within certain task domains.

Practical implications

An increasing number of Norwegian organizations seem to be employing mindfulness training programs in hopes of achieving specific organizational goals, both health and performance related. Organizations in Western countries are particularly drawn to the Eastern notion of mindfulness. This is reflected in the wide application of the MAAS scale (Brown & Ryan, 2003), as well as in training programs that try to induce mindfulness by focusing one's attention on present-moment phenomena, which is generally how Eastern mindfulness is conceptualized. As the title of an article by a Norwegian newspaper reads, ‘’More and more companies are training their employees in mindfulness. But nobody really knows if it has any direct effect on the company’’ (Ørstavik, 2014). A common issue behind this uncertainty and ambiguity surrounding the use of mindfulness techniques in the workplace is an ill-defined purpose as well as a lack of knowledge of the various conceptualizations of mindfulness that vary in terms of the outcomes they predict. For instance, organizations that seek to boost cognitive flexibility (or creativity) may be better off by using measurements and techniques based on a Western, rather than an Eastern, conceptualization of mindfulness (Langer, 1989). Moreover, an understanding of when to use measurements of trait mindfulness based on a Western or Eastern conceptualization may aid in various organizational processes, such as employee-selection procedures or in training programs. Furthermore, the findings in the present thesis suggest that organizations should consider the potential costs associated with irrelevant speech-based noise in open offices. Organizational policies and procedures can address this challenge by, for instance, requiring conferences calls to be made in rooms with closed doors.

Limitations

There are several important limitations to the present thesis. First and foremost, an important limitation is that, due to the complexity of the overall model and the number of variables, many tests have been performed on the current data set. Although many models were tested, these were not technically different models. Rather, we have proposed three central models (parallel, serial, and moderated mediation). But due to the number of variables, each focal PROCESS Model was tested several times. Thus, parallel and serial mediation models were each run twice with either one of the two DVs idea production and mental shifting. In the moderated mediation analysis, 6 models were run (3 moderators x 2 DVs). Nevertheless, we acknowledge that performing this family of tests increases the probability of a Type 1 error (i.e., rejecting the null hypothesis when it is true) (Abdi, 2007; Benjamini & Yekutiel, 2001; Bland & Altman, 1995). This is an important limitation to consider, particularly in light of the significant finding on the moderated mediation model where the alpha level may have been inflated. In this case, the statistical significance of the moderated mediation model may logically lead to erroneous conclusions due to an overestimation of the amount of information contained in the present thesis, and consequently, ignoring Type I errors and statistical power. Indeed, several strategies exist to deal with such inflation. One way involves using a smaller alpha level, however, that also makes it more difficult to detect real effects (Abdi, 2007). Nevertheless, the alpha level was kept at .05 when assessing significance in the current analyses. The problem of multiple testing could have been reduced by using a larger sample size than that of the present thesis (N=109). This limitation warrants further investigation into the hypothesized relationships in the present thesis.

The manipulation check suggested that the open-office noise failed to produce any significant differences in subjective arousal between the two groups. This might indicate that while experimental participants were physiologically aroused by the noise, they were not distracted by it. Indeed, the analysis revealed no significant changes in task performance between the two groups. Additionally, the extent to which the manipulation was successful is questionable. The null-effect may have been caused by the length of exposure to the noise being too short to produce any effects. Moreover, due to the artificial setting of the experiment (i.e., hearing open-office noise through headphones inside a laboratory), participants may have perceived the sound as a challenge and thus placed more focus on the tasks. This type of artificial setting may also have impacted SCR recordings through several confounding variables. It is important to keep in mind the sensitivity of SCR to several external and internal factors, such as room temperature, the presence of others, and mood. SCR measure could have been further validated by using additional indicators of physiological arousal, such as heart rate variability. Furthermore, considering the variety of methods used in the present thesis (self-reports, experimental tasks, and the physiological measurement), it is possible that this mixture of methods has contributed to Type 2 errors. That is, variation in methods that are used in capturing constructs can reduce the probability of finding effects, as opposed to in cases where methods are similar (e.g., all self-reports).

Finally, the three moderating variables Eastern mindfulness, Western mindfulness, and mind-wandering, were measured with scales consisting of items that seek to capture general tendencies rather than situation-specific tendencies. In hindsight, these scales should have been modified and adapted in order to capture participants' situation-specific tendencies, that is, during the performance of the experimental tasks. As such, the effects of the moderator variables should be interpreted with caution.

Conclusion

The detrimental effects of open-office noise on cognitive performance is quite robust in the literature. Nevertheless, consistent with recent studies that have questioned this effect, we did not discover a direct negative effect of open-office noise on cognitive flexibility. Furthermore, we did not discover any specific mediating effects of arousal or cognitive processing. However, at moderate to high levels of Western mindfulness, we observed a significant inconsistent mediating effect of physiological arousal on the relationship between open-office noise and the mental shifting aspect of cognitive flexibility. That is to say, the effect of open-office noise on cognitive flexibility, through arousal, is significantly negative under higher levels of Western mindfulness. This serves as interesting insight into the conditions in which open-office noise may become harmful, while also revealing the relative moderating roles of Eastern and Western perspectives of individual trait mindfulness. As to our knowledge, this is the first study to compare the moderating roles of Eastern and Western perspectives of mindfulness within the field of Judgment and Decision Making (JDM). We hope that the present thesis catalyzes further research into the conditional effects of noise on cognitive flexibility, while also highlighting the importance of treating mindfulness as a multifaceted construct.

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Appendices

Appendix 1 - Western mindfulness, as measured with the Langerian Mindfulness Scale

Each of the following lines (below) is rated using the following scale:

1. strongly disagree
2. disagree
3. somewhat disagree
4. neither agree nor disagree
5. somewhat agree
6. agree
7. strongly agree

The following lines need to be rated using the above scale:

1. I like to investigate things.
2. I generate few novel ideas.
3. I am always open to new ways of doing things.
4. I "get involved" in almost everything I do.
5. I do not actively seek to learn new things.
6. I make many novel contributions.
7. I stay with the old tried and true ways of doing things.
8. I seldom notice what other people are up to.
9. I avoid thought-provoking conversations.
10. I am very creative.
11. I can behave in many different ways for a given situation.
12. I attend to the "big picture."
13. I am very curious.
14. I try to think of new ways of doing things.
15. I am rarely aware of changes.
16. I have an open-mind about everything, even things that challenge my core beliefs.
17. I like to be challenged intellectually.
18. I find it easy to create new and effective ideas.
19. I am rarely alert to new developments.
20. I like to figure out how things work.
21. I am not an original thinker.

Appendix 2 - Eastern mindfulness, as measured by the Mindfulness Awareness Attention Scale (MAAS)

Each of the following lines (below) is rated using the following scale:

1. almost always
2. very frequently
3. somewhat frequently
4. somewhat infrequently
5. very infrequently
6. almost never

The following lines need to be rated using the above scale:

1. I could be experiencing some emotion and not be conscious of it until sometime later.
2. I break or spill things because of carelessness, not paying attention, or thinking of something else.
3. I find it difficult to stay focused on what's happening in the present.
4. I tend to walk quickly to get where I'm going without paying attention to what I experience along the way.
5. I tend not to notice feelings of physical tension or discomfort until they really grab my attention.
6. I forget a person's name almost as soon as I've been told it for the first time.
7. It seems I am "running on automatic" without much awareness of what I'm doing.
8. I rush through activities without being really attentive to them.
9. I get so focused on the goal I want to achieve that I lose touch with what I am doing right now to get there.
10. I do jobs or tasks automatically, without being aware of what I'm doing.
11. I find myself listening to someone with one ear, doing something else at the same time.
12. I drive places on "automatic pilot" and then wonder why I went there.
13. I find myself preoccupied with the future or the past.
14. I find myself doing things without paying attention.
15. I snack without being aware that I'm eating.

Appendix 3 - Mind-wandering Questionnaire

Each of the following lines (below) is rated using the following scale:

1. strongly disagree
2. disagree
3. somewhat disagree
4. neither agree nor disagree
5. somewhat agree
6. agree
7. strongly agree

The following lines need to be rated using the above scale:

1. I have difficulty maintaining focus on simple or repetitive work.
2. While reading, I find I haven't been thinking about the text and must therefore read it again.
3. I do things without paying full attention.
4. I find myself listening with one ear, thinking about something else at the same time.
5. I mind-wander during lectures of presentations.

Appendix 4 - Verbal Fluency Task 1, 2, & 3

VFT1 (phonemic fluency)

In this task, we will give you a letter of the alphabet and ask you to name as many different words as you can think of that start with that letter. DO NOT include the names of people, places, or same words with different endings (e.g. run, runner and running). You will have one minute to think of as many different words as you can. Press next when you are ready.

Write as many words as possible that start with the letter M.

(The following item allows the participant to enter information with the keyboard)

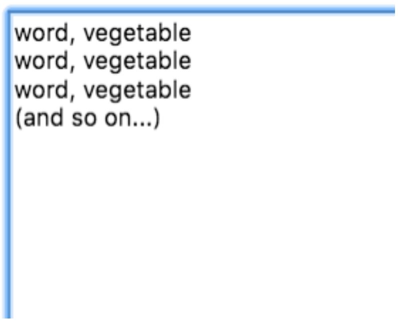
VFT2 (divergent thinking, creativity)

In this task, we are going to give you the name of an object and ask you to name as many different ways of using that object as you can think of. For example, if the object is "key", you might say "opening doors". You will have one minute for this task. Press next when you are ready.

Please down as many different uncommon uses for a cup.

(The following item allows the participant to enter information with the keyboard)

VFT3 (alternate between semantic category and phonemic criteria)



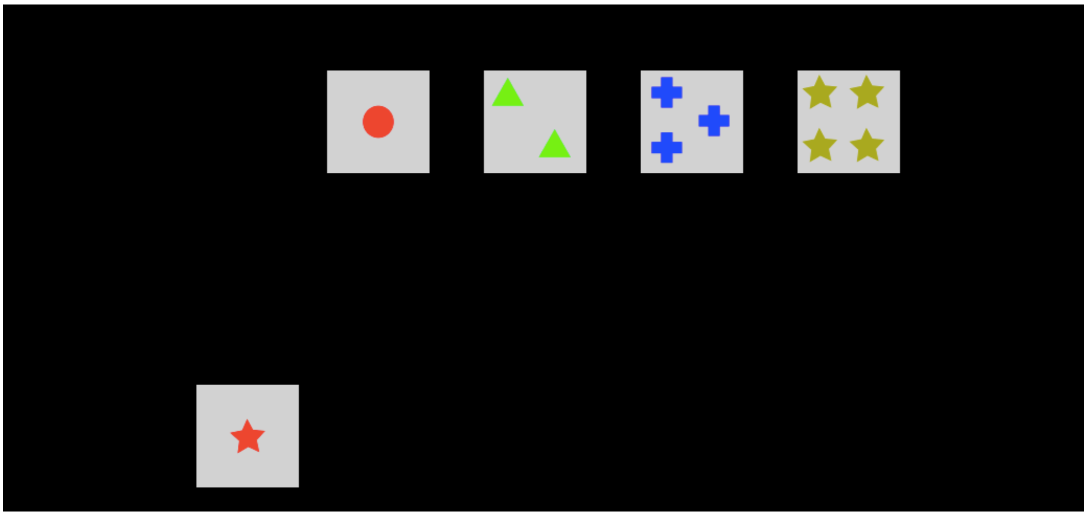
In this task, we want you to write as many words as possible that start with the letter M, followed by the name of a type of a vegetable. Look at the image above for an example. You will have one minute for this task. Press next when you are ready.

Please write as many words as possible where the first word begins with a letter L, and the following with a vegetable.

(The following item allows the participant to enter information with the keyboard)

Appendix 5 - Wisconsin Card Sorting Task

This is the final task of the experiment. Press anywhere on the screen below to read the instructions. The task takes around 5 minutes.
(Now participant is asked to respond in an embedded respone time test, presented in the browser window.)



Appendix 6 - Cognitive Processing Questionnaire

Think back on the two tasks you just performed on the computer and please answer the following questions. Your response will be treated confidentially. For each statement below, indicate on the scale whether you agree or disagree with the statement, from 1 = strongly disagree to 5 = strongly agree

Each of the following lines (below) is rated using the following scale:

1. strongly disagree
2. disagree
3. Neither agree nor disagree
4. agree
5. strongly agree

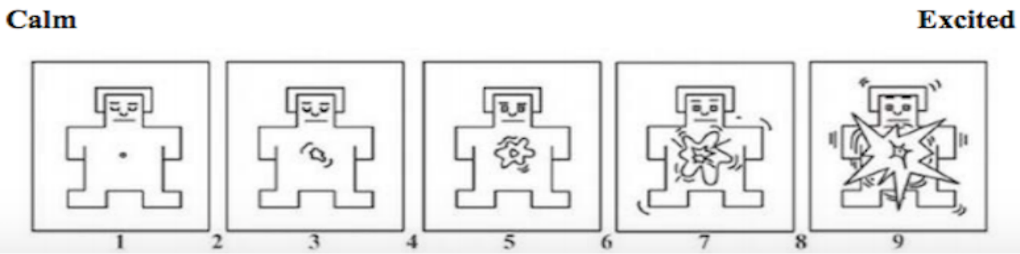
The following lines need to be rated using the above scale:

1. I considered carefully all alternatives
2. When making decisions, I considered all options
3. I evaluated systematically all key uncertainties
4. I analyzed all available information in detail
5. I considered all consequences of my decision
6. It was easy to get a clear picture of what needed to be done
7. I had enough knowledge to make the best decision almost immediately
8. When I had made a decision there was no doubt that this was the right action to take
9. My knowledge of similar situations led me to quickly recognise a solution
10. It was more important to make a quick decision than to wait for additional information
11. It was more important to make a quick decision than to think about all possible consequences
12. Even if the information was uncertain I tried to make a quick decision
13. It was better to make a quick and perhaps faulty decision than making the decision to late
14. If the information was conflicting I tried to look for additional information that could disconfirm my assumptions
15. If I was uncertain about what to do I tried to look for information that

would narrow the choices

16. Even if a decision seemed obvious I took time to think through if I might have overlooked something
17. I did not make any decision until I had thought about all possible outcomes, even if some were highly unlikely
18. Before I made my decision I tried to think if there was any information that could challenge my assumptions
19. I double-checked the description of the situation before making the decision
20. I made the decision because it felt right to me
21. I based the decision on my inner feelings and reactions
22. It was more important for me to feel that the decision were right than to have rational reasons for them

Appendix 7 - Manipulation check, as measured with the Self-Assessment Manikin (SAM) of physiological arousal level



Please indicate, using the scale represented below, how you FELT when hearing the sound while carrying out the tasks.

1. 1
2. 2
3. 3
4. 4
5. 5
6. 6
7. 7
8. 8
9. 9

Appendix 8 – Conditional direct and indirect effects of open-office noise through proposed mediators at values of Eastern Mindfulness and Mind-wandering.

	Idea production				Mental shifting			
	B	SE	Lower CI	Upper CI	B	SE	Lower CI	Upper CI
Eastern mindfulness								
Conditional effects of focal predictor	N/A				N/A			
Low								
Medium								
High								
Conditional direct effect								
Low	-.9522	1.96	-4.8473	2.9430	1.7467	1.00	-.2381	3.7315
Medium	.3689	1.32	-2.2597	2.9974	.5299	.67	-.8095	1.8694
High	.6899	1.88	-2.0532	5.4330	-.6868	.96	-2.5942	1.2205
Cond. Ind. effect: analytical								
Low	-.0448	.33	-.6107	.8165	-.0190	.21	-.2759	.5973
Medium	.0284	.18	-.3142	.4893	-.0031	.09	-.1837	.2380
High	.1208	.42	-.5669	1.1489	.0173	.17	-.2906	.4478
Cond. Ind. effect: intuitive								
Low	-.0442	.36	-.9952	.5135	.0130	.17	-.3776	.3565
Moderate	-.0831	.21	-.6661	.2106	.0342	.09	-.1478	.1719
High	-.1228	.40	-1.1547	.4911	.0559	.18	-.2750	.4667
*Cond. Ind. effect: ph.arous**								
Low	.3555	.55	-.8389	1.4311	-.5895	.47	-1.4611	.4523
Moderate	.7729	.51	-.1405	1.8368	-.4935	.37	-1.2949	.1719
High	.4417	.73	-.7964	2.1942	-.2100	.42	-1.3152	.3483
Cond. Ind. effect: sub.arou								
Low	-.3643	.70	-1.8969	.9577	-.0459	.19	-.3636	.4345
Moderate	-.1052	.31	-.7854	.5216	-.0212	.09	-.2149	.1772
High	-.0061	.27	-.5665	.5477	.0031	.18	-.2289	.5492

	Idea production				Mental shifting			
	B	SE	Lower CI	Upper CI	B	SE	Lower CI	Upper CI
Mind-wandering								
Conditional effects of focal predictor	N/A				N/A			
Low								
Medium								
High								
Conditional direct effect								
Low	.8711	1.92	-2.9428	4.6850	.8014	.97	-.1193	2.7220
Medium	.3305	1.34	-2.3410	3.0021	.2709	.68	-1.0745	1.6163
High	-.2100	1.90	-3.9861	3.5660	-.2595	.96	-2.1611	1.6421
Cond. Ind. effect: analytical								
Low	.0319	.47	-.8614	1.1829	.1404	.27	-.3296	.7613
Medium	.0083	.19	-.3661	.4686	-.0020	.11	-.2061	.2674
High	-.0002	.29	-.5375	.6716	-.0141	.22	-.4016	.5624
Cond. Ind. effect: intuitive								
Low	-.0558	.35	-1.0389	.4134	.0668	.21	-.3773	.5246
Moderate	-.0331	.24	-.6294	.3866	.0062	.08	-.1800	.1660
High	.0622	.53	-1.1331	1.1975	.0101	.17	-.4195	.3111
*Cond. Ind. effect: ph.arous**								
Low	.8880	.69	-.2537	2.3586	-.2854	.44	-1.3591	.4127
Moderate	.6215	.44	-.1260	1.6030	-.3807	.35	-1.2095	.1488
High	-.3211	.56	-1.3276	.7941	-.4023	.39	-1.0649	.5267
Cond. Ind. effect: sub.arou								
Low	-.0377	.41	-.7831	.9809	-.0426	.21	-.2865	.6097
Moderate	-.2115	.29	-.9173	.2932	-.0371	.09	-.2322	.1695
High	-.1924	.73	-1.8487	1.1572	-.0494	.20	-.5204	.3487