Distractions in the workplace revisited

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Abstract

Purpose – The purpose of this paper is to provide a holistic and systematic understanding of a fundamental issue within open plan office designs: the sustainability of two extremely contrasting requirements, concentration and collaboration, in the same workspace and work environment at a given time. A literature review is presented, along with initial suggestions for potential improvements in knowledge work organizations.

Design/methodology/approach – A thorough range of fields, including those outside the built environment, are investigated for their contribution to findings on distractions, especially auditory distractions and their impacts.

Findings – This research underpins the need for cost analysis of the impact that distractions have on knowledge workers. Provisions for appropriate and adaptable workspaces are needed to meet the dual needs of collaboration and concentration on complex tasks in order to maximize worker contribution and value.

Research limitations/implications – Additional field research on improved workspace is needed to confirm the hypothesis of savings from reduced or adaptation from auditory distractions.

Practical implications – As knowledge work grows, the evaluation of workplace architecture and design must include analysis of the needs of knowledge workers. The sole consideration of cost savings in real estate and facilities ignores the tremendous cost of human capital. This reduces overall value and profitability of the organizations choosing to ignore the workspace needs of their workers.

Originality/value – The paper provides a new and original review of multi-disciplinary research on the impact of distractions, especially auditory distractions, providing the groundwork for analysis of total costs of auditory distractions in the workplace.

Keywords Open plan offices, Workplace, Office layout, Noise control, Cognition, Information personnel

Paper type Literature review

This paper provides a holistic and systematic understanding of a fundamental issue with open plan office designs. That issue addresses the sustainability of two extremely contrasting requirements, concentration and collaboration, in the same workspace and work environment at a given time.

In the transforming context of knowledge work, knowledge workers, and office design, the research establishes recommendations and propositions that are in synchronization with the transforming nature of work, workers, and work environments in this age of enterprise transformation (Rouse, 2005). This requires an integration of built systems with work processes and work type that are responsive to dynamic functional, psychological, and physiological needs of the user. An overview of the research is shown in Figure 1, which outlines the theoretical backgrounds of: auditory distractions and performance of cognitive tasks; open office design and issues of social relations; and workplaces designed for knowledge workers and organizations.

An initial analysis is made of literature that discussed the relationship between externally generated auditory distractions, such as office noise (speech and non-speech),

Journal of Facilities Management
Vol. 6 No. 2, 2008
pp. 91-109

1472-5967
DOI 10.1108/14725960810872622

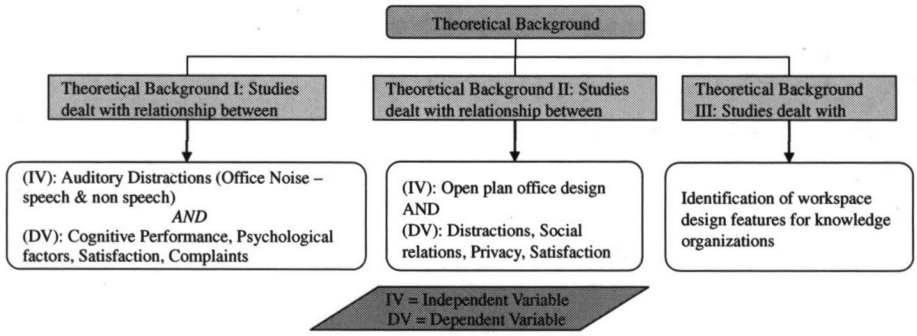


Figure 1.
Theoretical background of research

and knowledge worker's variables that includes the following: cognitive performance factors, such as efficiency, absenteeism, errors, or accidents; psychological influences like satisfaction, complaints, motivation, annoyance; physiological functioning factors like stress; and health and well-being. The domains contributing to this are mainly neurology, ergonomics, architecture, and psychology. The studies were mostly laboratory experiments involving human volunteers and field studies starting in 1958 (Broadbent) and continuing until today. The noise parameters that repeatedly surface include: intensity or level; duration of the noise; meaningfulness, such as forward speech, backward speech, random words, sentence from news, etc.; intermittency (changing state hypothesis); periodicity; and spectrum. In addition, the noise types research included mainly irrelevant office noise containing speech and non-speech, music, tones, and babble.

Literature that discusses the relationship between open plan office design and variables, such as performance, environmental satisfaction, job satisfaction, and communication, is investigated. The knowledge contributing domains are primarily social science and architecture.

The final portion of this paper includes studies that deal with identification of workspace design and environmental features that are perceived as most critical to job performance and overall satisfaction and are found to be most desired by users.

Diverse literature contributions

To deepen understanding of the three key perspectives, and to help clearly see a holistic connection in the wide theoretical framework covered in this study, an analysis of sources of research is made to categorize the various fields of study, as shown in Figure 2.

Influence of externally generated involuntary auditory distractions on knowledge workers

Before investigating influences of distractions on knowledge workers, it is important to state a definition for externally generated involuntary auditory distractions. Research and literature on distractions date back to Zajonc (1965), who drove social facilitation research (first published in 1898 by Norman Tripplet) in a novel direction. Zajonc supports the fundamental concept of social facilitation, which states the presence of others serves as a source of arousal. Through his experiments on several different species, including laboratory rats and cockroaches, he shows that arousal increases the

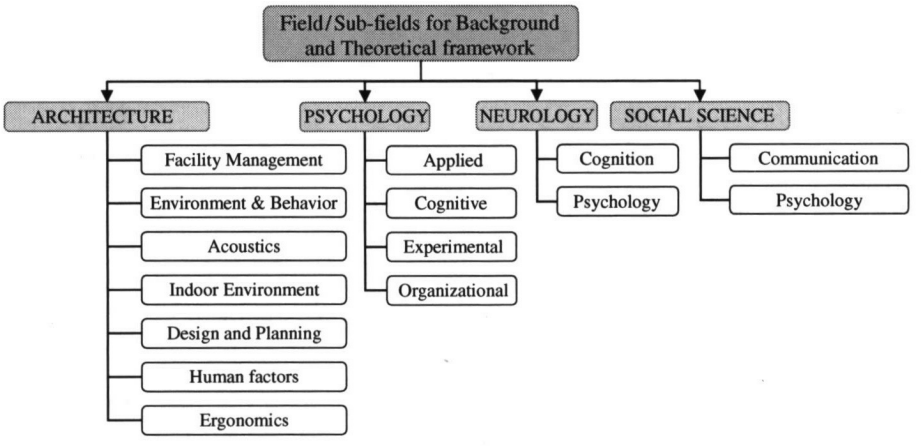


Figure 2.
Sub-fields of research

likelihood of an organism to make well-learned responses. The social facilitation theory, along-with Yerkes-Dodson law or the arousal-performance relationship, states that the optimal level of arousal for performance on a task is inversely related to task difficulty, so that the performance of more difficult tasks will be impaired at lower levels of arousal than will the performance of easier tasks. This explains performance improvement on simple tasks and impairment of performance on complex tasks. In a case of complex tasks, such as analytical reasoning or reading comprehension, the performer is required to use more cognitive processes to think and act beyond the well-learned and seasoned behaviors. However, in contrast to more pressure on cognitive resources, increase in arousal due to social facilitation also taxes cognitive resources, thereby causing the cognitive process efficiency to drop. The hypothesis is further supported by Groff *et al.* (1983) in which they find that the presence of co-actors and audiences facilitate simple tasks, but impair performance on complex tasks.

The research is further advanced in another direction by Baron (1986), who proposes a distraction-conflict theory to provide an attentional conflict explanation to social facilitation, rather than the arousal explanation proposed by Zjonac. Baron integrates his theory with attentional theories (Kahneman, 1973; Cohen, 1978; Broadbent, 1971) to explain why distraction and attentional conflict facilitate simple task performance and impair complex task performance. Distraction-conflict theory states that distractions cause attentional conflict, which acts as a partial mediator to cause social facilitation or social impairment. Attentional theories state that because distractions tax attentional capacity, it increases attentional overload. This overload causes organisms to take cognitive short-cuts, in order to conserve their limited attentional capacity. The cognitive short-cuts result in a usage of stereotypes, prior experiences, etc. thereby allowing a worker to do a good job on well-learnt or simple tasks. But it limits cognitive exploration abilities for performance on complex tasks, due to natural inclinations to go beyond putting pieces together. The phenomenon is called cognitive economy and it is more likely to occur in distracting settings that tax attentional capacity. Baron (1986) further corroborates his hypothesis by documenting that:

> [...] there seem to be at least 16 studies that demonstrate that distraction can either facilitate simple task performance, increase performance on tasks facilitated by other stressors, or impair complex task performance.

Furthermore, Cohen's (1978) arguments support Baron's (1986) theory. His theory suggests that, because a complex task requires processing of a wide range of cues/stimuli at the same time, by restricting attention to the center or by focusing the attention due to attentional overload, a performer tends to leave out crucial stimuli that must be processed for successful task performance, thereby impairing performance. Conversely, only a few stimuli/cues are required to perform simple tasks. Therefore, by focusing the attention to the most central cues, the performer screens out non-essential stimuli that take time away from the task at hand, thereby resulting in performance enhancement.

The topic of distraction has been addressed in a number of domains from different perspectives. Several definitions of "distraction" are available in the literature and some of these are presented in Table I. Some of the definitions refer to interruptions rather than distractions; these are included because both result in performance impairment. A number of studies give a more precise distinction between distraction and interruption; regarding "distraction as a provocative stimulus that directs attention away from an ongoing activity" and calling "interruption a severe attentional distractions that can place greater demands on cognitive processing resources than available capacity can handle thereby magnifying the influence of distractions" (Speier, 1996).

Whether a break from an ongoing task is due to an interruption or a distraction, a common feature in the above definitions is the attentional capacity overload, which is shown to cause cognitive disruption.

Distraction is a generally occurring phenomenon in human surroundings that can be caused by many factors, such as noise, anxiety, stress, temperature, poor appraisal, and new organizational policies. The impact of distraction is either social facilitation caused by arousal or social impairment caused by overload. According to the literature, some of these distractions are internally generated. An example is provided by Mark *et al.* (2005) who argue that checking an e-mail as soon as it arrives gives a person "instant gratification for getting that e-mail out of way". The authors also argue other distractions are externally generated by and in the surrounding environment (Mark *et al.*, 2005).

Table I.
Definitions of distractions and interruptions

Study	Definitions
Baron *et al.* (1973) and Glass and Singer (1972)	Distraction is a "manipulation that taxes attentional capacity leading to the organism to make priorities, take cognitive shortcuts, and ignore certain stimuli and tasks"
Cohen (1980)	"Uncontrollable, unpredictable stressors that produce information overload"
Covey (1989)	"Typically require immediate attention and insist on action"
Corragio (1990)	"Intermittent interruption – externally-generated, randomly occurring, discrete event that breaks continuity of cognitive focus on a primary task"

These are generally either facilitated or inhibited by workplace architecture, indoor environment, technological architecture, and organizational policies. Examples of these distractions include background noise, inappropriate lighting, less desk space, etc. One additional consideration is that some distractions are voluntary, like a person leaving his chair for a short break, while others are involuntary, like a colleague stopping by a person's desk to inquire about plans for the evening. Out of all distractions taking place in and around social beings, auditory distractions that are generated in open plan offices are repeatedly shown to be of significant concern and stress, creating performance impairment for knowledge workers (Moore, 1977; Baron *et al.*, 1978; Sanders and Baron, 1975; Sanders, 1981). This is the focus of this research, as well as the financial impact to knowledge organizations. Additional research on methods to calculate costs associated with distractions is the topic of other papers and ongoing research.

Based on the existing literature, a comprehensive distraction model is shown in Figure 3. The shaded type within the model highlights areas that are out of scope for

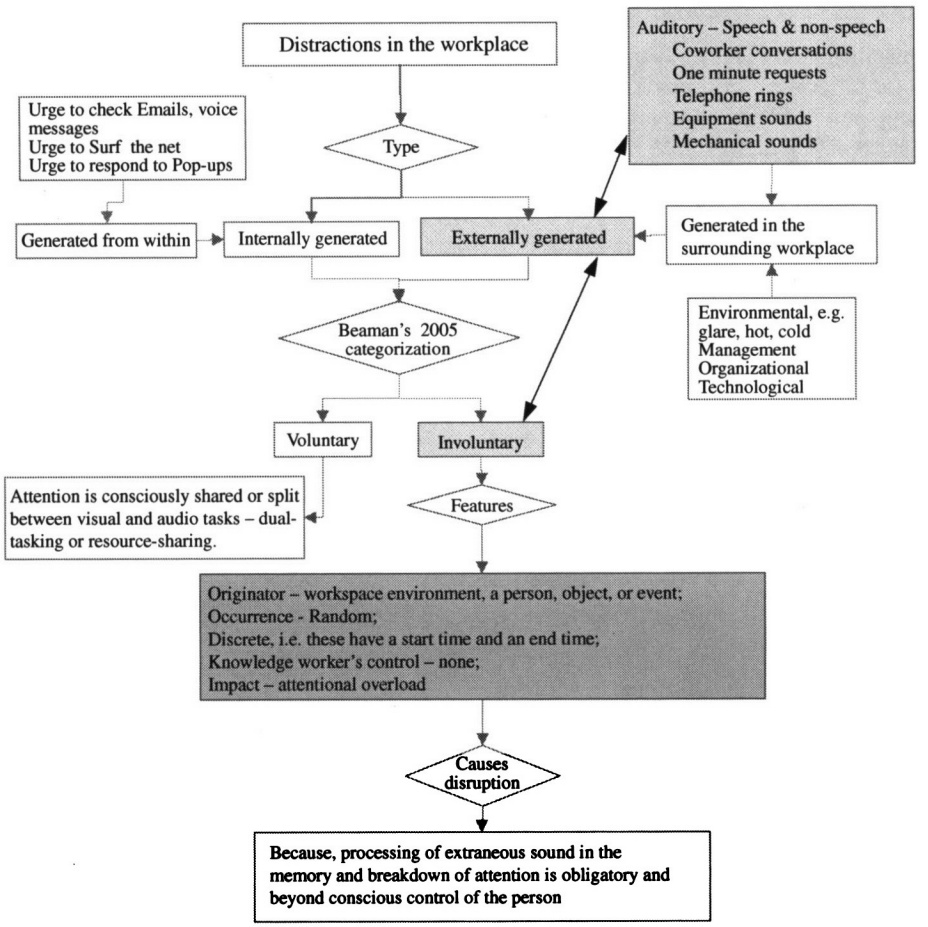


Figure 3.
Comprehensive distractions model

this study; however, these distractions must also be considered in other applications and designs for office settings. The limited scope of externally generated involuntary auditory distractions is the focus of the research behind this paper. Summarily, the main characteristics of these distractions are defined as: originating in workspace environment; random occurrence; discrete, i.e. these have a start time and an end time; out of the knowledge worker's control; and resulting in the impact of attentional overload.

Based on prior discussions about distractions, it is shown that distractions are phenomena of concern for complex tasks only. In order to establish a connection between distractions and knowledge workers, it becomes imperative to describe complex tasks and how knowledge worker's tasks are complex.

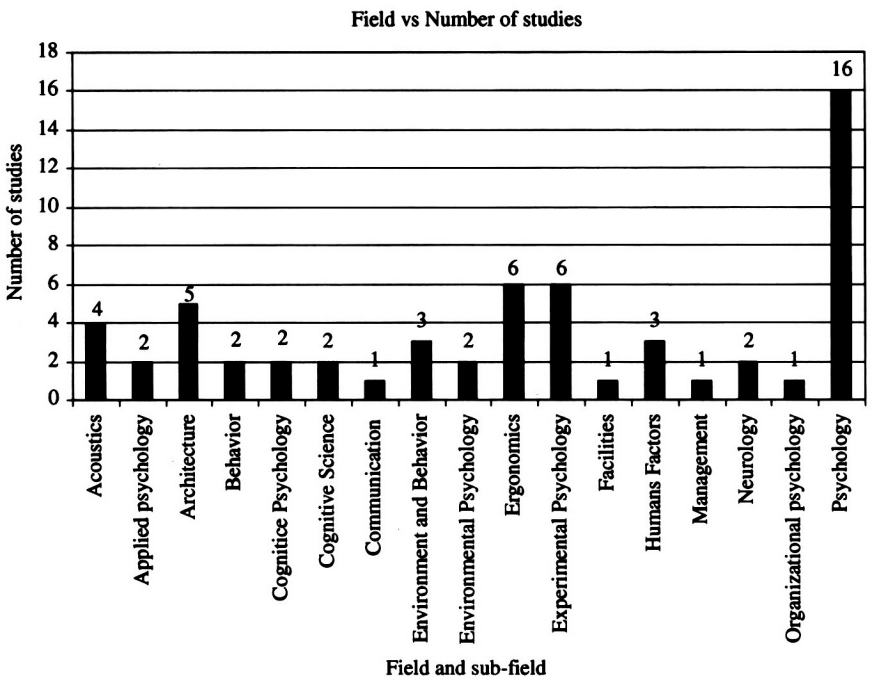
Influence of distractions on knowledge work and knowledge workers

A large body of literature exists on disruptive impacts of extraneous sounds on the performance of complex tasks, particularly on the establishment of theories and replicable validation of interference effects of sounds on cognitive processing. It seems that there is a key link between this body of research and its theoretical and practical implications for workplace architecture. Although intuitive, the relationship has yet to be explored and analyzed scientifically. Nor have the results been documented so that decisions about workplace's architecture for knowledge organizations are guided by well-established theoretical background and scientific knowledge base concerning the costs of auditory distractions to knowledge work and knowledge organizations. Figure 4 shows the number of studies from various fields and subfields imparting knowledge to this multi-disciplinary concept of workplace distractions.

Primary knowledge sources include studies from psychology and its sub-fields, ergonomics, and architecture. It is also important to recognize that Facility Management research still lags other fields despite, or perhaps due to the fact, that Facility Management is a "profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, process and technology" (International Facility Management Association, n.d.). This study provides a significant and timely contribution to the knowledge-base in Facility Management concerning both the impact of other various research disciplines, such as psychology and cognitive sciences, and the need to reassess the use of open plan architecture in design for knowledge age work and workers.

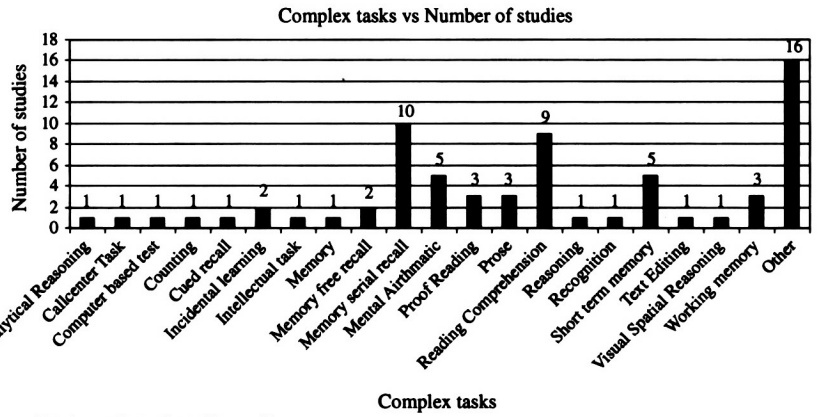
Many researchers discuss that the performance on complex cognitive tasks is significantly disrupted by office noise (speech and non-speech), with people conversing in the background as the most disruptive and bothersome (Jensen *et al.*, 2005; ASID, 1996; Berti and Schroger, 2001; Zijlstra and Roe, 1999; Heerwagen *et al.*, 2004; Olson, 2002; ASHRAE, 2005; Pejtersen *et al.*, 2006; Stone and Luchetti, 1985; Boyce, 1974; Langdon, 1966; Sundstrom *et al.*, 1980; Nemecek and Grandjean, 1973). In all, 59 studies are reviewed showing different types of tasks that are closely representative of real world office tasks and investigated to understand the impact of auditory distractions on performance, as measured by the number of errors or accidents. Figure 5 shows the number of studies for different complex tasks that have been investigated.

It is clear that memory recall tasks are the most frequently investigated; however, almost all the tasks involve memory and seriation (placing in serial order) at some



Note: Total number of studies = 59

Figure 4.
Field, sub-field and number of studies



Note: Total number of studies = 69

Figure 5.
Complex task and number of studies

instance during the task performance. The phenomenon studied in almost all the studies is called irrelevant speech effect, as introduced by Colle and Welsh (1976).

In this research, a short-term visual serial recall task is conducted in the presence of an auditory distraction and participants are asked to ignore any sound they hear (because this sound is irrelevant to the task at hand). The impairment of the task performance measured as errors in serial recall validates the negative impacts of

speech on performance. The results are also further validated for free recall tasks. It is suggested that similar results are obtained because order (serial) information is used as a cue to remember the item information. Banbury *et al.* (2001) explains the phenomenon as breakdown in selectivity of attention (introduced by Broadbent) that arises due to interference between two concurrent processes of seriation. The involuntary registration and organization of this unwanted auditory stimuli changes the seriation order of the primary task activity, requiring the preservation of order, and resulting in a diminishment of the performance. For instance, reading and comprehending a sentence involves processing a sequence of words, which is affected if the sequence of words is changed due to any other interference. The following predictions could be made about the relationship between order information in primary task, changes in successive streams of extraneous auditory stimuli, and performance on primary tasks: the more the involvement of working memory in preserving order information for a primary task, the greater will be the possibility of interference if the extraneous auditory stimuli are dynamic in nature. In contrast, if the level of seriation in the irrelevant auditory stream is less (i.e. the auditory stream is in steady-state) then the degree of interference in the performance on primary task will be less. Furthermore, according to Gathercole and Baddeley (1993), most everyday mental or cognitive activities require short-term memory and order information, and open office designs posits frequently changing extraneous noise, either speech or non-speech.

Consequently, because order and short-term memory are a key features of knowledge work and changing auditory streams is a key feature of open plan office designs, it is imperative and timely to establish this link so that costs of auditory distractions are considered.

A note on working memory

Working memory is analogous to a cache memory in computers that provides temporary space for storage, fast access, and manipulation of information necessary for the primary task at hand. In addition, working memory also has an access to long-term memory for the stored data (like regular storage for computers, which the microprocessor accesses when it does not find the required information in the cache) and acts as an interface between perception, action and long-term memory. A simplified model of working memory system that was invented by Gallanter Miller and Pribram as a unitary model but further adopted and advanced by Baddeley and Hitch as a three component system is shown in Figure 6. The model helps explain the irrelevant speech effect.

Subsequently, it was found that non-speech sounds like pure tones (Jones and Macken, 1993; Neath, 2000), instrumental music (Salame and Baddeley, 1989; Nittono, 1997), clicks and bangs, or pitch glides (Jones and Macken, 1993) also profoundly disrupts task performance. Therefore, to incorporate the negative impacts of non-speech sound, Jones (1993) advanced the irrelevant speech effect phenomenon as "irrelevant sound effect." According to irrelevant sound effect, the office noise, speech or non-speech, disrupts the performance of visual serial recall tasks due to the interference induced by the segmented, changing states of the sounds reaching ones ears (Jones *et al.*, 1992; Lecompte, 1995). This theory states that:

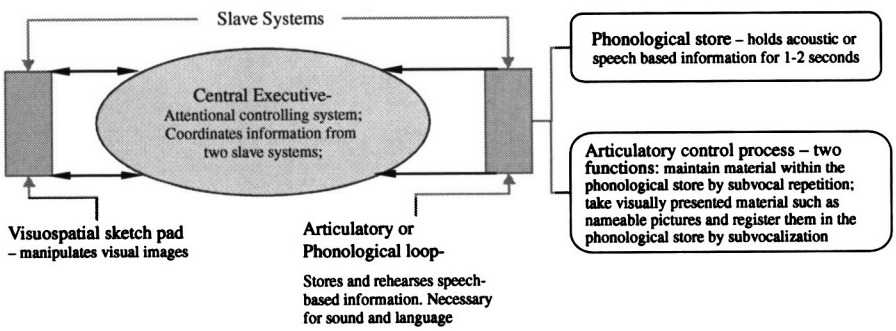


Figure 6.
Baddeley and Hitch's working memory model

> [...] the primary determinant of interference with the primary task is the change in state between successive auditory streams, i.e. the more the degree of change in the irrelevant sound sequence, the more the disruption (Jones *et al.*, 2000).

For instance, a rhyming irrelevant sequence like sea, flea, key, proves to be much less disruptive than a dissimilar sequence like hat, cow, nest. This helps recognize that speech is not the only category of sound that is disruptive for performance efficiency, but music, tones, etc. which are generally adopted to mask the surrounding noise, also interfere with performance of knowledge work and thence bear financial consequences for knowledge organizations.

As mentioned above, the validation of irrelevant sound effect is not limited to memory tasks only, but also has been extended to tasks involving cognitive aptitude, like analytical reasoning, reading comprehension, mental arithmetic, and proofreading, that are representative of real world knowledge tasks. For instance, Witterseh *et al.* (2004) and Evans and Johnson (2000) report that the participants performed worse on various tasks involving proof-reading, addition, and creative thinking when distracted by irrelevant speech or intermittent noise, such as telephone ringing, even when they were told to ignore the irrelevant speech. Similarly, Zijlstra and Roe (1999), in their study of effects of interruptions on cognitive performance on text editing tasks and well-being, find that interruptions have a negative impact on emotional well-being and lead to an increase of efforts to account for performance decline. However, with an increase in the number of interruptions during the day, the resumption time, i.e. the time needed to re-start the task execution, becomes disproportionally longer, and this impact is described in terms of decreasing motivation and mental fatigue. In line with this theory, Takahashi (2006) concludes that the memory that remembers the text to use in the task at hand, is susceptible to background sound, regardless of whether the sound consists of speech or the music. Further, evidence is provided by Vilimek and Hempel (2005) in their study of the impact of speech and non-speech sounds on short-term memory and the possible implications for automobile drivers. The results indicate that long speech messages have a significantly detrimental effect on short-term memory performance, leading to longer response times and increased cognitive demands.

It is revealed consistently that one cause of disruption is that of order information as most of these tasks involve some form of seriation (order) (Beaman and Jones, 1997); however, it is also suggested that the extent of disruption depends on the amount of seriation involved. For instance, the effect of irrelevant speech on free recall is

relatively smaller than the serial recall, and this effect is attributed to the fact that order information acts as a cue to remember the item information (Richardson, 1984; Salame and Baddeley, 1990; Lecompte, 1994; Beaman and Jones, 1998).

Most importantly, the studies reveal that distractions from intelligible and irrelevant conversations – for instance, people talking about sports, politics, personal relationships, or movies – are the most disturbing and are unacceptable (Kjellberg and Landstrom, 1994; Keighley, 1970). Keighley (1970) shows that distinctive sounds, i.e. sounds above the ambient level, are least acceptable to office workers. Olson (2002) shows that, on average, people spend about 25 per cent of their time talking in and near individual workspaces, which disrupts the concentration of people working in adjoining workspaces. While some of the conversations are business critical, others are personal and non-critical to the knowledge worker. In either case, the impact is the same – reduced ability for the adjacent workers to concentrate on the task at hand.

Sound pressure level is not shown to impact irrelevant sound effect. A whisper, 48 dB(A) is as disruptive as a shout 76 dB(A) (Colle, 1980; Ellermeier and Hellbruck, 1998; Salame and Baddeley, 1987). Therefore, it is an important point to be considered in the decision-making process for workspace design. Likewise, different kinds of meaningless manipulated speech, like foreign language, are also shown to produce interference in memory processing (Lecompte *et al.*, 1997; Jones *et al.*, 1990; Salame and Baddeley, 1982, 1987). However, if tasks involve meaning, such as reading comprehension, proof-reading, etc. then the meaning of irrelevant speech will further add to disruption on primary task performance (Jones *et al.*, 1990; Martin *et al.*, 1988). Furthermore, tasks that are devoid of memory and seriation, like sentence acceptability tests (Boyle and Coltheart, 1996) and perceptual tasks (Baddeley and Salame, 1986; Burani *et al.*, 1991), are shown to be immune to extraneous sound disruption, thereby suggesting the key properties of tasks that are susceptible to interference are memory and seriation tasks.

At this point, it is important to mention that many studies through experimental and observational recordings also show that irrelevant sound effects are not fleeting with time and sufficient exposure (Tremblay and Jones, 1998; Nemecek and Grandjean, 1973). This means habituation does not seem to come into play with respect to irrelevant sound effect. Therefore, it is imperative to recognize the significance of including extraneous sound effect in the cost of performance to knowledge organization during life cycle cost analyses of facilities so that necessary attention is given to containing these costs through workspace design and planning.

This work supports Purcell and Thorne's (1977) results in which they demonstrated that irrelevant speech and sudden changes of the noise in offices may interrupt a chain of thought, and thereby impair performance. Graham (1979) describes the same issue as "orienting reflex," in which any change in environment, for instance, an onset of neighbor conversation, may lead to attentional response involving a redirection of sense organs towards the noise source and a series of physiological responses lasting one or a few seconds. Further evidence is provided by Demarco and Lister's (1999) theory "the state of flow." According to their theory, performance on complex tasks, such as reading, designing, decision-making, programming, writing, and editing, involve a continuous and delicate state of concentration, that once disrupted can take 15 or more minutes to reach again. This flow is easily broken by distractions such as irrelevant speech. All these studies are of interest because they are representative of the

cognitive costs that are incurred in the workplace due to extraneous auditory distractions. The studies suggest that in open work environments, where the probability of distraction is high, there is a high probability of reduced performance and thus, reduced productivity and net revenue. Numerous field studies have also shown that employees working in open design environments most often complain about the office noise and especially the irrelevant speech, i.e. colleague's conversations in the background. Open plan designs invite the problem of frequent complaints of distraction and disturbance because in open designs conflicting requirements of good communication and good speech privacy are forced to coexist in a same work environment.

Influence of open plan office design on knowledge workers

In 1950, Eberhard and Wolfgang Schnelle conceived and designed the revolutionary office with movable screens, furniture, and planters and called it Burolandschaft (i.e. the office landscape). The motivation behind this invention was two-fold: one, to provide an extremely flexible and easily-reconfigurable work environment that can be transformed to meet the fast-paced, rapidly changing demands of an organizational world; and two, to create an egalitarian system with equal working conditions for all employees so as to facilitate social cohesiveness and horizontal functional communication among all levels of employees. Although a number of variants of Burolandschaft have evolved, an absence of floor-to-ceiling partitions is the main characteristics of these designs. However, in spite of the advantages, employees working in open plan workspaces feel little enthusiasm about their work environment and mostly have a number of complaints, such as too many interruptions, an increase in audio and visual distractions, and an increase in stress. These distractions are shown to cost performance efficiency (Brennan *et al.*, 2002; Brookes, 1972). With employees, especially knowledge workers, becoming the most critical assets of an organization, these issues of disruption eventually become a large cost to an organization, thus negatively impacting their financial bottom line. In today's organizational context where most of the work is knowledge based, the issues with open plan design cannot be ignored.

Open plan office designs and dependent variables of research interest

The influence of open plan office design on office workers has been studied from a number of perspectives. Some studies address issues in terms of short-term reactions, including: increased visual and oral distractions (Hundert and Greenfield, 1969; Manning, 1966; Canter, 1972; Brookes and Kaplan, 1972; Hedge, 1986; Ives and Ferdinands, 1974; Nemecek and Grandjean, 1973; Oldham and Brass, 1979; Sundstrom *et al.*, 1980; Brookes, 1972); increased cognitive loading (Oldham and Brass, 1979; Becker *et al.*, 1983); frequent interruptions by colleagues (Hedge, 1986; Hundert and Greenfield, 1969); concentration difficulty; lack of privacy, both visual and audio or both psychological and architectural; increased psychological stress (Evans and Johnson, 2000); increased physical stress (Brennan *et al.*, 2002); lower motivation (Oldham and Brass, 1979); and reduced social facilitation and interactions (Brennan *et al.*, 2002; Bencivenga, 1998; Wineman, 1986; Cohen, 1978). One researcher found no effect on social facilitation (Sundstrom *et al.*, 1980; Sundstrom, 1986). Bill Sims, former Cornell University Professor of Facility Management and planning, explains the reduced social facilitation effect by stating that in open plan designs "people can't control the

communication, they actually communicate less". Heusser explains the same effect from the perspective of basic human need for security. He states that in large open spaces "many people tend to arm themselves against the political coordination" thereby resulting in a decrease of personal interest in the working sphere. Furthermore, Jacobi, who established a mathematical relationship between a number of people in the same area and communication, concludes that "if it comes to quantitative consideration of communication, there is no sound argument in favor of building larger open-plan offices than is made necessary by other requirements" like flexibility or cost effectiveness, which analytically flaws the main argument behind the concept of open plan designs. These disruption problems are shown to result in long-term effects like: reduced individual performance (perceived or actual) on complex tasks (Becker *et al.*, 1983, Brennan *et al.*, 2002; Hedge, 1982); reduced team performance; reduced environmental, functional, and social satisfaction (Croon *et al.*, 2005; Marans and Yan, 1989; Oldham and Brass, 1979; Brennan *et al.*, 2002; Spreckelmeyer, 1993; Zalesny and Farace, 1987; Sundstrom *et al.*, 1994); weak interpersonal relations; and increased health problems (Hedge, 1986). Furthermore, Sundstrom *et al.* (1980) show that employees with the most demanding jobs were most negatively affected by the conditions of the open plan office. This is interesting to note because knowledge worker jobs are identified to be cognitively demanding, thereby increasing the significance of negative impacts for knowledge organizations. Brennan *et al.* (2002), further add that the negative impacts such as "increase in physical stress, decreased team member relations, and lowered perceived job performance, etc. did not abate over time," suggesting that habituation does not take place. This suggestion is well supported by a number of studies from psychological sciences that document dishabituation to irrelevant sound effects over a period of time. Furthermore, according to Hedge (1986), due to problems with open plan office design, they have been abandoned in West Germany, which opposed the concept in 1977, when almost 99 per cent of West Germany's white collar workers were working in open plan offices (Kraemer, Sieverts & Partners, 1977).

In contrast, many researchers argue for the benefits of the open plan designs, which primarily include cost effectiveness, and building cost savings, as well as improved information flow and increased collaboration and communication among co-workers at all levels and departments (Allen and Gerstberger, 1973; Zahn, 1991; Ives and Ferdinands, 1974; Brookes, 1972). The creation of flexible and easily re-configurable and responsive office layout as Steele (1986) put it:

> [...] the aim of landscape office is specifically work-flow oriented: to design a layout that fits the actual work happenings in a system and to facilitate these through appropriate spatial arrangements.

However, Hedge (1982) finds little evidence that this feature was ever utilized. He reports that once the workspace arrangement is set-up, it remains the same for a number of years.

Collectively, statistics suggest that office noise problems in open plan offices have reached a level of epidemic proportions. Langdon (1966) reports office noise, especially people talking, as a most frequent complaint (20 per cent); Boyce (1974), reports office noise to be a significant source of disturbance (more than 50 per cent); and Sundstrom *et al.* (1994) document 54 per cent of office workers from 58 US and Canadian offices being bothered often by one or more sources of noise. All these studies report a

significant negative correlation between office noise and performance, and office noise and overall satisfaction. At least ten studies (Boyce, 1974; Brookes and Kaplan, 1972; Hedge, 1982, 1980; Oldham and Brass, 1979; Riland, 1970; Croon *et al.*, 2005; Becker *et al.*, 1983; Sundstrom *et al.*, 1994; Hundert and Greenfield, 1969) provide evidence that employees prefer privacy over accessibility – the main focus of open plan designs. The primary reason for this preference is given as increase in noise, increase in distractions, and increase in interruptions. These are experienced continuously in open plans, even when the employee is trying to concentrate or needs a quiet environment to get the job done (Marans and Spreckelmeyer, 1982; Canty, 1977; Becker *et al.*, 1983).

A recent survey of 1,000 information workers by US-based information technology research firm Basex Inc. (2005) reports evidence that "interruptions take up more than two hours of the working day amounting to a cost of $588 billion a year to the US economy." This figure is based on an estimated average salary of $21 per hour, per knowledge worker; the distraction time wasted is equal to the time spent on the interruption/distraction, plus the recovery time associated with getting back to the primary task. Mark *et al.* (2005) have shown that because the knowledge workers are often multitasking (characteristics of a complex task), any distraction costs an average of at least 25 minutes before a full, focused return to the primary task, if the original primary task is even returned to on the same day.

Figure 7 shows the categorization of studies on the basis of number of studies versus the problem variables with open plan office design. As many as 18 studies

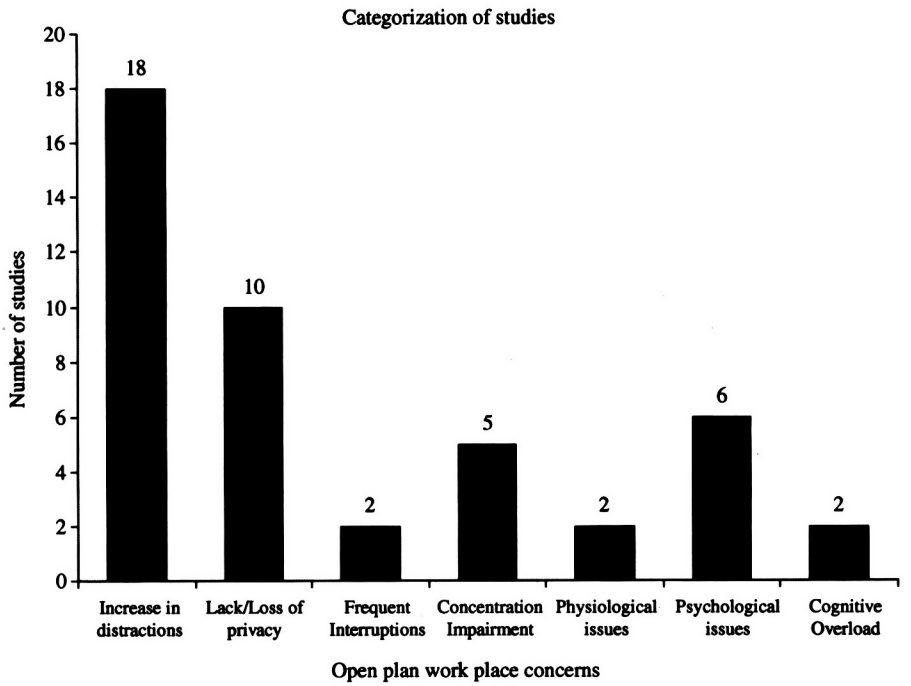


Figure 7.
Studies reporting issues with open plan workplaces

report an increase in disturbances and distractions due to conversations, and report noise as a significant source of frequent complaint in open office designs. Ten studies report lack/loss of privacy as a significant issue with open plan office designs. The other factors that have been stressed as a problem are frequent interruptions (two studies); concentration impairment (five studies); physiological issues (two studies); and cognitive overloading (two studies).

This background provides an extremely strong rationale for considering these factors in the decision-making process for workspaces designed for knowledge workers. However, existing life cycle cost models typically do not include this productivity reduction. Because cost effectiveness is generally the primary objective, the most often-selected method is the most cost-effective alternative. However, the inclusion of worker disruption is needed. Most existing life cycle cost models are currently restricted to tangible factors, such as construction costs, maintenance costs, operation costs, depreciation, tax, etc. since it is easy to convert these tangible factors into a dollar figure rather than the subjective variables, such as performance improvement, annoyance, satisfaction, etc. Although research has consistently shown that open plan designs increase physiological and psychological stress, many companies continue to adopt open-plan office designs primary because of the reduced costs in construction and maintenance. More progressive companies, such as Microsoft, Frog Creek, and Google, are moving back to conventional enclosed/private offices because of the realization that their employees, primarily knowledge workers, are their most critical assets and the productivity of the company is a direct result of employee performance, which is shown to be negatively affected in open plan designs.

The evidence is sufficient and significant to raise alarm for knowledge organizations, architects, engineers, facility decision-makers, facility managers, and researchers that a more-detailed investigation about the relationship between workspace design and knowledge worker's job performance and overall (functional, environmental, and social) satisfaction is needed. The aim would be to come up with a more realistic, yet cost-effective workspace solutions backed by strong scientific studies.

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