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Individual differences in employee reactions to open-plan offices

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Abstract

This study examined the independent and joint influences of stimulus screening, inhibitory ability, perceived privacy and task complexity on the satisfaction and performance of employees working in open-plan offices. One hundred and nine participants from two organizations completed questionnaires and inhibitory ability measures. Performance was assessed through manager ratings. Results partially confirmed hypotheses that satisfaction and performance would be reduced for employees with poor stimulus screening or poor inhibitory ability, low perceived privacy, or complex tasks. Expectations that these factors would interact to produce employees' negative reactions were also partially confirmed. Importantly, results verify stimulus screening as a significant determinant of employees' reactions to the open-plan workplace. Implications for understanding employees' attitudinal and behavioral responses to the workplace, limitations of the study, and implications for future research are discussed.

1. Introduction

Research has consistently demonstrated that characteristics of the office environment can have a significant effect on behavior, perceptions, and productivity of workers (e.g. Altman & Lett, 1969; Oldham & Rotchford, 1983; Woods & Canter, 1970). Workplace characteristics such as noise, lighting conditions, and the amount of space available per employee can contribute to employee turnover (Oldham & Fried, 1987; Sundstrom, Herbert, & Brown, 1982), discretionary withdrawal (Oldham & Fried, 1987), satisfaction (Block & Stokes, 1989; Oldham, 1988; Oldham & Brass, 1979; Sundstrom, Burt, & Kamp, 1980), and performance (Sundstrom et al., 1982; Wineman, 1986).

A fundamental aspect of the workplace environment that contributes to such employee behavior is the layout of office space. Conventional workplace designs tend to provide closed, private offices for employees. In contrast, the more contemporary open-plan design is characterized by an absence of floor-to-ceiling walls and internal boundaries, as illustrated by cubicles or partitioned workspaces (Zalesny & Farace, 1987). Both open and closed offices have featured in studies addressing the relationship between the physical features of the workplace and employee perceptions and behavior (Becker, Gield, Gaylin, & Sayer, 1983; Block & Stokes, 1989; Brookes & Kaplan, 1972; Crouch & Nimran, 1989; Hedge, 1982; Oldham, 1988; Oldham & Brass, 1979; Oldham & Fried, 1987; O'Neill, 1994; Sundstrom et al., 1980, 1982; Wineman, 1986). The open-plan office design in particular has received attention in current research. Its popularity as a workplace design has increased substantially (Krekhovetsky, 2003; The Economist, 1998), prompting researchers to question the value it offers to the employee and the organization in comparison to traditional designs. The current research examines the open-plan office design and employees' reactions to this working environment.

1.1. The impact of the open-plan office design on employee behavior and attitudes

Proponents of the open-plan office suggest that the open plan creates flexible space, allowing for a reduction

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in set-up and renovation times. It also enables the accommodation of greater numbers of employees in reduced amounts of space (Brennan, Chugh, & Kline, 2002; Zeitlin, 1969). As a result the total office space required is reduced and organizations save on air conditioning, maintenance and building costs. Supporters of the open-plan design also claim that the design facilitates communication and increases interaction between employees, and as a result improves employee satisfaction, morale and productivity (Bach, 1965; Brennan et al., 2002; Dean, 1977; Oldham, 1988). Indeed, some evidence exists to support these positive effects. Open-plan offices have led to increased communication among coworkers (Allen & Gerstberger, 1973; Hundert & Greenfield, 1969; Zahn, 1991), higher aesthetic judgements, and more group sociability than more conventional designs (Brookes & Kaplan, 1972). It is not surprising then that many contemporary workplaces have adopted this design to decrease costs and increase employee performance.

There is research, however, indicating that the purported benefits of the open-plan design are accompanied by important costs as well. For example, open-plan offices have been linked to increased workplace noise (Brookes & Kaplan, 1972; Sundstrom et al., 1980; Zalesny & Farace, 1987), increased disturbances and distractions (Brookes & Kaplan, 1972; Clearwater, 1979; Hedge, 1982; Hundert & Greenfield, 1969; Oldham & Brass, 1979; Sundstrom et al., 1980), increased feelings of crowding (Sundstrom et al., 1980), and loss of privacy (Boyce, 1974; Brookes & Kaplan, 1972; Clearwater, 1979; Hundert & Greenfield, 1969; Hedge, 1982; Sundstrom et al., 1980). Further, researchers have observed that these negative outcomes of the design tend to result in dissatisfaction with both work and the workplace (Marans & Yan, 1989; Oldham & Brass, 1979; Spreckelmeyer, 1993), reduced functional efficiency (Brookes & Kaplan, 1972), and decreased performance (Becker et al., 1983; Oldham & Brass, 1979). Thus it appears that although the reduction in space and increased communication are reputed to be benefits of the open-plan design, this design may also induce negative reactions from the individuals occupying such workspaces.

1.2. The influence of space in the workplace

The contrary findings regarding the influence of open-plan office designs have brought researchers to consider which characteristics of the design specifically contribute to its negative versus positive effects. The evidence resulting from such research consistently indicates that it is the inherent loss of space and increased contact with coworkers that appear to drive the negative behavioral and attitudinal responses of employees (Desor, 1972; Hundert & Greenfield, 1969; Oldham & Rotchford, 1983; Sundstrom et al., 1980). The open-plan office has exposed workspaces (few walls or partitions) and places employees in close proximity to coworkers. Consequently, employees find it difficult to avoid interpersonal contact or maintain privacy. Different frameworks have been adopted by researchers to explain this negative impact of crowding or excessive social interaction in office designs. Of these approaches, overstimulation theory (e.g. Oldham, 1988) provides a particularly useful basis for understanding the impact of crowded office space. According to this theory, the combination of excessive social interaction and small amounts of personal space characteristic of the design exposes employees to overstimulation (Desor, 1972; Paulus, 1980). Overstimulation generally evokes a negative response from individuals, both behaviorally and attitudinally, and in the workplace this likely results in employee dissatisfaction and withdrawal (Oldham, 1988; Paulus, 1980).

Empirical research supports the theory of overstimulation as a partial explanation of the negative effect of the open-plan office. Employees prefer low levels of spatial density, high levels of privacy, and a greater amount of architectural privacy (enclosures) in their workplace (Oldham, 1988; Oldham & Rotchford, 1983; Sundstrom et al., 1980). They seek minimization of unwanted intrusions and potential sources of excessive stimulation in their workspace, and accordingly are dissatisfied when the open-plan design does not allow for these desired working conditions (Oldham & Rotchford, 1983).

1.3. Individual differences in overstimulation

While much of the research on open-plan design has examined why particular characteristics of the design have a negative rather than positive influence, researchers have also considered whether individual differences may also contribute to the variation in the impact of the design. Empirical evidence confirms that the severity of employees' negative reactions indeed differs from person to person (Wineman, 1986); some individuals appear better able than others to cope with the excessive stimulation inherent to the open-plan office environment. Mehrabian (1977) proposed that such individual differences in coping are due to an ability he labels *stimulus screening*. He distinguishes between *screeners*, who effectively reduce overstimulation by attending to information on a priority basis, and *nonscreeners*, who do not (or cannot) apply this approach and tend to become overstimulated.

Consistent with Mehrabian's hypothesis, screeners are less affected by crowding and spatial density than nonscreeners (Baum, Calesnick, Davis, & Gatchel, 1982; Mehrabian, 1977; Oldham, 1988). Additionally, the evidence suggests that screeners appear to effectively

reduce the stress of numerous stimuli whereas non-screeners tend to become overaroused by the same stimuli and as a result report more negative attitudinal responses toward the environment (Mehrabian, 1977; Oldham, Kulik, & Stepina, 1991).

1.4. The role of inhibitory ability

Evidence in support of Mehrabian's (1977) concept of screening ability highlights a crucial factor in effective workplace performance: the ability to effectively block excessive stimulation to concentrate on the relevant information at hand. The processes underlying the selective attention required for such concentration have been the focus of substantial cognitive research, which identifies inhibition of distractions as playing a crucial role in selective attention (Dempster, 1991). Selective attention appears to involve two opposite but complementary mechanisms: attention and inhibition (Dagenbach & Carr, 1994; Hasher & Zacks, 1988; Marcel, 1983; Tipper, 1985, 1992). To pay attention to a particular stimulus within a dynamic environment an individual must attend to relevant information and inhibit or suppress irrelevant information that is also present. Effective inhibition allows the individual to avoid simultaneous processing of many competing stimuli. Inhibition is crucial to the individual's capacity to concentrate in a distracting environment as it reduces the likelihood that overstimulation will occur and thus allows the individual to effectively process the situation (Dempster, 1991).

Like most cognitive skills, the ability to inhibit information differs between various types of individuals. For example, individuals with schizophrenia, attention deficit disorder, obsessive behavior and individuals high in cognitive failures have demonstrated reduced cognitive inhibition (Beech, Powell, McWilliams, & Claridge, 1989; Tipper, 1992). Similarly, older adults display poorer inhibitory ability than younger adults (Connelly, Hasher, & Zacks, 1991; Hartman & Hasher, 1991; Hasher, Stoltzfus, Zacks, & Rypma, 1991; Tipper, 1991) and are more susceptible to distraction (Hasher & Zacks, 1988).

Aside from these group differences in inhibitory ability there is considerable evidence to suggest that there are individual differences in the inhibitory ability of normal adults (Conway, Cowan, & Bunting, 2001; Hasher & Zacks, 1988; Rosen & Engle, 1997). For example, normal adults show reliable and stable differences in their ability on selective attention tasks (e.g. the Stroop test) due to variations in the ability to inhibit distractions (Tipper & Baylis, 1987). Harnishfeger and Bjorklund (1994) also propose that individual differences in inhibition are associated with differences in performance in a wide range of tasks and abilities, including reading ability and creativity. Because the ability to inhibit irrelevant information lessens the likelihood of one becoming overstimulated in highly distracting situations (Dempster, 1991), it is feasible that inhibitory ability influences an individual's ability to cope in such an environment. This research examines the possibility that inhibitory ability may be the cognitive mechanism through which stimulus screening exerts its impact. Thus, whereas stimulus screening represents individuals' self-report of how well they cope in a stimulating environment, inhibitory ability may represent the underlying cognitive ability that allows individuals to effectively screen out distractions inherent in a stimulating environment.

According to this logic, a significant determinant of an employee's reaction to and performance in the workplace may be the ability to screen out or inhibit distracting or irrelevant information. This is particularly true of an open-plan office, in which distractions and overstimulation are intrinsically linked to the design. Individuals with poor inhibitory ability are less capable of suppressing distractions (Connelly et al., 1991) and thus are more likely to be disrupted by the overstimulation commonly experienced in open-plan offices (Desor, 1972; Paulus, 1980). As a result, negative attitudinal and behavioral reactions of employees in open-plan offices may be moderated by their inhibitory ability.

This hypothesis, however, does not specify the precise relationship between stimulus screening and inhibitory ability. It may be that inhibitory ability serves as a mediator between stimulus screening and employees' reactions to the open plan offices. In such a manner, inhibitory ability may be the cognitive mechanism that differentiates a good screener from a poor screener. Alternatively, inhibitory ability may enable people to engage in stimulus screening, but their self-report of stimulus screening may be primarily driven by affect or arousal rather than cognitive responses to overstimulating environments. According to this latter possibility, inhibitory ability may exert an independent influence from stimulus screening in predicting employees' reactions to open plan offices. These competing relationships between inhibitory ability and stimulus screening will be explored in this paper.

1.5. The role of task complexity in the open-office design

The workplace design and an individual's stimulus screening appear to be capable of affecting work performance in an open-plan office, but the extent to which either effects employee behaviors and attitudes may depend on precisely what each employee does within the workplace. Different tasks require different levels of attention and thus different levels of concentration for their completion (Oldham & Fried, 1987). Indeed, task complexities have been shown to influence

how employees perform in and react to workspaces of various designs (Block & Stokes, 1989; Brookes & Kaplan, 1972; Hackman & Oldham, 1975; Hedge, 1982; Oldham et al., 1991; Oldham & Fried, 1987; Stone, 2001; Sundstrom et al., 1980). The relationship between task complexity and workplace environment on performance is not straight forward, however. At first blush, it seems likely that less complex tasks (e.g. such as routine or well-learned tasks) which tend to require little conscious attention will be less likely to be affected by distractions within the work environment. In turn, more complex tasks are likely to require more intense concentration and are thus more likely to incur performance deficits if employees become distracted (Block & Stokes, 1989; Sundstrom et al., 1980). In contrast, Oldham et al. (1991) suggests that simple tasks require little concentration to complete and thus individuals executing such tasks tend to focus their attention on workplace intrusions, rather than the task, and dissatisfaction ensues. In contrast, individuals executing complex tasks have their attention diverted toward task completion, thus their focus on intrusions and associated dissatisfaction are abated.

Nonetheless, the bulk of the evidence suggests that employees with complex jobs are most influenced by open-plan offices in terms of satisfaction, workplace attitudes, withdrawal behaviors and performance (Block & Stokes, 1989; Brookes & Kaplan, 1972; Stone, 2001; Sundstrom et al., 1980). Individuals performing highly complex jobs appear to be more likely to be distracted by the open-plan office, resulting in poor performance and negative attitudes.

1.6. The role of perceived privacy in the open-office design

Two common factors affecting privacy are limited personal space and excessive unwanted interaction (Chan, 1999). Yet individuals can interpret the same situation very differently (Kaya & Weber, 2003). Various adaptive processes and coping mechanisms can result in different subjective interpretations of the same environment (Chan, 1999). According to Hall (1966), individuals have their own personal space which, when violated, leads them to feel crowded and uncomfortable. Thus, when infringements on personal space intrinsic to the open-plan design exceed employees' comfort levels, feelings of crowding and loss of privacy are likely to emerge. These feelings of crowding and loss of privacy then result in the dissatisfaction and negative reactions displayed by employees working in open-plan workspaces (Oldham & Rotchford, 1983). Moreover, given that *perceptions* of crowding appear to influence employees' reactions to their work environment, it is conceivable that the reactions of individuals in the same work environment could vary significantly depending on individual differences in perceptions of crowding and privacy. This possibility will be examined in the current study.

1.7. The present study

The literature on open-plan offices suggests that although the open-plan design has been associated with the positive effects of increased employee communication and reduced office costs, this design has a negative influence on employees' attitudes and behavior. The extent of this negative influence differs across individuals and situations. In particular, the empirical evidence suggests that reactions to the open-plan design are influenced by the relationship between the features of the workspace and employees' perceptions of privacy (e.g. Paulus, 1980), screening ability (e.g. Oldham, 1988), and the complexity of tasks they perform (e.g. Oldham et al., 1991). Research thus far, however, has not yet examined all three of these relationships simultaneously, thereby enabling an assessment of whether all three of these variables may interact to impact employee attitudes and behavior. This study therefore aims to add to the literature on open-plan office designs by investigating potential interaction between these variables and how they may jointly influence employee reactions to the design.

More specifically, the primary goal of this paper is to examine the interactions among stimulus screening, privacy, and task complexity. If certain individuals are particularly skilled in blocking out distractions (i.e. screeners) they may be able to effectively concentrate on their work regardless of the distractions evident in the workplace. Thus, reactions to open-plan offices are expected to be the most negative among nonscreeners when task complexity is high and perceptions of privacy are poor, as it is under these conditions that overstimulation most likely occurs.

Although Mehrabian's concept of stimulus screening ability appears to incorporate the concept of inhibiting excess information as a means of avoiding overstimulation, it does not directly measure inhibitory ability. The self-report scale used to measure stimulus screening (Stimulus Screening Scale; Mehrabian, 1977) focuses on an individual's tendency to become overaroused when faced with the stress of numerous stimuli (Oldham, 1988). Studies investigating the influence of screening ability on reactions to workplace design therefore appear to be assessing the relationship between an individual's reported ability to cope with arousal and reactions to the open-plan environment. Although the ability to cope with overstimulation may be a function of inhibitory ability, this ability is distinct from stimulus screening, and as noted earlier, may even be independent of it. Consequently, a secondary aim of this study is to investigate the proposition that inhibitory ability will

influence employees' attitudinal and behavioral responses to the open-plan design, either as a mediator of stimulus screening or in a manner distinct from the influence of stimulus screening. Thus, this paper will also examine the interactions among inhibitory ability, job complexity and perceived privacy. It is expected that these variables will interact in a manner similar to the predictions expected with stimulus screening, independent of whether inhibitory ability mediates stimulus screening effects.

In all, this study aims to define the role of stimulus screening and inhibitory ability in employees' reactions to workplace design, and then examine the combined influence of inhibitory ability and stimulus screening, perceived privacy and task complexity on employees' responses to the open-plan environment. It is expected that performance deficits and dissatisfaction will be the greatest among nonscreeners/poor inhibitors, when privacy is low and task complexity is high.

2. Method

Research setting and participants: The research was conducted in two workplaces in Sydney, Australia—a large Municipal Council and an international architecture and design firm. Both workplaces were of an open-plan design. The number of enclosures around each employee's workspace ranged from one to four partitions or walls ($M = 2.57$, SD = .71). The social density (number of employees within a 5 m radius of each workspace) ranged from 1 to 22 employees ($M = 11.77$, SD = 4.64), and the distance between coworkers ranged from 0.5 to 5 m ($M = 1.74$, SD = .60).

A total of 54 employees (25 males, 29 females) from the Municipal Council and 61 employees (39 males, 22 females) from the architectural firm participated in the study. Six participants (three from each workplace) were from a nonEnglish speaking background and were excluded from the analysis, as some tasks in the study involved timed recognition of English words. Both samples were comparable in terms of job levels, age and education of employees, and tenure within the organization (see Table 1 for participant characteristics). Therefore, the two workplaces were combined to create a final sample of 109 participants (60 males, 49 females).

Procedure: Data were collected on site by the researcher. Prior to the commencement of the study, employees were emailed about the nature and purpose of the study and were notified of the organization's endorsement of their participation. Employees were instructed to complete a consent form if they wished to participate. Confidential questionnaires were then administered to each participating employee's desk. The questionnaire included items that measured screening ability, perceptions of the work environment (task demands and privacy), and job satisfaction. Questionnaires were completed at the employees' leisure and were collected by the researcher when employees attended a session for measuring inhibitory ability.

To maintain anonymity employees were each given a code number based on the position of their workplace in the office. They were also asked to supply their position title and some demographic information. All participants supplied this information.

After completing the questionnaire participants were asked to complete the Stroop test to measure inhibitory ability. Participants were informed the session would take 5 min of their time and would be held one-on-one with the researcher in a site assigned by the organization. During the session the researcher checked the location of the participant's workspace against a floor plan to ensure their code number was correct. Participants were then given the instructions and informed that they would be timed on the reading task. After completing the session the researcher asked if the participant had any questions, explained that the reading task was a measure of inhibitory ability, and clarified how it related to the research project.

Once all questionnaires were collected and Stroop tests completed, managers were asked to complete performance ratings for each participant. Managers were required to assess each participant's performance on the three tasks each employee listed as the most

Table 1
Participant characteristics

	Workplace 1	Workplace 2	Total
Total participants	51	58	109
Males	22	38	60
Females	29	20	49
Job level	Clerical–Senior Management	Clerical–Chairman	Clerical–Chairman
Education range	High school–graduate school	High school–graduate school	High school–graduate school
Age	36.04 (9.56)	36.79 (15.17)	35.31 (9.49)
Age range	23–62	18–64	18–64
Tenure (years)	4.59 (6.33)	3.66 (5.45)	4.10 (5.87)
Tenure range	0–32.50	0–25.33	0–32.50

Note: standard deviations are in parentheses.

common they performed in their job. Managers were also asked to give an overall performance rating. Each manager was given a list of the tasks to rate for each supervisee who participated in the study. New code numbers were allocated to each participant to ensure that the participants' responses remained anonymous.

2.1. Measures

Objective privacy: The experimenter measured various characteristics of the work environment, such as the number and height of partitions for each employee. The "social density" of each employee's workspace was also measured through the number of employees within a 5-m radius and the physical distance between coworkers.

Perceived privacy: As discussed earlier, employees' perceptions of the impact the physical characteristics of the work environment may be more important in influencing reactions to the workplace than the characteristics themselves. Therefore perceived privacy was included as a measure of employee perceptions of the work environment. Following Sundstrom et al. (1980), privacy was operationalized as perceived control over access to oneself. Five questionnaire items taken from Crouch and Nimran (1989) and O'Neill (1994), were averaged to form an index ($\alpha = .71$). Responses were provided on a seven-point scale ranging from "Strongly Disagree" to "Strongly Agree". A sample item is "My normal work position is private", with a high score indicating a high degree of perceived privacy.

Stimulus screening ability: As in Oldham (1988), stimulus screening was operationalized as the degree to which the participant is able to effectively reduce the stress of environmental stimuli. Ten items from Mehrabian's (1977) Stimulus Screening Scale were averaged to form an index ($\alpha = .77$). Responses were provided on a seven-point scale ranging from "Strongly Disagree" to "Strongly Agree". A sample item is: "I am strongly moved when many things happen at once", with a high score indicating poor screening ability.

Inhibitory ability: Inhibitory ability was assessed through the Stroop (1935) Test. The Stroop test was administered to participants individually during the reading task session. It involved two color-identification tasks. For the first task (no-inhibition required), participants were instructed to name the color of blocks listed on a page. For the second task (inhibition required) participants were instructed to name the color of the ink of a list of printed words that are also the names of colors, but different from the color of the ink (e.g. the word *blue* written in red ink). Here participants have to inhibit the word meaning (blue) in order to name the color of the ink (red). The difference in reading times between the color blocks and the color words indicates how well the participant can inhibit distractions. Inhibitory ability was thus operationalized as the ratio of the difference in reading times between the nondistracting and distracting task to the reading time for the nondistracting task, with a higher ratio indicating greater distraction and thus poor inhibitory ability. Stroop tasks with similar measurement parameters have been shown to measure inhibitory ability (e.g. West & Alain, 2000).

Task complexity: The questionnaire asked participants to nominate three tasks that they most commonly performed in their job. Participants then rated each task on "Task Attribute" items constructed for this study. These items assessed, how much concentration it required, how readily one can be distracted from it, and how difficult the task is. Responses were given on a five-point scale ranging from "Not at all" to "Extremely". Sample items include "Does this task require your full attention?" and "How easily are you distracted when doing this task?" An additional complexity rating was also assigned to each task by relying on the complexity ratings adapted from Hedge (1982). This scale involves five levels of complexity: routine clerical, advanced clerical, technical, advanced technical and managerial. The Hedge ratings were then combined with the self-report ratings of each task to create an overall job complexity score for each participant ($\alpha = .80$).

Performance: Performance was acquired through manager ratings. Managers of each participant were asked to rate performance in the last 6 months on a 10-point scale ranging from "Poor" to "Outstanding". Ratings were made for each participant's overall performance as well as their performance on each of their three nominated tasks. As with task complexity, supervisor ratings were also averaged to form an overall task performance scale ($\alpha = .90$).

Job satisfaction: Overall job satisfaction was measured with items taken from the general satisfaction scale of the Job Diagnostic Survey (Hackman & Oldham, 1975). Five items were averaged to form an index of job satisfaction ($\alpha = .80$). Items were answered on a seven-point scale ranging from "Strongly Disagree" to "Strongly Agree." A sample item is "Generally speaking, I am very satisfied with this job", with a high score indicating a high degree of satisfaction.

3. Results

A series of hierarchical linear regression analyses were performed examining the relationship between expected predictors (stimulus screening ability, inhibitory ability, perceived privacy, and task complexity), and the dependent variables (task performance, and job satisfaction). Perceived privacy, task complexity, and stimulus screening/inhibitory ability were expected to interact to affect performance and satisfaction. These predictions

were assessed with moderated regression analyses (see Baron & Kenny, 1986).

3.1. Preliminary analyses

All 109 participants returned complete data. However, managers returned only 86 performance ratings. Therefore, the analyses involving task performance as a dependent variable were restricted to a sample size of 86.

Initial analyses examined whether any demographic characteristics of the sample impacted on the dependent variables. Task performance and job satisfaction were therefore regressed onto sample characteristics (gender, age, education level and tenure). Results indicated that no sample characteristic significantly predicted any of the dependent variables (p's $> .20$ for all predictors). Consequently, they were not included in further analyses.

Preliminary analyses also examined whether the location of each participant's workplace (i.e. Municipal Council versus architecture firm) influenced responses on any of the measures included in the analyses. Analysis of variance was used to identify any workplace location effects. This analysis revealed that participants from the architecture firm had significantly higher ratings on perceived privacy, task complexity, and job satisfaction ($F(1, 108) = 14.99$, 7.85, and 4.47, respectively; $p < .01$, .01, and .05, respectively). These findings indicate that the workplace location influenced both independent and dependent variables and may consequently influence analyses involving these variables. Workplace location was therefore included as a predictor variable in the relevant analyses to ensure that location effects were controlled.

Tables 2 and 3 show the means, standard deviations, and intercorrelations of all measures.

Stimulus screening: Stimulus screening ability was correlated with performance and job satisfaction indicating that employees with better screening ability have higher performance and job satisfaction.

Inhibitory ability: It was proposed that inhibitory ability might mediate the effect of stimulus screening on employees' reactions to open office spaces. For mediation to emerge the independent variable and the mediator must be correlated (Baron & Kenny, 1986). The fact that no correlation emerged between stimulus screening and the Stroop task indicates that inhibitory ability is distinct from stimulus screening, and thus may play an independent role in predicting employee reactions to their workspace. This possibility is examined in the regression analyses presented below.

The Stroop task was correlated with perceived privacy, suggesting that employees who are better able to inhibit distractions within their environment also perceive their workplace as more private.

Perceived privacy: No relationship emerged between privacy and task performance or job satisfaction.

Task complexity: Task complexity was not significantly correlated with any of the measures (except location, discussed previously).

Objective privacy: Consistent with the prediction that employees would respond in a variety of different ways to the objective privacy provided by the workplace, the only correlation between objective measures of privacy and perceived privacy was the height of the partitions. Employees who had high partitions reported greater levels of perceived privacy. All other objective measures of privacy (i.e. number of partitions, interpersonal distance, and density) were not correlated with perceived privacy.

3.2. Moderated regression analyses

Hierarchical linear regression analyses were conducted to examine the higher order interactions (see

Table 3
Intercorrelations between privacy measures

	1	2	3	4
1. Perceived privacy				
2. # of partitions	−.10			
3. Height of partitions	.23*	−.46**		
4. # of employees in 5 m radius	−.02	−.56**	.14	
5. Physical distance between coworkers	.13	.39**	.16	−.31**

*$p \leqslant .05$, **$p \leqslant .001$.

Table 2
Intercorrelations between measures

	Mean	Standard deviation	1	2	3	4	5	6
1. Perceived privacy	2.91	1.13						
2. Stroop	.61	.30	−.21*					
3. Stimulus screening	4.12	.87	.06	.02				
4. Task complexity	3.29	.57	.10	.17	.05			
5. Task performance	7.60	1.00	.09	−.11	−.56*	.10		
6. Job satisfaction	4.83	1.08	−.09	−.17	−.23*	.07	−.01	
7. Location	—	—	.26*	−.03	−.04	.35**	.02	.20*

*$p \leqslant .05$, **$p < .01$.

Aiken & West, 1991). The first step was to enter the main effects into the model. In order to avoid possible multi-colinearity, all variables were centered prior to creating the interaction terms (see Aiken & West, 1991) that were entered in step two. Finally, the three-way interactions were entered in step 3. This procedure was conducted separately for stimulus screening and inhibitory ability. The significant outcomes are discussed below.[1] Interactions were interpreted according to the procedures offered by Aiken and West (1991), in which the simple slopes were estimated at one standard deviation above and below the mean for the variables in the interaction term. These "high" and "low" values were then tested for significance to determine the shape of the interaction.

Main effects: Stimulus screening ability significantly predicted task performance ($\beta = -.30$, $p < .05$). These results confirm previous findings that individuals with poor stimulus screening ability demonstrate lower performance than other workers.

Perceived privacy, task complexity and inhibitory ability: A significant interaction emerged between perceived privacy, task complexity and inhibitory ability for job satisfaction ($\beta = .24$, $p < .05$). All other interactions were nonsignificant (all p's $> .30$). Following Aiken and West (1991), further analyses revealed that the effect of the Stroop on job satisfaction was significant only when perceived privacy was low and task complexity was high ($\beta = -.62$, $p < .05$). These results confirm the hypothesis that when perceived privacy is low and task complexity is high, people with weak inhibitory ability have lower job satisfaction than people with strong inhibitory ability. Contrary to predictions, interaction effects were not evident for performance.

Perceived privacy, task complexity and stimulus screening ability: Akin to the results for inhibitory ability, a significant interaction effect emerged between perceived privacy, task complexity and stimulus screening ability only for job satisfaction ($\beta = -.32$, $p < .05$; all other p's $> .50$). The effect of stimulus screening was significant only when perceived privacy and task complexity were high ($\beta = -.73$, $p < .01$; all other p's $> .10$). This result indicates that poor stimulus screening leads to lower job satisfaction only when perceived privacy is high and task complexity is high. This relationship is contrary to the hypothesis that stimulus screening would have its strongest effect when privacy is low rather than high. It seems that the higher partitions may provide visual privacy but may fail to block the noise inherent to an open office plan, thereby leading to even greater problems for some workers by suggesting privacy that is not achieved.

[1]The main effect between the Stroop task and job satisfaction is not reviewed because it is qualified by the higher order interactions.

4. Discussion

The goal of this study was to identify the moderating effects of inhibitory ability, stimulus screening, perceived privacy, and task complexity on the satisfaction and performance of employees working in open-plan work environments. These factors were found to interact in predicting employees' job satisfaction, providing partial confirmation of hypotheses. In particular, although the relationship among these factors was varied, both poor inhibitory ability and stimulus screening consistently led to lower levels of employee satisfaction. The hypothesized interactions, however, were not evident for performance, suggesting that the interaction of these variables primarily promotes an affective rather than behavioral response. Furthermore, the nature of these interaction effects was not always consistent with expectations.

As predicted, inhibitory ability interacted with task complexity and perceived privacy to impact employee satisfaction. Results were consistent with the hypothesis that when individuals had low perceived privacy and were required to execute highly complex tasks, those with poor inhibitory ability would report low job satisfaction. This finding suggests that ability to inhibit distractions enables individuals working in complex jobs with low levels of privacy to avoid overstimulation from numerous sources of interference in open-plan offices, resulting in a more positive affective response to the job.

Stimulus screening also combined with perceived privacy and task complexity to influence job satisfaction, but here the results were inconsistent with predictions. Poor screening led to lower satisfaction when privacy and task complexity were high, rather than when task complexity was high but privacy was low as was predicted. Somewhat counter-intuitively, the ability to block out distractions apparently influenced employees' affective responses to the workplace only when the workplace was perceived to be less intrusive. It seems that higher partitions provide visual privacy but do not effectively block sound transmission. It is possible that the noise is more intrusive when employees do not have the visual cues to determine the locus of the noise. Alternatively, this finding supports the proposal by proponents of the open-plan design that the increased communication and social interaction inherent to the design increases employee satisfaction and morale (Bach, 1965; Brennan et al., 2002; Dean, 1977), rather than leading to overstimulation.

These results have important implications for open-plan design research. Not only did the findings confirm that stimulus screening ability is an important factor in determining an individual's ability to cope with the distractions inherent to the open-plan environment (e.g. Baum et al., 1982; Mehrabian, 1977; Oldham, 1988; Oldham et al., 1991), but the results also suggest that

inhibitory ability is an equally crucial factor. Further, the effect of inhibitory ability was independent of any influence of stimulus screening, indicating that these two measures may be tapping into different mechanisms for coping with overstimulating environments. The evidence indicated that the tendency to become overaroused (assessed by the Stimulus Screening Scale, Mehrabian, 1977) and the ability to inhibit irrelevant stimuli led to separate independent affective responses to the workplace design. At the same time, both concepts are theoretically similar, each referring to an ability to filter numerous stimuli to reduce the possibility of cognitive (and perhaps affective) overload. These points highlight an important direction for future research: inhibitory ability needs to be further examined as a determinant of employee's attitudinal and behavioral responses to the open-plan design, possibly independent of stimulus screening. In considering the role of inhibitory ability, however, it is important to recognize that different inhibitory mechanisms may be involved in the inhibition of different types of stimulation. Individuals' inhibitory ability differs across the domains of memory, conscious attention and reading comprehension (Gaultney, Kipp, Weinstein, & McNeill, 1999), suggesting that a different process is used to inhibit each of these stimuli. Further, different measures of inhibitory ability are often found to be uncorrelated (e.g. the Wisconsin Card Sorting Task and the distracting-text task from Connelly et al. (1991); see Kramer, Humphrey, Larish, & Logan, 1994), suggesting that there are different processes being measured by each task. There are many different sources of distraction in the open-plan office, all potentially impacting at the same time, and the Stroop task probably was not measuring inhibition of all of the relevant types of stimulation.

To measure the impact of inhibitory ability on employee reactions to such an environment, the researcher must first identify the types of stimuli that require inhibition and then find ways of measuring such inhibition processes. Typologies of inhibitory functioning have been offered in the literature (see Yoon, May, & Hasher, 2000), and a closer mapping of these inhibitory measures to the specifics of the workplace environment might reveal a stronger role for inhibitory ability than was documented in the current research.

4.1. Limitations of the present study

One important problem worth noting in the current research was the lack of variance on performance measures provided by managers. This restricted range may in part account for the lack of findings in this study regarding performance. Future research might address this problem by obtaining more objective indicators of job performance.

A second limitation of this study concerns measures of task complexity. The job descriptions provided by the organizations did not include comprehensive descriptions of the tasks that each employee's job entailed and thus complexity could not be evaluated in a very thorough manner. In an ideal situation a full job analysis would have been conducted to allow an objective evaluation of job complexity, for example via the *Dictionary of Occupational Titles* (US Department of Labor, 1991). Because organizational restraints did not allow for this possibility, complexity ratings were based upon employees' self-reported ratings as well as the relatively broad categorizations provided by Hedge (1982). Also, because jobs in this study generally ranged from a technical level upwards, there was some restriction in range of task complexity. Both of these issues may have reduced the probability of substantial findings regarding task complexity. Future studies should attempt to gain more objective and detailed measures, as well as a wider range of complexity, to achieve greater understanding of the role of task complexity in reactions to workplace design.

A third limitation of this study is the lack of incorporation of tactics that employees develop to avoid the distractions inherent in their open-plan workspace. Numerous employees mentioned that they and their colleagues frequently engage in behavioral techniques to minimize disruption to their work, such as relocation to dedicated quiet spaces or using headphones to block out noise. The fact that employees use these tactics indicates both that employees are highly aware of the distractions inherent to the workplace environment and that they actively avoid these distractions to ensure completion of their work. Failure to systematically consider the effect of these actions on employees' responses to the workplace environment meant that some effects of workplace design on employee attitudes and behavior may have been masked. For example, employees may perform their tasks well despite their poor ability to inhibit distractions and low levels of privacy because they take important work elsewhere if they are having difficulty completing it. These observations indicate that future studies should consider the actions employees take to limit their exposure to the distractions inherent to their workplace.

Finally, it should be noted that this study does not rule out the possibility that stimulus screening is equally important in a closed office environment. This possibility seems unlikely given that employees in open offices are more susceptible to noises and uncontrollable distractions (Sundstrom et al., 1980). Nonetheless, the organizations that participated in this research had very few closed offices, not allowing for comparisons to be made between closed and open office layouts. Indeed, many organizations today are increasingly turning to the open plan layout, even for their most senior employees (Hymowitz, 1998).

4.2. Practical implications and future research

This study indicates that inhibitory ability, stimulus screening, perceived privacy and task complexity interact in determining employees' affective responses to the open-plan work environment. These findings support previous research indicating that employees react negatively to open-plan office designs, particularly if they feel crowded and their work requires high levels of concentration (e.g. Oldham & Brass, 1979). More importantly, however, this study has provided evidence that the ability to block out distracting stimuli and selectively attend to relevant information plays a fundamental role in employee satisfaction.

This finding has implications for workplace design. First, the fact that inhibitory ability was found to impact on reactions to the workplace design suggests that further research is necessary to confirm and expand these findings. Also, due to the complexity of measuring inhibition, additional research is needed to determine which mechanisms of inhibition are relevant to the workplace and how best to measure them. Second, once the nature and impact of inhibitory ability in the workplace has been more clearly delineated, a number of questions relevant to workplace design and organizational performance and morale can be addressed. For example: Can employees be taught to enhance their inhibitory ability? Which particular stimuli prove most distracting in the workplace, and to whom? Which mechanisms of inhibition can be used to effectively reduce these distractions? Do employees need to be given strategies to avoid distractions? Are private work areas necessary in open-plan offices to help people who are poor inhibitors avoid distractions? The informal observations that employees were intentionally addressing workplace distractions, in combination with the empirical findings regarding inhibitory ability and stimulus screening, suggest that these are important questions for future research.

In conclusion, this study has identified the importance of employee perceptions, task characteristics, and the ability to inhibit distractions in enabling an individual to cope with the overstimulation inherent to the open-plan workplace. Inhibitory processes are acknowledged as playing a fundamental role in an individual's ability to effectively function in their environment, and they appear to influence employees' affective response to their workplace.

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