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ARCHITECTURAL ENCLOSURE'S EFFECT ON OFFICE WORKER PERFORMANCE: A COMPARISON OF THE PHYSICAL AND SYMBOLIC ATTRIBUTES OF WORKSPACE DIVIDERS

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ABSTRACT

Most studies of offices examine their physical or symbolic attributes independently. Yet office components can contain both attributes. To minimize unintended but potentially negative effects on occupants, researchers must consider both the physical and symbolic attributes of components when making recommendations about their deployment. This study compares the effects of the physical and symbolic attributes of architectural enclosure on worker performance using a survey database that contains workers' ratings of their office components. The amount of enclosure is determined by the height of the occupant's workspace divider, with taller dividers offering more enclosure. Divider height is positively associated with ratings of the two physical attributes considered: speech privacy and visual privacy. Divider height, however, does not affect occupants' ratings of a home-like atmosphere or workplace pride, the symbolic attributes considered. Yet, the occupants indicate that the two symbolic attributes are more important than the two physical attributes in improving their work performance. This might lead to office design choices. An office designed to maximize worker performance might do so by maximizing its symbolic impact. This analysis suggests that an office's symbolic impact may not always be increased by including more offices with tall dividers like enclosed, private offices.

KEYWORDS

Workspace Design, Office, Performance, Privacy, Enclosure, Architectural Symbolism

1. INTRODUCTION

Office design problems can be difficult to solve due to the multitude of factors affecting workers. It is challenging to understand how changes to one factor might affect other factors [1]. For example, a decision to improve collaboration may affect privacy. As this example suggests, designers need ways to control competing factors in their designs [2]. Although much has been discovered regarding individual relationships between buildings and occupants, the research community has just begun to investigate conflicts between factors.

Potential conflicts between the building's physical environment and its symbolism deserve particular concern. Designers and managers are expected to understand that 'how people feel about their workplace matters as much as how they use it' [3], and that the symbolism of an office design may be just as important as the physical conditions in that office. Yet without further research, designers will lack techniques to counteract conflicts between the two. Here, potential conflicts between the physical and symbolic attributes of architectural enclosure are addressed using survey data. This paper compares the effect of two physical attributes and two symbolic attributes of architectural enclosure on worker performance. The two physical attributes of interest are speech privacy and visual privacy. The symbolic attributes analyzed are feelings of a home-like atmosphere and workplace pride. The amount of enclosure is determined by the height of workspace dividers. These comparisons provide the background for discussing the spatial implications of deploying workspace dividers in offices.

2. BACKGROUND

2.1 Definitions

The four workspace divider types presented in this paper and described below reflect variations in layout as defined by Vos [4]. The layout variations are classified by type of divider [5] and the degree of enclosure that divider offers. As the height of the divider decreases, so does the amount of enclosure. Thus in this paper, offices with full height walls are described as enclosed. Cubicles with high partitions

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are offices with dividers over five feet tall, but that are not full height. Cubicles with low partitions are offices with dividers less than five feet tall. An open office has no partitions.

This study discusses the association between the level of enclosure offered by the different dividers and two physical and two symbolic attributes of enclosure. Both physical attributes relate to privacy, which is a 'sense of control over access to oneself or one's group' [6]. Thus, speech privacy is the ability to control access to your conversations and those of your neighbors. Visual privacy is the ability to control access to the sight of you or your coworkers. Speech and visual privacy survey responses rate the building's success at offering such control as necessary. Environmental stimuli with discrete magnitudes can be measured in relation to both speech and visual privacy. For example, it is possible to accurately measure sound, light and occupant density.

Symbolic attributes relate to a building element's ability to invoke an idea. A common connotation of 'home' is a place of refuge or sanctuary. Thus, we take occupants' ratings of a home-like atmosphere to reflect how well the building's components invoke or symbolize refuge or sanctuary for workers. A common connotation of pride is to take pleasure in something believed to reflect credit upon oneself. Thus, we take ratings of workplace pride to reflect how well the building's components reflect prestige upon its occupants. In contrast to the physical attributes, only relative magnitudes can be attached to the symbolic attributes.

As is described in section 3.2, the physical and symbolic attributes are easily comparable because they are measured on the same relative scale. From these data we glean occupants' satisfaction with the amount of physical or symbolic stimulus the building facilitates or prevents. We cannot compare however, the quantities of associated stimuli directly since the exact magnitudes of the symbolic stimuli are unknown. Precise methods of measuring symbolic stimuli have not been developed.

Long-term exposure to the building's stimuli –physical or symbolic-- can affect worker performance [7]. When conditions inhibit work, extra cognitive or emotional effort is required to overcome deficiencies in work performance [8]. The opposite is also true; a building can support work performance with its stimuli. Worker performance responses rate whether a building's physical and symbolic stimuli compel extra effort to produce work.

2.2 Architectural enclosure's physical and symbolic attributes

Numerous studies show that an occupant's sense of visual privacy and speech privacy are correlated with the degree of enclosure offered their by workspace divider [9-15]. Workers in enclosed configurations rate both their visual and speech privacy higher than those in open configurations. Further, workers that are moved from closed to open configurations show decreased satisfaction and motivation [14, 16]. This is logical as the degree of enclosure decreases, so does an occupant's ability to prevent intrusions from sound or other occupants' movements.

While there is a great deal of research about associations between office configurations and privacy, there is very little written about the association of enclosure with the symbolic attributes analyzed in this study. Krohe [3] speculates that enclosed work spaces feel 'more like home' to occupants. Two additional studies suggest that the absence of a home-like feeling makes occupants feel threatened or vulnerable [16, 17]. Yet, no study has directly investigated the association between feelings of a home-like atmosphere and the degree of enclosure a particular office configuration offers.

Konar's [18] study implies a relationship between workplace pride and enclosure via status. This study suggests a relationship between the status associated with an enclosed office and an overall workspace indicator that included pride. Ferguson [19] found a statistically significant correlation between indicators of material permanence and workplace pride. Occupants saw enclosed offices as more permanent than cubicles; thus workers in enclosed offices exhibited higher levels of workplace pride than their

counterparts in cubicles. Konar and Ferguson found a correlation between pride and degree of enclosure, but each through a different intervening variable. Notwithstanding the intervening variable, the literature suggests that degree of enclosure is associated with workplace pride; thus it is plausible that workers experience a sense of pleasure from the possession of more architectural enclosure.

2.3 Architectural enclosure and worker performance

Many studies have found a positive association between decreased speech and visual privacy and increased cognitive workload [13, 14, 20, 21]. This increased cognitive workload, in turn decreases worker performance. In contrast to the physical attributes, the relationship between the symbolic attributes and worker performance has not been widely studied. Greenberg's [22] study is perhaps a more relevant one, having researched the association between status and worker performance. A direct relationship to pride however, was not investigated. We earlier described a relationship between status and workplace pride, one of the symbolic attributes in this study. Still very few, if any studies exist that relate the symbolic variables of interest to worker performance directly. This study is the first of its kind in this regard.

2.4 State of the literature

Studies of the physical attributes are plentiful while studies of the symbolic attributes are sparse. Further, in many studies of both the physical attributes, population sizes are small and effects of age and gender are not included. Additionally, most of the literature focuses on discreet physical or symbolic attributes and rarely looks at potential conflicts between both. This paper compares the physical attributes of speech privacy and visual privacy and the symbolic attributes of a home-like feeling and workplace pride. It first describes the effect of architectural enclosure on the two physical and two symbolic variables of interest. It next compares the effect of these variables on worker performance. The comparisons are made with models that include demographic factors, including age and gender.

	Physical attributes	:	Symbolic attributes
architectural enclosure	Comparison 1		
worker performance	Comparison 2		

Figure 1 – Matrix of comparisons made in this paper

3. CBE DATABASE

The Center for the Built Environment (CBE) operates a survey that provides an opportunity to make such comparisons. Its database includes subjective perceptions including occupant’s self-reported work performance, occupants’ rating of the physical and symbolic attributes, and information about the building’s physical components --such as workspace divider height. In short, the database permits the analysis of the subjective parameters along with the physical parameters.

Data are gathered through research collaborations with building owners, managers and designers that are interested in their building’s performance. CBE provides individual building performance information to collaborators, while using the aggregate data to investigate broad trends. The data are gathered via a web-based survey with a standard set of questions that allows comparison across sets of buildings. In addition, the standard question set may be enhanced with questions for specialized research. The symbolic attribute ratings were gathered during just such a research project.

Of the buildings in the database, most are located in the United States, with a small number in Canada, Europe and Australia. About 60% of the buildings are owned or leased (and primarily occupied) by some government entity (federal, state or local). Most of the buildings are offices or contain offices, of which 22% provide secondary functionality, such as courthouse, bank, educational, hospital or laboratory. The survey is conducted at any time of year so results should not be construed as seasonal. Occupants in each building are invited to take the survey at their discretion during a two-week period, via an invitation email that explains the survey and includes its web address.

3.1 Benchmark dataset

CBE has been continuously gathering building occupant responses since April of 2000. As of fall 2009, the CBE database contained responses from approximately 51,000 respondents in over 450 buildings. This set of buildings represents the CBE benchmark set. The majority of responses in the database and the benchmark set are occupants' ratings of their building's indoor environmental quality. These ratings are collected using questions similar to the following:

How satisfied are you with visual privacy?

Despite its breadth, the CBE dataset is limited in that its primary focus is indoor environmental quality, with most of the responses in this area. Of the symbolic attribute ratings contained in the database, the set considered in this paper contain only the questions that relate more to the building than to the organization occupying the building. This limitation reduces both the number of buildings and occupants that can be used in this project.

3.2. Data for analysis

The data for analysis are a subset of the larger CBE dataset. Thirteen buildings in the Center for the Built Environment's Occupant Satisfaction database include physical, symbolic and worker performance ratings. We refer to this set as "sample buildings" throughout this paper. It is the focus of our analysis.

We first compare the magnitudes of the following relationships:

1. *Visual privacy and amount of enclosure.*
2. *Speech privacy and amount of enclosure.*
3. *A worker's sense of a home-like atmosphere and amount of enclosure.*
4. *A worker's pride in their workplace and amount of enclosure.*

We next compare the magnitudes of these relationships:

1. *Visual privacy and worker performance.*
2. *Speech privacy and worker performance.*
3. *A worker's sense of a home-like atmosphere and worker performance.*
4. *A worker's pride in their workplace and worker performance.*

Among the six physical attributes analyzed (Table 1) in preparation for this paper, speech and visual privacy are highlighted because of their strong association with architectural enclosure. Among the six symbolic attributes analyzed (Table 1) in preparation for this paper, the sense of a home-like atmosphere and workplace pride are highlighted because of their strong association with worker performance.

The range of individual physical, symbolic and worker performance ratings are gathered using a 7-point scale, from -3 to 3 where zero is the neutral (or no opinion) response. The demographic and workplace indicators are categorical. Note that as the workspace divider code decreases, divider height increases. Thus, a response of 5 denotes an open office and a response of 1 represents an enclosed, private office.

4. STATISTICAL METHODS

The data were analyzed using Intercooled Stata 9. Results are significant to a 95% confidence level (or greater) unless otherwise specified. Regression coefficients were produced using an ordered logistic regression specification with either worker performance or a symbolic attribute as the outcome variable. In all cases demographic and workplace variables shown in Table 1 are included in the regressions. Standard errors are clustered at the survey level -- which is also the building level-- so general error heteroskedasticity within and across buildings is handled appropriately.

In all specifications, variables are entered additively and directly; no mathematical operations are performed on any variables. For example, integers from the 7-point scale used for the physical and symbolic ratings are entered directly into the regressions. Output is presented as percentages. This is equivalent to the following operation on the regression coefficient: $\exp(a) - 1$. We refer to this output as exponentiated coefficients.

TABLE 1 -- LIST OF VARIABLES BY TYPE

Outcome	worker performance or symbolic attribute
Physical	speech privacy noise level amount of light air quality temperature visual privacy
Symbolic	I feel at home in my individual workspace. I feel at home in the area immediately surrounding my individual workspace. I feel at home in the spaces occupied by other branches in other parts of the building. I feel at home everywhere in the building. A workplace that makes me proud to be part of the organization. A workplace that makes me feel like I'm part of a community.
Demographic	gender age building tenure job type
Workplace	workspace divider height near window? near exterior wall? survey year

5. RESULTS

Table 2 compares the sample buildings' mean in four indoor environmental quality categories to the CBE benchmark means in those same categories. The air quality mean averages responses for a single question about air quality satisfaction. The thermal comfort mean is based on responses to a single question about temperature satisfaction. The acoustic quality average is the average of speech privacy and general noise ratings. The lighting mean is the combination of the quality of light and the amount of light ratings. The

data suggest an average level of indoor environmental quality performance. Overall, the sample buildings' category mean scores are similar to CBE benchmark's category means. Table 3 shows the means for three symbolic attributes individually. It demonstrates that respondents in the sample buildings are also moderately positive about these items.

TABLE 2–SAMPLE BUILDINGS PHYSICAL ATTRIBUTE CATEGORY MEANS AND CBE BENCHMARK CATEGORY MEANS

	sample buildings	CBE benchmark
Acoustic Quality	-0.30	-0.25
Air Quality	0.24	0.31
Lighting	1.11	1.11
Thermal Comfort	-0.13	-0.12
# responses	~2,200	~51,000

TABLE 3 –SELECTED SYMBOLIC ATTRIBUTE MEANS

I feel at home in my individual workspace	1.33
A workplace that makes me proud to be part of the organization	0.77
A workplace that makes me feel like I'm part of a community	0.43

5.1. Comparing architectural enclosure's relationship to physical and symbolic attributes

Table 4 shows that architectural enclosure is not a consistently significant predictor of symbolic attribute ratings. It presents coefficients from three unique regressions, each with one symbolic attribute as its outcome. The complete set of demographic, workplace and physical attributes was included in all regressions. The exponentiated coefficients for divider height are small (5%, 6%, and 4%) and statistically insignificant. Thus, the data suggest that among CBE survey respondents, divider height or the amount of architectural enclosure is not primarily associated with the notion of a home-like atmosphere or workplace pride.

TABLE 4 – ARCHITECTURAL ENCLOSURE’S EFFECT ON THE SYMBOLIC ATTRIBUTES

	exponentiated coefficients* divider height
I feel at home in my individual workspace	5%
A workplace that makes me proud to be part of the organization	6%
A workplace that makes me feel like I'm part of a community	4%

* Exp (divider height coeff.) -1

TABLE 5 – WORKSPACE DIVIDER’S PAIRWISE CORRELATIONS

	max	min
Physical attributes	-0.42	-0.02
Symbolic attributes	-0.17	-0.01

WORKSPACE DIVIDER’S CORRELATION W/ PHYSICAL ATTRIBUTES

	visual privacy	speech privacy
	-0.42	-0.37

WORKSPACE DIVIDER’S CORRELATION W/ SYMBOLIC ATTRIBUTES

	Pride	home-like
	-0.08	-0.03

Even the highly valued enclosed office is not a determinant of a home-like atmosphere or feelings of workplace pride. Instead, the correlation coefficients in Table 5 demonstrate that architectural enclosure is most strongly associated with ratings of speech privacy and visual privacy. It appears then that among these four variables, users value the environmental stimuli attenuation of enclosed offices more than the potential symbolic impact of enclosed offices.

5.2. Comparing physical and symbolic attributes to worker performance

Table 6 shows exponentiated regression coefficients for the physical and symbolic attributes most related to worker performance. The exponentiated coefficients were derived from a regression with worker performance as the dependent variable and included the complete set of demographic, workplace and physical attributes.

TABLE 6 -- EXPLAINING WORKER PERFORMANCE

Explanatory Variables	exponentiated coefficients*
<u>Panel A: physical attributes</u>	
Speech privacy	23%
Noise Level	19%
Amount of Light	15%
Air Quality	10%
Temperature	11%
<u>Panel B: symbolic attributes</u>	
(1) I feel at home in my individual workspace	35%
(5) A workplace that makes me proud to be part of the organization	38%
(6) A workplace that makes me feel like I'm part of a community	12%

* Exp (a) -1

The workplace pride and home-like atmosphere factors surpass the physical attributes in terms of effects on worker performance. Both seem particularly important and have double the effect of most of the physical attributes. The results in Table 6 also show the independent statistical significance of both the physical and symbolic attributes in predicting worker performance. If respondents were simply “generally happy” or “generally unhappy”, we might not expect to find enough independent variation for both to have explanatory power in a regression framework.

Goins et al. [23], which is based on a much larger and broader set of observations, suggests that the effect of the physical attributes on worker performance is pervasive and powerful. It is worth noting that these symbolic factors are additionally powerful predictors of occupants’ opinions about the building’s ability to support workplace tasks. Yet, for the buildings in question these feelings of workplace pride and a

home-like atmosphere are not related to a worker's workspace divider or the amount of architectural enclosure it offers.

5.3. PHYSICAL FACTOR'S SUPPORT OF SYMBOLIC FACTORS

The physical and symbolic ratings are themselves associated. Figure 2 displays coefficient ranges for six physical attributes to demonstrate the pervasiveness of the physical attribute's support of the symbolic attributes. We are not able to show a visual privacy coefficient due to data limitations. The upper and lower edges of each bar equal the maximum and minimum coefficient sizes that a particular physical factor takes when used to explain either symbolic attributes 1, 5 or 6 in an ordered logistic regression. All of the physical attributes except visual privacy are included in this regression specification, as are all other demographic and workplace variables from Table 1. The results suggest that buildings with high physical attribute ratings are likely to also have high symbolic attribute ratings.

Air quality and speech privacy ratings were most highly associated with the symbolic attributes. For every one point increase in air quality satisfaction on the -3, 3 scale the likelihood of an increase in the symbolic attributes is between 15% and 21%. The amount of light is the next most powerful variable in predicting SEQ factor increases, with a 17% likelihood of an increase. This result stands in contrast to the amount of architectural enclosure, which is not a predictor of a symbolic attribute rating increase.

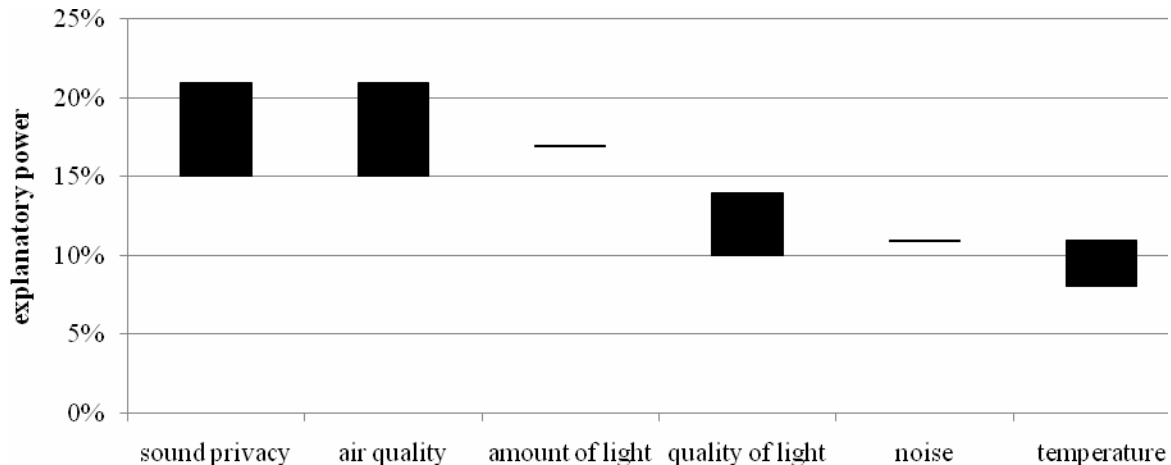


Figure 2 -- Maximum and minimum regression coefficients of physical attributes with symbolic attributes as the outcome variable. The figure shows that the physical attributes support ratings of the symbolic attributes. Coefficients are exponentiated [Exp (a) -1]

6. CONCLUSION

The symbolic attributes captured by the CBE's occupant survey are measuring, in aggregate, expectations about the symbolic meaning of workspace organization and design, while the physical attributes are mostly measuring expectations about the tangible and sensory environment. The symbolic attributes appear to be more important to worker performance than are the physical attributes analyzed. The effect of some symbolic attributes on worker performance ratings is double the effect of some physical attributes effect.

At the same time, among CBE survey respondents the symbolic attributes tested are not associated with workspace divider height. That is, our results suggest that lower worker performance scores have less to do with workspace divider height or the amount of architectural enclosure, because workspace divider height has less to do with the building's symbolic impact.

This paper does not include analysis of other symbolic attributes --like material permanence—which may be associated with other features of workspace dividers besides height. More research comparing the

effects of the symbolic and physical attributes of office components is needed. Yet, these findings could influence design choices. Adding higher workspace dividers may improve occupants' sense of the building's physical attributes. Increasing height alone however, may not affect the building's symbolic impact. Since the symbolic attributes tested have a larger effect on worker performance, a designer seeking to create a space that maximizes worker performance might opt not include increased divider heights in their design in lieu of other elements that support the building's symbolic impact.

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