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CHOICE, PERCEIVED CONTROL, AND PERFORMANCE DECREMENTS IN THE PHYSICAL ENVIRONMENT

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Abstract

Psychologists and environmental designers have asserted that the provision of choices in the physical environment will lead to desirable outcomes for employees, such as better performance and improved mood. This assertion, applied to workstation lighting, was tested using a 2×2 Choice (over lighting)×Preference (for lighting) factorial design with an additional no-treatment comparison group. Male and female undergraduates participated in 2-h sessions during which they completed mood and perceived control scales and several intellectual and creativity tasks. As expected, subjects in the choice and preference-given conditions reported more perceived control than those under no-choice and preference-denied conditions. However, contrary to conventional wisdom, subjects given choice performed more poorly and more slowly than subjects not given choice, at least on the creativity task.

Introduction

Psychologists have embraced the idea that providing choices gives personal control to the individual, and that personal control is necessary to well-being (*cf*. Averill, 1973; Burger, 1989). The pervasive view is that when personal control is lacking, feelings of powerlessness and unhappiness and decreased task performance will follow. Two classic studies often used to support this view are those by Seligman (1974) on learned helplessness and Glass and Singer (1972) on noise after-effects.

Similarly, many environmental psychologists and designers hold that the provision of choices in the physical environment will lead to desirable outcomes (Gifford, 1987). Barnes (1981), for instance, argued that providing choices in the physical environment is one means of preventing the detrimental effects seen in situations where control does not exist. He distinguished between 'perceived freedom' and 'perceived control': perceived freedom is the recognition that one has alternatives in the physical environment from which to choose, and perceived control is the perception that one's choices determine outcomes. He associated perceived control with a desire for certainty, to be able to predict the outcome of a particular choice accurately. Perceived freedom was associated with a variety of options, and with the possibility of failure accompanying a wrong choice. Barnes concluded that providing choices in the physical environment is generally desirable: experience with perceived freedom will lead to perceived control, in which one can anticipate the likely outcome of a particular choice, making it more likely that one will obtain the desired outcome.

The experiment reported here was designed to test the notion that providing choices in the physical environment leads to improved mood and performance by separating the availability of a choice from the experience of a preferred environmental condition. We hypothesized that one might feel in control because of obtaining conditions that one prefers, without having had the opportunity to choose those conditions. The broad personal control literature provided support for this separation between choice and perceived control.

Averill (1973) defined three types of personal control. *Decisional* control offers the opportunity to choose between courses of action. *Cognitive* control exists in 'the way in which an event is interpreted, appraised, and incorporated into a cognitive set' (Cornelius & Averill, 1980, p. 503). This type of control is closest to what is commonly termed 'perceived control'. *Behavioural* control, according to Averill (1973), exists when a response is available to the individual that might influence a threatening event.

Combining control types to provide more control does not necessarily lead to better outcomes. For example, Mills and Krantz (1979) found that the effects of cognitive and decisional control were not additive in reducing adverse outcomes of blood-donation procedures. Giving both information about a stressful event (cognitive control) and the choice of which arm would be used for the donation (decisional control) was less effective in reducing stress than either type of control given alone.

Cornelius and Averill (1980) studied the effects of different types of control on reactions to electric shock. They found that either behavioural or cognitive control, when given alone, caused an increased skin conductance response to shock; when given together, the skin conductance response to shock was decreased. The effects of one type of control were reversed depending on the availability of another type of control.

Paciuk (1989), in an unpublished doctoral dissertation released after the present study had been designed, investigated control in relation to satisfaction with the thermal environment and thermal comfort. She found support for a path model in which the availability of thermal control (e.g. adjustable thermostats, window blinds) and the perception of control both contributed to thermal satisfaction. However, the exercise of control decreased thermal satisfaction. To use Averill's (1973) terminology, in this study decisional and cognitive control contributed to satisfaction; behavioural control decreased satisfaction.

The present study applied the control concept, as defined by Averill (1973), to office lighting. Lighting designers (e.g. Wotton, 1989) concur with the theorists that providing control to workers will improve their performance and their mood. There have been no experimental tests of this belief; however, 54 per cent of the office workers in a 1979 Louis Harris poll rated control over office lighting as important ('Office lighting', 1980).

For this experiment, participants were given control over the lighting, in the form of choices between pre-set lighting configurations (decisional control). (Providing behavioural control to subjects, in which they could alter the amount, position, or type of lighting, could have led to confounding effects of the intensity of illumination, glare, and spectral composition. These might have obscured any effects of the control manipulation.) The availability of choices about the lighting was separated experimentally from the experience of obtaining a desired alternative to examine the effects of obtaining a preferred alternative without having chosen it.

The design was a 2×2 (Choice×Preference) factorial design. We hypothesized that obtaining one's preference would result in perceiving control (cognitive control, to use Averill's (1973) phrase), and that both choice and preference would lead to improved mood and intellectual task performance. Measures of self-efficacy, motivation, and attention were included to test path analysis models, the discussion of which is beyond the scope of this paper.

Method

Subjects

The subjects were 192 undergraduates from a medium-sized Canadian university, 96 men and 96 women between the ages of 17 and 36. All had normal or corrected-to-normal hearing and vision. Each participant received an honorarium of $8 at the end of the 2-h session. They were tested either singly or in pairs.

Setting

The study was conducted in a 5·18 m×5·18 m windowless room with three desks. The illuminance level on the three desks was 750 lx mean horizontal illuminance, consistent with the Illuminating Engineering Society of North America (IESNA) recommendations for paper-based office work (IESNA, 1987). One of the three workstations was lit using ambient lighting only; that is, the existing overhead fluorescent luminaires provided all the light for this workstation. Another was lit using a combination of ambient lighting and supplemental incandescent task lighting with a 60-watt lamp. The third workstation was lit by ambient lighting and supplemental task lighting with an 11-watt Osram Dulux EL compact fluorescent lamp.

The ambient lighting in the room consisted of cool-white fluorescent lamps (GE F40CW/RS/WM) in recessed troffers with K-12 acrylic lenses. Roscolux gel 97, a neutral grey, was used to reduce the brightness of the ceiling luminaires over the desks with additional task lighting to achieve the target desktop illuminance. Each layer of this gel reduces transmission by 50 per cent. The luminaires over the workstations having supplemental task lighting contained enough layers of gel to maintain equivalent illuminance.

Each subject was free to adopt any comfortable posture at the workstation, provided that the task materials remained on the desk surface and that the position of the task lamps was not altered. Neither during pilot testing nor the experimental sessions did any subject complain about veiling reflections or other factors that might have reduced the visibility of the task materials.

Independent and dependent variables and procedure

The independent variables each had two levels. Choice over workstation lighting was given or denied, and subjects performed the tasks at a workstation with lighting that either was their most-preferred configuration (of three choices, described below), or their least-preferred configuration. The manipulations of these variables occurred as follows.

Subjects completed one section of a three-part demographic questionnaire at each of the three workstations after completing a consent form. Then, they rated their relative preference for each of the three workstation lighting configurations by allocating 10 'preference units' among the three options. The instructions for this rating differed for the choice and no-choice groups: the subjects in the choice group were explicitly told that their ratings would determine the lighting they worked under for the rest of the session, whereas no such explanation was given to no-choice subjects. The preference rating information was used to assign subjects to workstations for the remainder of the experimental session.

The wording of the instruction to change workstations constituted the manipulation of choice. The instruction set in the choice condition was a modification of the original Glass and Singer (1972) instructions for their studies of perceived control over noise. In the present study, the experimenter said:

> I'm going to ask each of you to sit in a particular seat for the rest of the session. If you really want to work under a different lighting set-up, you have the choice of sitting elsewhere. All you need to do is tell me. The choice is yours, but I would prefer that *you* (subject 1) sit at this desk, and that *you* (subject 2) sit at that desk.

The choice was real; any subject who asked to sit elsewhere was permitted to do so. Five subjects exercised that choice. Only data from subjects who did not exercise the choice were included in the subsequent analyses. Replacement subjects were recruited for that condition to maintain the sample size.

No-choice subjects were politely, but firmly, asked to move to the appropriate seat, and no explanation was given. No-choice subjects who were already seated at the appropriate seat were told that they would remain at that workstation for the remainder of the session. The desk assignment was either the subject's preferred (preference-given) or least-preferred (preference-denied) workstation.

In the Hawthorne experiments, subjects' awareness of the lighting manipulation obscured the results (Roethlisberger & Dickson, 1939; Snow, 1927); the lighting preference rating might have had a similar effect in this experiment. Therefore, a fifth group of subjects (no-treatment condition) performed the preference rating task at the end of the session, although they did complete the three-part questionnaire at the three workstations at the beginning of the session. Their seating instructions were to return to their original seat, which had been randomly assigned.

Following the seat assignment, the tasks were administered to all subjects in the following order:

(1) Self-Efficacy Scale (Sherer *et al*., 1982).

(2) A booklet of mixed problems involving logic and creativity. The problems were of the type given to potential members of Mensa (e.g. Fixx, 1972). The creativity problems required the subjects to list novel uses for common objects. Subjects also recorded the time at which they began and completed each question.

(3) An attention test (a measure of incidental learning of fonts and paper colours in the problem booklet; *cf*. Craik & Tulving, 1975).

(4) The Feather persistence task (Feather, 1961), which was used as the motivation measure.

(5) Timed arithmetic and grammar tasks.

(6) The Russell and Mehrabian Three-Factor Mood Scale (Russell & Mehrabian, 1977).

(7) The Survey of Personal Influence in Common Environments (Gifford & Eso, 1988).

After all the dependent variables had been measured, the no-treatment subjects rated their lighting preferences. All subjects completed a post-experimental questionnaire concerning their perceptions of control and beliefs about the purpose of the experiment.

Results

The total sample used for analysis numbered 180 subjects. Data from 12 subjects were excluded: seven because of experimenter error in seat assignment, and five subjects in the choice/preference-denied condition who chose to sit at a workstation other than the one to which they had been assigned. The exclusion of the data from the five subjects who exercised their choice is consistent with Glass and Singer (1972), who excluded from analysis the data from those subjects who chose to terminate the noise.

The analytical model was a modified 2×2 factorial design with four planned comparisons. The expectancy effect contrasted the no-treatment group against the no-choice condition, as a test for subject biases caused by the preference rating procedure. The choice, preference, and Choice×Preference effects were standard main effect and interaction contrasts.

Perceived control

Principal component analysis was performed on the 10 perceived control items. Three interpretable components emerged, collectively explaining 58·4 per cent of the variance (see Appendix). Examination of the component loadings led to the labelling of the components (and the associated subscale scores) as: Lighting Control (3 items, alpha=0·83; e.g. 'I had some control over the lighting in this study'), Environmental Control (3 items, alpha= 0·66; e.g. 'Being able to control my environment makes me feel better'), and Session Control (2 items, alpha=0·61; e.g. 'I had some control over events during this session'). These items are somewhat similar to items in the Rotter Internal–External Locus of Control scale (Rotter, 1966), whose 23 items have reliability estimates of 0·69 to 0·76. Given the small number of items in each, the relatively lower internal consistency estimates for the Environmental Control and Session Control components are not surprising.

Subscale scores were calculated to correspond with these three components by taking the mean of the contributing items. These subscale scores were analysed using the MANOVA model described above. There were significant multivariate effects for the choice (Wilks' lambda=0·68; $F(3,171)=26{\cdot}36$, $p<0{\cdot}001$), preference (Wilks' lambda=0·82; $F(3,171)=12{\cdot}62$, $p<0{\cdot}001$), and expectancy (Wilks' lambda=0·84; $F(3,171)=11{\cdot}06$, $p<0{\cdot}001$) effects. The interaction of Choice×Preference was not statistically significant. In each case, the multivariate effects were associated with significant univariate effects only on the Lighting Control subscale. The univariate effects are summarized in Table 1.

The expectancy effect indicated that subjects who rated their lighting preferences before being assigned to a seat had higher Lighting Control scores than subjects who rated them at the end of the session. The preference effect indicated that subjects given their lighting preference had higher Lighting Control scores than subjects who were not. The choice effect was consistent with the manipulation. Choice subjects reported having had more control over the lighting than no-choice subjects.

Performance and mood analyses

MANOVA and ANOVA tests were conducted on conceptually related groups of variables using the same analytic model as above. Only the statistically significant tests ($p<0{\cdot}05$) are described in detail below.

Cognitive task performance. The scores on the logic problems, the creativity problems, and the arithmetic and grammar tasks were analysed using MANOVA. The results showed a significant multiv-

TABLE 1
Marginal means and standard deviations for significant lighting control effects

Contrast		*M*	S.D.	*n*
Choice	($F(1,173)=76{\cdot}95$, $p<0{\cdot}001$)			
Choice		2·52	1·23	72
No-choice		1·33	1·14	71
Preference	($F(1,173)=34{\cdot}94$, $p<0{\cdot}001$)			
Given		2·45	1·26	71
Denied		1·43	1·19	72
Expectancy	($F(1,173)=32{\cdot}91$, $p<0{\cdot}001$)			
No-choice		1·33	1·13	71
No-treatment		0·81	0·76	36

One subject in the no-choice/preference-given failed to provide control ratings on any of the scale items. Range 0–4; higher scores indicate greater perceived control over the lighting in the session.

TABLE 2
Marginal means and standard deviations for choice effects

Variable	Group	
	Choice	No-choice
Creativity	M=5·39 S.D.=2·40 n=72	M=7·19 S.D.=3·17 n=72
Creativity speed	M=0·76 S.D.=1·51 n=61	M=0·65 S.D.=1·62 n=66

Creativity=total number of novel uses suggested for common objects. Creativity Speed=average time (min) per novel use suggested ({inverse log(10)} of the transformed variable, {log(10Creativity Speed}). Unequal cell sizes for Creativity Speed analysis resulted from missing data. For Creativity, $F(1,175)=12{\cdot}25$, $p<0{\cdot}01$. For {log(10)Creativity Speed}, $F(1,154)=4{\cdot}28$, $p<0{\cdot}05$.

ariate test for the choice effect (Wilks' lambda=0·93, $F(4,172)=3{\cdot}47$, $p<0{\cdot}01$). Examination of the univariate tests revealed a significant effect on the creativity measure ($F(1,175)=12{\cdot}25$, $p<0{\cdot}01$). Choice subjects had lower scores than no-choice subjects (see Table 2).

Performance speed. The speed at which each subject reached a correct response on the brain-teaser puzzles was calculated by taking the average time across the items correctly answered. Faster performance is reflected in a lower score. Two questions in the puzzle booklets required creative thought. The speed measure was the sum of the time spent on both items divided by the total number of novel uses suggested (the creativity score). Log(10) transformations were calculated on these data to normalize the distributions. Subjects who had scores of 0 on either the logic puzzles or the creativity items were dropped from this analysis because there was no logical speed score, leaving n= 159.

MANOVA of the performance speed data showed one significant main effect, for choice (Wilks' lambda=0·96, $F(2,153)=3{\cdot}10$, $p<0{\cdot}05$). The univariate tests revealed a significant difference between the groups in the speed of creativity performance ($F(1,154)=4{\cdot}28$, $p<0{\cdot}05$). The means and standard deviations of the transformed scores are shown in Table 2. The direction of the effect is inconsistent with the hypothesis that choice subjects would work more quickly: choice subjects were slower on the creativity items than no-choice subjects.

Discussion

The results of this experiment challenge the conventional wisdom that providing choices in the physical environment is, in itself, beneficial to people. Those subjects who actually had a choice regarding the lighting reported perceived control over the lighting but performed more poorly and more slowly on the creativity task in comparison to the no-choice subjects.

The subjects who worked under their preferred lighting also perceived that they had controlled the lighting to a greater degree than those who worked under their least-preferred lighting. Even those who had merely rated their lighting preferences at the start of the session perceived greater control over the lighting during the session than subjects who rated their preferences at the end of the session. These effects are demonstrations of cognitive control in which the control was inferred from the ratings procedure and subsequent events during the session. However, neither the preference, expectancy contrasts, nor the Choice×Preference interaction, was associated with improvements in either mood or cognitive task performance. The conditions that lead to cognitive control do not necessarily affect these important outcomes, and can lead to undesirable outcomes, as they did in this study.

The observed detrimental effect of choice (decisional control) on creativity performance, although unexpected, parallels the reversed direction of stress response found by Cornelius and Averill (1980) when different types of control interacted. Paciuk's (1989) finding that decisional control related to dissatisfaction with the thermal environment, whereas cognitive control predicted satisfaction, is also consistent with this finding.

Circumstances under which control does not lead to desirable outcomes are chiefly those in which the subject fears that a poor choice could lead to failure or embarrassment (Burger, 1989). In this experiment, no feedback was provided about whether or not the choice group subjects had made the 'correct' decision about staying at the assigned workstation or moving to another with different lighting. It is possible, although unanticipated, that self-presentation and fear of failure were heightened in the choice group subjects after they had made their lighting choices. If so, this might explain the performance decrements in that group. In practical applications, this finding has implications for the relationships between facilities managers (or employers) and building occupants (or employees). If a choice, even a comparatively minor one, is provided in a context that leads people to fear that these powerful others will judge their decision negatively, then poorer subsequent performance is likely.

We note one unavoidable methodological limitation of this study. Gardner (1978) noted that all participants in research projects using informed consent procedures have a degree of control in that they may end their participation at any time without penalty. In the present experiment, too, all subjects possessed and perceived some control in this sense (the means on the Session Control subscale were approximately at the scale midpoint for all groups). Thus, it proved impossible to create a true no-control condition. This might account for the absence of strong performance or mood effects associated with the preference and expectancy manipulations.

This experiment used a subtle manipulation under carefully created laboratory conditions to attempt to clarify the common phrase 'personal control' as applied to features in physical settings. The setting and sample were not representative of present-day offices, but the experimental design was appropriate for the examination of the psychological process (*cf*. Mook, 1983). The observed effect of this manipulation is small, but nonetheless important. As Prentice and Miller (1992) observed, 'the use of a minimal manipulation serves to demonstrate that even under the most inauspicious circumstances, the independent variable still has an effect' (p. 161). Having found that decisional control reduced performance on a creativity task under these conditions underscores the importance of understanding similar effects in less restrictive conditions.

Environmental psychologists have argued that cognitive control develops from repeated experience with choices (decisional control) in the physical environment, in which one learns how to obtain desired outcomes (e.g. Steele, 1973, 1980; Barnes, 1981). Jutras and Cullen (1983) noted that some of the interactions with the physical environment that lead ultimately to the development of environmental competence can fail, and feelings of weakness and inability will then result. Steele has, however, recommended several means to avert this problem, including user participation in the design process (Steele, 1973).

The design professions have taken up this call (e.g. Kleeman, 1981). For example, Becker (1991) described the employee involvement process used in the design of a new Corporate Development Center for Steelcase Corporation. The building was not yet occupied, but the involvement process had already succeeded in eliciting suggestions that had resulted in substantial savings in construction costs. Becker believed that this process would also succeed in stimulating a new corporate culture based on innovation and creativity.

Nonetheless, it remains unknown whether cognitive control over the physical environment emerges from repeated experiences with decisional control and its consequences. Moreover, there are as yet too few empirical investigations concerning control in the physical environment to state confidently that this cognitive control has the beneficial effects it is said to have. We do not know which features of the physical environment are the ones for which control is desired, nor can we reliably predict which experiences of the physical environment will lead to the development of such control (Becker, 1991).

The poorer and slower creativity performance for the choice condition in this experiment underscores the importance of these empirical questions for employers. It can be costly to support choices in the physical environment (for example, by changing wiring from zonal to individual-workstation switching). Choices that might also lead to productivity losses are doubly costly. Becker (1991) also noted that the time associated with employee involvement is costly to organizations; cost-benefit analyses are necessary to determine whether decisional or cognitive control are beneficial to individuals and organizations.

This study also has important implications for all psychologists interested in personal control. Personal control is taken by some authors to mean the perception of control, whereas others reserve the term personal control to refer to the existence of alternative behaviours between which the individual must choose. In this study, the availability of choice led to a performance decrement as well as to increased perceptions of control; however, obtaining a desired condition had no effect on performance even though it caused an increase in perceived control. The complexity of the personal control concept places a burden of precision upon those who investigate it. Without greater clarity about the language used to discuss it, the precise nature of the effects under discussion will remain elusive.

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Appendix
Component loadings for perceived control questions

Item	Component		
	1	2	3
6. I had some control over the lighting in this study.	−0·811	0·023	0·356
10. The experimenter controlled every aspect of what occurred during the session, including where I sat. (R)	−0·800	0·128	0·049
9. There were choices I could make about the lighting where I worked during the session.	−0·785	0·094	0·483
8. The type of lighting where I work affects my performance.	0·184	0·743	−0·005
2. I work better when I like the physical setting I am in.	0·002	0·708	0·035
7. Being able to control my environment makes me feel better.	0·197	0·682	0·038
1. I had some control over events during the session.	−0·383	0·159	−0·757
5. The experimenter had all the control during the session. (R)	−0·503	0·120	−0·715
3. How well I perform depends entirely on me.	0·024	−0·318	0·128
4. My mood depends on the features of my environment.	0·134	0·386	0·362
Eigenvalues	2·404	1·835	1·596

(R) denotes items that were reverse-coded, so that low scores denote the absence of perceived control.

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