

SPECIAL SECTION

# Relationships between Ambient Sounds and the Accuracy of Pharmacists' Prescription-Filling Performance

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Associations between ambient sounds and accuracy of pharmacists' prescription-filling performance in a pharmacy was studied. Pharmacists were videotaped as they filled prescriptions each workday for 23 days. Each filled prescription was inspected by the investigator. Deviations from the physician's written order were considered errors. Videotape analysis was used to detect unpredictable, predictable, uncontrollable, and controllable sounds. A within-subjects case control study design was employed to determine whether the frequency of ambient sounds was significantly different when prescriptions with errors, compared with those without errors, were filled. Loudness, in terms of equivalent sound levels ( $L_{eq}$ ) for each half hour, was analyzed for a relationship to dispensing error rate. A mean dispensing error rate of 3.23% was found. Unpredictable sounds, controllable sounds, and noise had a significant effect on pharmacists which resulted in a decreased dispensing error rate. These results suggest that the quality of pharmacists' performance is not adversely affected by ambient sound. As equivalent sound levels increased, the error rate increased to a point, then decreased.

## INTRODUCTION

Consumption of accurately filled prescriptions is an important component of patient recovery. However, evidence shows that there may be a problem with the accuracy of prescription filling. Medication dispensing error rates ranging from 2% to 24% have been detected by visual inspection in pharmacies (Allan, 1994; Allan, Barker, Malloy, & Heller, 1995; Buchanan,

Barker, Gibson, Jiang, & Pearson, 1991; Guernsey et al., 1983; Kistner, Keith, Sergeant, & Hokanson, 1994; McGhan, Smith, & Adams, 1983). For example, if 5% of the two billion prescriptions filled in the United States each year are filled in error, 100 million errors occur annually (National Association of Chain Drug Stores, 1994).

A limited number of factors have been associated with medication dispensing errors. These include excessive prescription workload (Allan, 1994; Buchanan, 1989; Guernsey et al., 1983), insufficient illumination level (Buchanan et al.,

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1991), interruptions (Allan, 1994), and distractions (Allan, 1994). A review of the human factors literature was performed to identify additional variables in the work environment that may be related to dispensing errors.

Ambient sound was identified as a variable that has had a significant effect on the accuracy of human performance. A number of reviews of the effects of ambient sound characteristics on performance are available (Cohen & Weinstein, 1981; Gawron, 1982; Glass & Singer, 1973; Glass, Singer, & Pennebaker, 1977; Kjellberg, 1990; Kryter, 1985; Sundstrom, 1986). Three theories propose ways in which noise affects human performance (Cohen & Weinstein, 1981). Noise can focus attention by increasing arousal, but the level of performance depends on the complexity of the task (Broadbent, 1971). Cohen (1978) proposed that performance is affected by the predictability and controllability of the noise. Poulton (1978, 1979) theorized that adverse effects are attributable to distraction that results from the initiation of intermittent noise, which may mask environmental cues and internal speech. Jones and Broadbent (1991) summarized research on the effects of noise on performance. The list that follows is drawn from this work (limited to those stimuli that may be present in a pharmacy):

1. Bursts of noise decrease performance when the participant is (simultaneously) receiving information.
2. Frequent noises are distracting at first but start having an arousal effect after a long duration of exposure (length not specified).
3. The perceived level of controllability over noise affects performance; decreased control is associated with poorer performance.
4. Performance of simple tasks is not affected by continuous noise.
5. Performance of more than one task simultaneously results in diminished performance of one of the tasks in the presence of noise.
6. Intelligible speech and irrelevant speech disrupt performance.

This summary, along with consideration of research by Glass and Singer (1973), suggests that uncontrollable noise and unpredictable noise might be associated with an increased frequency

of dispensing errors. Pharmacists are exposed to uncontrollable and unpredictable noise as they fill prescriptions, including loudspeaker announcements, telephone rings, and conversations. A study of the effect of ambient sound on the accuracy of pharmacists' prescription filling may provide evidence of whether these factors adversely affect pharmacists to the point that they commit errors.

Another characteristic of ambient sound that may affect the quality of performance is loudness. Studies of performance on tasks while exposed to decibel (dBA) levels similar to what might be found in a pharmacy (less than 80 dBA) have conflicting conclusions. Gawron (1982) studied the effects of 55, 70, and 85 dBA noise on the performance of a tracking task with two levels of task complexity. Accuracy improved in a linear manner on both simple and complex tasks as loudness increased. Sust (1989) concluded that accuracy of proofreading (comparable to pharmacists' inspection of prescription label information) decreased when the sound level exceeded 50 dBA. The effect was more pronounced when office workers were under time pressure. (Pharmacists are under pressure from patients and employers to fill prescriptions quickly.)

Weinstein (1974) studied the effects of 70-dBA teletype noise on proofreading accuracy. No difference in performance was found between the noise group and the quiet group. However, only 7 min were spent in the noise conditions, which may limit the applicability to 8-h shifts in pharmacy. If the effect of loudness is to decrease the accuracy of pharmacists' performance, pharmacies could be designed to control decibel levels.

A guideline that may apply to pharmacists' performance has been provided by the Environmental Protection Agency (1978), which identified a 24-h equivalent sound level of 45 dBA as a limit for indoor areas to avoid interference with activities. This is based in part on maintaining speech intelligibility.

The goal of the current study was to determine if certain characteristics of ambient sound are associated with dispensing errors committed by

pharmacists. The characteristics of interest were predictability, unpredictability, controllability, uncontrollability, and loudness.

### Definitions

*Study unit.* The basic study unit was a *filled prescription*, defined as a medication packaged for dispensing to a patient in response to a physician's order. A *prescription set* was defined as all prescriptions filled for the same patient. The construct of a prescription set was invented to permit synchronization of stimuli in the work environment as recorded on videotape with the prescription set being processed at that time. It was possible to determine which ambient sounds affected a group of prescriptions for a particular patient, but not which affected each individual prescription.

*Dependent variable.* A *dispensing error* was defined as one or more deviations from a physician's written medication order (Barker, Kimbrough, & Heller, 1966). The number of deviations from the physician's order per prescription was recorded by the investigator.

Dispensing errors were classified into the following categories (Buchanan, 1989): wrong drug, wrong dosage strength, wrong dosage form (correct drug), wrong prescription label information, and wrong quantity. Wrong prescription label information was defined to include deviations from these label requirements (Fink, Marquardt, & Simonsmeier, 1985): (a) name and address of dispenser (pharmacy); (b) serial number of prescription; (c) date of prescription or date of filling; (d) name of prescribing physician; (e) name of patient, if stated on the prescription; (f) directions for use, as indicated on the prescription; (g) drug name; (h) drug strength (if more than one strength was available); (i) quantity dispensed; and (j) manufacturer or distributor.

The *dispensing error rate* was calculated as a percentage derived from the number of prescriptions containing one or more errors divided by the total number of prescriptions filled.

*Normative variables.* Noise has been defined as

an "auditory stimulus or stimuli bearing no informational relationship to the presence or completion of the immediate task" (Burrows, 1960, p. 163). Noise was operationally defined as a change in loudness bearing no relationship to the task being performed. *Sound* was defined as a change in loudness bearing some informational relationship to the task at hand. Sound was differentiated from noise because the information it could convey might prevent errors.

*Predictable sounds* were defined as a change in loudness that could be anticipated based on previous experience in the pharmacy, or based on the occurrence of the same stimulus just prior to the present stimulus. A predictable sound or noise occurred at known, regular intervals as determined by videotape review.

*Unpredictable sounds* were defined as audible stimuli that occur at unknown, irregular intervals. The first ring of a telephone is unpredictable, but additional rings for the same call are predictable. The mean number of predictable and unpredictable sounds per minute was calculated.

*Controllability* of sound was determined based on its potential for modification (of frequency or volume) within accepted policy and practice. For example, it is possible to turn down the volume on a telephone or answer the telephone promptly to prevent future rings.

*Loudness* was quantified in terms of equivalent sound levels ( $L_{eq}$ ) calculated for each half hour. The  $L_{eq}$  was selected because it is an indicator of time-varying sound that relates to the effects of sound on humans (Environmental Protection Agency, 1978). In order to calculate the  $L_{eq}$  for each half hour, sound levels were continuously recorded in decibels (A scale) by a noise-logging dosimeter (Quest Electronics Noise-Logging Dosimeter, model M28-12) located at a 70° angle above the main prescription-filling area (Peterson, 1980). The mean and maximum decibel levels were recorded every 10 s throughout each study day. The  $L_{eq}$  was calculated for each half hour using the method described by Taylor and Lipscomb (1978) for analyzing decibel levels that change over time.

## METHOD

### *Site and Participants*

The study pharmacy was located at a 451-bed, not-for-profit medical center that provided inpatient and outpatient clinic services. The pharmacy filled an average of 221 prescriptions per day. The typical staffing level was one to two pharmacists and one to two technician assistants per 8-h shift.

Participants were licensed pharmacists assigned to fill and inspect prescriptions in the pharmacy for at least one day during the 23-day study period. Thirteen pharmacists (8 women and 5 men) agreed to participate and provided written informed consent. Each participant underwent a hearing acuity examination following OSHA guidelines (McGuire, 1991). All participants' hearing tests were within normal limits, as was the investigator's. The age range of the participants was 26–51 years ( $M = 34.4$ ,  $SD = 7.8$ ).

Technicians performed some prescription-filling tasks under the supervision of the pharmacist, such as creating a prescription label, obtaining medications, and counting doses. Technicians were excluded from the data analysis because pharmacists provided the final inspection of the prescription.

### *Procedures*

Prescription accuracy data were collected by the principal investigator for 8 h per day on 23 consecutive workdays (Monday through Friday). When the pharmacists finished processing each patient's prescription, the prescriptions were inspected by the investigator. Deviations from the physician's order were considered an error. When an error was detected, it was corrected by the staff pharmacist, who inspected it prior to dispensing the prescription to the patient. The investigator was a registered pharmacist with experience in prescription filling.

The potential influence of the investigator on the pharmacists was a concern. Did the pharmacists improve their accuracy over time partly because they received feedback about errors? Did

the continuous presence of the investigator have any impact? In order to check for an effect of the investigator, each pharmacist's dispensing error rate was plotted over the study period to identify trends. Pharmacists also answered a questionnaire after the study asking them to describe the effect of the investigator's presence on them.

Ambient sound was recorded throughout the study by two video cameras placed in inconspicuous locations. The videotapes were synchronized with the time that each patient's prescription set was being filled in order to determine which sounds affected the pharmacist as he or she worked on a particular set of prescriptions.

### *Study Design*

Because of the time-consuming nature of analyzing the videotapes for audible stimuli, a subset was selected, as described below. A within-subjects case comparison study design was used for the analyses of the associations between sound and errors (Ahlbom & Norell, 1984; Gehlbach, 1982). This design compares specific factors surrounding situations that include the characteristic of interest (an error) with factors surrounding situations that lack the characteristic (no error). The situations under study should be similar (matched) with respect to other factors that may explain the occurrence of an error. For example, the same participant should serve as his or her own control if possible.

In order to compare sound characteristics affecting prescriptions with errors with those affecting prescriptions without errors, a stratified random sample of prescription sets was selected. Thirty-one matched pairs of prescription sets were randomly selected: One set in each pair had one error, and the other set had no errors. The number of prescription sets from which the random selection took place for each pharmacist depended on how many the pharmacist had filled, a number that varied from 1 to 434 sets. The pairs were matched based on the pharmacist who filled the prescriptions and the number of prescriptions in the set (each pharmacist served as his or her own control).

The number of case comparison pairs selected for each pharmacist was based on the percentage of prescriptions the pharmacist filled during the study. The objective was to compare the mean number of sounds per minute affecting each prescription set as detected during videotape analysis to determine whether there was a significant difference in the mean number of sounds. The videotape for the entire prescription set was viewed twice by the principal investigator to verify the accuracy of sound detection. Each sound was categorized as predictable or unpredictable, controllable or uncontrollable, and noise or sound. The investigator was blind to the occurrence of errors while analyzing the videotapes.

*Data Analysis*

A repeated-measures (within-subjects) analysis of variance was used to evaluate the data in the case comparison study. Analysis of covariance was used to determine if loudness had a significant effect on error rates, controlling for pharmacist. The alpha level was preset at .1 because the associations under exploration here were being studied for the first time in a pharmacy setting. The investigators and statistical advisers did not want to rule out the possibility of an effect in this early stage of exploration involving a field setting. Also, the cost of making a Type I (alpha) error would not harm a patient (though it could lead to increased facility expenditures).

**RESULTS**

*Dispensing Errors*

Data were collected for 23 days (184 h) at the study pharmacy. A total of 164 errors were detected for 5072 prescriptions, an error rate of 3.23%. Examples of errors detected during the study include the following: Xanax dispensed instead of Halcion (wrong drug error); Tylenol with codeine elixir was dispensed instead of Tylenol plain elixir (wrong drug error); label instructions read "Take 2 tablets every morning" instead of "Take 2 tablets every other morning"

for a Medrol prescription (wrong label error and label instructions omitted "as needed" on narcotic pain medication (wrong label error).

*Effect of Sound Predictability on Errors*

Pharmacists were exposed to somewhat fewer unpredictable audible stimuli per minute when they made errors, mean = 16.47 unpredictable sounds, than when they did not make errors: mean = 18.01, Wilks' Lambda = .9064,  $F(1, 30) = 3.0979, p < .1$  (see Table 1). Recall that the alpha level was preset at .1 for reasons discussed in the data analysis section. Pharmacists' performance was not affected by the mean number of predictable audible stimuli per minute.

*Effect of Controllability of Sound on Errors*

There was no effect of the mean number of uncontrollable audible stimuli per minute on pharmacists' performance. Pharmacists were exposed to a somewhat higher mean number of controllable audible stimuli (8.13) on sets without errors than on sets with errors (7.07), Wilks' Lambda = .8783,  $F(1, 30) = 4.1557, p < .1$  based on preset alpha = .1. Table 2 lists data for each pharmacist.

*Effects of sound versus noise on errors.* Sound

TABLE 1

Effect of Unpredictable Sounds on Prescriptions Sets with and without Errors

Pharmacist	No. Matched Pairs	Mean No. Unpredictable Sounds per Minute*	
		No Error	Error
1	1	26.79	15.00
3	3	16.36	15.38
4	1	19.22	21.74
5	5	19.92	14.81
6	1	18.46	17.93
7	1	21.95	17.32
8	3	18.50	18.55
9	8	16.34	17.84
10	3	15.43	14.99
11	2	14.82	15.92
12	2	19.58	14.19
15	1	30.00	11.49
Overall mean		18.01	16.47
Standard deviation		3.92	3.78

\* Represents means for prescription sets selected for analysis in each column for each pharmacist.

TABLE 2

Comparison of Controllable Sounds for Prescription Sets with and without Errors

Pharmacist	No. Matched Pairs	Mean No. Controllable Sounds/Minute*	
		No Error	Error
1	1	11.79	5.72
3	3	7.88	6.78
4	1	12.23	10.43
5	5	8.82	7.03
6	1	9.65	8.28
7	1	8.78	6.80
8	3	10.31	7.36
9	8	6.08	6.83
10	3	10.59	7.70
11	2	5.19	4.68
12	2	9.07	5.03
15	1	8.28	14.04
Overall mean		8.13	7.07
Standard deviation		2.91	2.48

\* Represents means for prescription sets selected for analysis in each column for each pharmacist.

was compared with noise as an indicator of the relevance of the stimulus to errors. Noise was expected to have an adverse effect on performance, increasing errors. This study found that noise had a significant effect, but it was related to fewer errors, *Wilks' Lambda* = .89,  $F(1, 30) = 3.62$ ,  $p < .1$ . (Alpha level was preset at .1; see the data analysis section.)

Table 3 lists the results for each pharmacist. Sounds were not associated with dispensing errors, as had been predicted.

#### Loudness and Error Rate

A total of 352 half-hour periods (22 days) were included in the analysis of the effect of loudness levels on dispensing error rates. Decibel data for Day 21 were accidentally erased because of battery drainage. The equivalent sound level ( $L_{eq}$ ) for each half hour ranged from 58 dBA to 70 dBA, with a mean of 64.8 dBA and standard deviation of 1.40. The mean value represents the arithmetic mean; it is not the  $L_{eq}$  for the entire study period. The logarithmic nature of decibel levels would require a different calculation to determine the overall  $L_{eq}$  (Environmental Protection Agency, 1978).

The effect of loudness for each half hour on the

dispensing error rate approached significance when controlling for pharmacist,  $F(1, 13) = 2.70$ ,  $p = .101$ , based on a preset alpha of .1. The error rate per half hour per pharmacist was used as the dependent variable in order to control for the effects of prescription workload on pharmacists' performance (Allan, 1994).

Figure 1 depicts a negative trend for the relationship between equivalent sound level and dispensing error rates, but the data suggest that error rates increase to a certain sound level and then decrease. The  $R^2$  was .0087, and the slope was  $-.4334$ .

The range for the maximum  $L_{eq}$  per half hour was 68.5 to 82.0 dBA, with a mean of 74.0. The maximum  $L_{eq}$  per half hour had a significant effect on the dispensing error rate,  $F(1, 13) = 4.59$ ,  $p = .03$ . The estimated omega squared for the relationship between maximum  $L_{eq}$  per half hour and error rate was .029 (see Keppel, 1982, pp. 90-92). As the maximum  $L_{eq}$ /half hour increased, the dispensing error rate increased (see Figure 2), but only to a point, when it started decreasing. The overall trend was that as the maximum  $L_{eq}$  per half hour increased, the dispensing error rate decreased,  $R^2 = .0209$ ; slope =  $-.5678$ .

TABLE 3

Comparison of Sound and Noise for Prescription Sets with and without Errors

Pharmacist	Mean No. Noises per Minute*		Mean No. Sounds per Minute*	
	No Error	Error	No Error	Error
1	27.86	15.19	2.14	1.87
3	17.53	17.12	2.44	1.56
4	19.22	22.61	5.24	4.35
5	21.55	15.83	4.00	3.66
6	19.72	20.00	5.45	3.45
7	20.49	20.41	1.46	2.47
8	20.52	20.67	3.65	4.15
9	19.16	18.60	2.39	2.92
10	16.50	16.37	6.57	4.16
11	16.42	18.97	1.04	1.46
12	21.69	14.93	4.77	3.06
15	31.03	12.77	1.03	7.66
Mean	19.74	17.84	3.43	3.33
Standard deviation	4.40	4.18	2.07	1.75

\* Represents means for prescription sets selected for analysis in each column for each pharmacist.

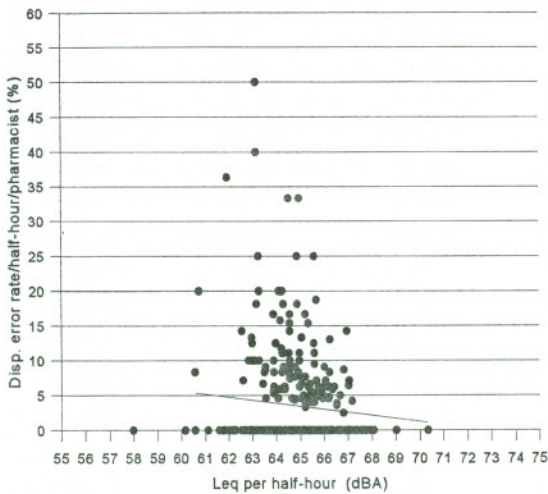


Figure 1. Relationship between equivalent sound level ( $L_{eq}$ ) and dispensing error rate, by half hour and by pharmacist. (Straight line indicates regression fit.)

#### Effect of the Investigator

Error rates were plotted against time to look for evidence of decreasing error rates, which might have been caused by feedback about errors. Of the 13 pharmacists, 3 were found to have decreasing error rates over time: Pharmacist 5 ( $r = -.1371$ ), Pharmacist 9 ( $r = -.0844$ ), and Pharmacist 15 ( $r = -.2903$ ). Pharmacists 9 and 5 filled 41% of the prescriptions in the study. The results of the questionnaire identified three pharmacists who said they were more careful during the study, including Pharmacist 9.

#### DISCUSSION

Contradicting some research findings to date, unpredictable audible stimuli and controllable audible stimuli were statistically associated with fewer errors (improved performance). This contradiction is not surprising; the effect of noise on performance is difficult to interpret. This has been pointed out by Gawron (1982), who found 7 of 58 studies in which noise improved performance, whereas in 29 studies it diminished performance.

The present study is different from the majority of noise studies because it is a field study. One explanation of the difference may be that

unpredictable audible stimuli and controllable audible stimuli have an arousal effect. Arousal can increase concentration in a way that improves performance, as has been found in work by Yerkes and Dodson (1908) and Hockey (1970). Yerkes and Dodson found that performance increased as environmental stimuli increased in intensity for simple tasks, but only to a point for complex tasks. Perhaps the frequency of audible stimuli did not reach a point at which performance diminished in the study pharmacy, or perhaps prescription-filling tasks may be classified as simple.

Controllable stimuli may have been associated with fewer errors because of a perception by the workers that these stimuli were not annoying based on their potential to be controlled. The implication of these results is that more audible stimuli should be added to the environment to decrease errors. If resources are available, one recommendation is to study the sources of *uncontrollable* audible stimuli that may be converted to controllable stimuli, potentially reducing the error rate. For example, candidates for modification or elimination in the study pharmacy include the doorbell, buzzer, cash register, typewriter, loudspeaker, and waiting room conversations.

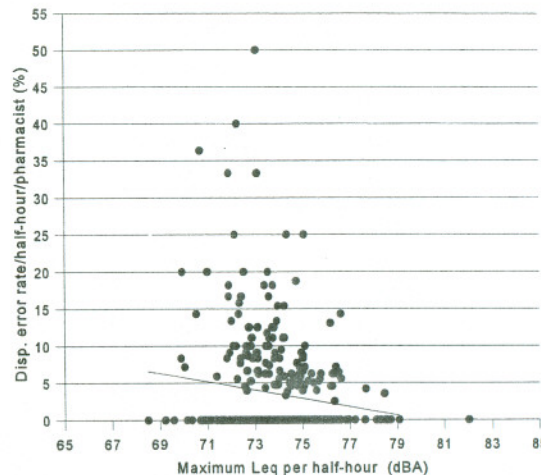


Figure 2. Relationship between maximum equivalent sound level ( $L_{eq}$ ) and dispensing error rates, by half hour. (Straight line indicates regression fit.)

The absence of an effect of uncontrollable noise on the accuracy of pharmacists' performance may be explained by a coping mechanism described by Topf (1989) as a noise-induced stress resistance mechanism. Critical care unit nurses who reported less sensitivity to noise and who had a greater ability to concentrate on their tasks may have had a stress-resistance resource that made them less vulnerable to stress (Topf, 1989).

Although the overall trend was for error rates to decrease under increasing loudness levels, some pharmacists were able to maintain perfect accuracy across a broad range of equivalent sound levels (see Figures 1 and 2), supporting research by Gawron (1982) but contradicting evidence that loud sounds have a masking effect. The loudness levels reported here can be used in a laboratory experiment, exposing pharmacists to continuous white noise as they fill prescriptions, to analyze accuracy and to clarify the relationship between loudness and error rates.

The investigator did not appear to have an important impact on pharmacists' error rate. Pharmacists continued to commit errors throughout the study despite their knowledge that an error study was in progress. If the investigator made some study participants work more carefully, we interpreted it to mean that the investigator measured the pharmacists at what they thought was their best performance. Errors detected would therefore be more likely the result of the environment or of some other factor than of the ability of the pharmacists to be more careful.

### CONCLUSION

The quality of pharmacists' performance while filling and dispensing prescriptions is not impaired by ambient sound, based on this case study. This is important because the general perception in pharmacy, and other health professions, is that noise hurts performance. Resources can be redeployed to other factors that have been found to decrease the accuracy of performance, such as insufficient lighting levels (Buchanan et al., 1991), in pursuit of quality.

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### REFERENCES

- Ahlbom, A., & Norell, S. (1984). *Introduction to modern epidemiology* (pp. 48-56). Chestnut Hill, MA: Epidemiology Resources.
- Allan, E. L. (1994). *Relationships among facility design variables and medication errors in a pharmacy*. Doctoral dissertation, Auburn University, Alabama. (University Microfilms No. 94-30107)
- Allan, E. L., Barker, K. N., Malloy, M. J., & Heller, W. M. (1995). Dispensing errors and counseling in community practice. *American Pharmacy*, *NS35*, 25-33.
- Barker, K. N., Kimbrough, W. W., & Heller, W. M. (1966). *A study of medication errors in a hospital*. Fayetteville: University of Arkansas.
- Broadbent, D. E. (1971). *Decision and stress*. New York: Academic.
- Buchanan, T. L. (1989). *On the effect of varying levels of illumination on the prescription dispensing error rate in an Army high-volume outpatient pharmacy service*. Unpublished master's thesis, Auburn University, Auburn, Alabama.
- Buchanan, T. L., Barker, K. N., Gibson, J. T., Jiang, B. C., & Pearson, R. E. (1991). Illumination and errors in dispensing. *American Journal of Hospital Pharmacy*, *48*, 2137-2145.
- Burrows, A. A. (1960). Acoustic noise: An informational definition. *Human Factors*, *2*, 163-168.
- Cohen, S. (1978). Environmental load and the allocation of attention. In A. Baum, J. E. Singer, & S. Valins (Eds.), *Advances in environmental psychology, Vol 1*. Hillsdale, NJ: Erlbaum.
- Cohen, S., & Weinstein, N. (1981). Nonauditory effects of noise on behavior and health. *Journal of Social Issues*, *37*, 36-70.
- Environmental Protection Agency. (1978). *Protective noise levels: Condensed version of EPA levels document* (EPA 550/9-79-100). Washington, DC: U.S. Government Printing Office.
- Fink, J., Marquardt, K. W., & Simonsmeier, L. M. (Eds.). (1985). *Pharmacy law digest* (pp. DC-15-DC-16). St. Louis: Lippincott.
- Gawron, V. J. (1982). Performance effects of noise intensity, psychological set, and task type and complexity. *Human Factors*, *24*, 225-243.
- Gehlbach, S. H. (1982). *Interpreting the medical literature: A clinician's guide*. Lexington, MA: D. C. Heath.
- Glass, D. C., & Singer, J. E. (1973). Experimental studies of uncontrollable and unpredictable noise. *Representative Research in Social Psychology*, *4*, 165-183.
- Glass, D. C., Singer, J. E., & Pennebaker, J. W. (1977). Behavioral and physiological effects of uncontrollable environmental events. In D. Stokols (Ed.), *Perspectives on environment and behavior: Theory, research, and applications* (pp. 131-151). New York: Plenum.
- Guernsey, B. G., Ingram, N. B., Hokanson, J. A., Dautre, W. H., Bryant, S. G., Blair, C. W., & Galvan, E. (1983). Pharmacists' dispensing accuracy in a high-volume outpatient