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# Methodology for Evaluating and Reducing Medication Administration Errors

Amanda Carrie Boone

# METHODOLOGY FOR EVALUATING AND REDUCING MEDICATION ADMINISTRATION ERRORS

By

Amanda Carrie Boone

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MEDICATION ADMINISTRATION ERRORS

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Amanda Carrie Boone

Approved:

| | |
|---|---|
| Vincent G. Duffy<br>Associate Professor of Industrial Engineering<br>(Director of Thesis) | Stanley F. Bullington<br>Graduate Coordinator of the Department of Industrial Engineering |
| Allen G. Greenwood<br>Associate Professor of Industrial Engineering<br>(Committee Member) | A. Wayne Bennett<br>Dean of the College of Engineering |
| Mingzhou Jin<br>Assistant Professor of Industrial Engineering<br>(Committee Member) | |

Name: Amanda Carrie Boone

Date of Degree: August 2, 2003

Institution: Mississippi State University

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Major Professor: Dr. Vincent G. Duffy

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Candidate for Degree of Master of Science

Caregivers of elderly people may make errors in administering medicine. This study aims to determine a more effective method of presenting prescription instructions to caregivers and to determine if the multiple resource hypothesis holds in the context of prescription instructions by evaluating the effect a voice prescription label (that gives audio instructions) has on comprehension and memory of a drug regimen under varying training level, task complexity, and instruction format. In performing a multivariate analyses of variance on data collected among formal and informal caregivers, training level, task complexity, sound condition, and instruction format were found to significantly affect caregivers' memory and comprehension. There is evidence that audio instructions and the matrix format reduce errors. These results could lead to the development of a Medication Scheduling Management System that would organize medicines according to administration time and incorporate decision rules to determine what to do if a dose is missed.

DEDICATION

I want to dedicate this research to my granddaddy, Mr. Teddy M. LaMunyon.

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I would like to say a special thank you to my thesis director, Dr. Vincent Duffy for his guidance throughout my pursuit of a master's degree. Thanks are also due to my committee members, Dr. Allen Greenwood and Dr. Mingzhou Jin for their patience and willingness to provide suggestions for improvement. Also, I express my appreciation to Mr. Bobby Gann, Director of the Golden Triangle's Area Agency on Aging for recruiting informal caregivers to participate in this research. Thank you to all of the informal and formal caregivers who were willing to take part in this research.

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Thanks and praise be to God for carrying me through, as always!

"Whatever you do, work at it with all your heart, as working for the Lord, not for men."

Colossians 3:23

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# CHAPTER I

# INTRODUCTION

## 1.1. Increasing Elderly

The number of elderly people in the United States is increasing, and the aged population, as a whole, is getting older. According to the 2000 U.S. Census, people age 65 and older comprised 12.4% of the population (U. S. Census Bureau, Population Division, 2000). Projections suggest that by 2025, people age 65 and older will make up 18.5% of the U.S. population (U.S. Census Bureau, Population Projections Program, Projections Division, 2000).

## 1.2. Medication Use

People age 65 and older are estimated to consume 30% of all prescription drugs and to purchase 40% of all over-the-counter medications. Over 60% of adults age 65 and older use one or more medications daily. Approximately 25% of this group takes three medicines per day (Council on Family Health, 2002). A person age 65 and older takes 4 or 5 prescriptions on average and has up to 17 prescriptions filled per year (Drake & Romano, Jun. 1995). According to the U.S. Chamber of Commerce, about half of all filled prescriptions are taken incorrectly (Statistics, 2003).

1.3. Caregivers

Many senior citizens require assistance from a caregiver in carrying out instrumental activities of daily living, such as taking medicine. The Family Caregiver Alliance defines a caregiver as "anyone who provides assistance to someone else who is in some degree incapacitated and needs help." Caregivers are classified as formal (i.e., associated with a service system) or informal, (i.e., a family member or friend of the care recipient). An informal caregiver may or may not live with the care recipient (Family Caregiver Alliance, Oct. 2001).

1.4. Medication Errors

The National Coordinating Council for Medication Error Reporting and Prevention (2002) defines a medication error as "any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the health care professional, patient, or consumer." Errors may occur in the hospital, physician's office, nursing home, pharmacy, urgent care center, or while care is delivered in the home (Agency for Healthcare Research and Quality, Feb. 2000). Errors may occur in the process of prescribing, labeling, packaging, dispensing, administering, monitoring, and using the medication (American Society of Consultant Pharmacists, 1998). An estimated 38% of errors that occur in the medication use process occur during medication administration and only 2% are caught before they actually happen (Yang, Brown, Trohimovich, Dana, & Kelly, Apr. 2001).

There are a variety of administration errors that can occur which include: omission errors, unauthorized drug errors, wrong dose errors, wrong route errors, wrong dosage form errors, wrong time errors, and deteriorated drug errors (American Society of Consultant Pharmacists, 1998). This research aims to address omission errors, wrong dose errors, and wrong time errors. Omission errors are defined as "the failure to administer an ordered dose by the time the next dose is due" (American Society of Consultant Pharmacists, 1998). Wrong dose errors are defined as occurring when the patient "receives an amount of medication that is greater than or less than the amount ordered by the prescriber" (American Society of Consultant Pharmacists, 1998). Wrong time errors are defined as the "failure to administer a medication within a predefined interval from its scheduled administration time" (American Society of Consultant Pharmacists, 1998). The likelihood that medication administration errors will occur in a formal caregiving setting increases when a patient is prescribed 6 or more medications. Furthermore, the potential for errors increases as the number of times per day each medication is to be given increases (Cooper, 1994).

This research aims to address administration errors, including omission errors wrong dose errors, and wrong time errors that occur while care is delivered in a hospital, nursing home (including personal care homes and assisted living facilities), or patient's home by a caregiver. This research is concerned with errors committed by formal and informal caregivers and excludes errors committed by other health professionals. Figure 1.1 diagrams where medication errors occur and what types of administration errors occur. The items underlined are the focus of this research.

**Medication error**: a preventable event that may cause or lead to inappropriate medication use or patient harm when the medication is in the hands of the health care professional, patient, or consumer (National Coordinating Council for Error Reporting and Prevention, 2002)

**Where do errors occur?**

- Hospital*
- Physician's office
- Nursing home
- Pharmacy
- Urgent care center
- Care delivered in home

(Agency for Healthcare Research and Quality, Feb. 2000)

**Errors can occur in:**

- Prescribing
- Order communication
- Product labeling
- Packaging
- Dispensing
- Administration
- Education
- Monitoring
- Use

(American Society of Consultant Pharmacists, 1998)

**Types of administration errors:**

- Omission error
- Unauthorized drug error
- Wrong dose error
- Wrong route error
- Wrong rate error
- Wrong dosage form error
- Wrong time error
- Wrong drug preparation error
- Wrong administration technique error
- Deteriorated drug error

(American Society of Consultant Pharmacists, 1998)

* The items underlined are the focus of this research.

Figure 1.1. Diagram of Medication Errors

## 1.5. Formal Caregivers and Errors

Approximately 28% of community-dwelling older people who need long-term care receive help from both informal and formal caregivers. Eight percent receive care solely from formal caregivers. An estimated 1.7 million Americans age 65 and older receive formal home health care (Family Caregiver Alliance, Sept. 2001).

Home health care providers (formal caregivers) may come into the home on a daily, weekly, or even monthly basis. Formal caregivers who come into the home of the care recipient on a daily basis may administer medicine, that is, remove individual doses of medicine from labeled containers, give the dose to the care recipient, and record the time the dose was given. Formal caregivers may also assist with self-administration, that is, open medicine containers for the care recipient, remind the care recipient of the correct time to take the medicine, and remove the medicine from its container (Medication Administration, n.d.). Formal caregivers who come to the care recipients' houses on a less frequent basis may set up the medicine in an organizer or teach the informal caregiver or care recipient how to set up the medicine in an organizer (D. Compston, personal communication, December 3, 2002). If the care recipient does not take the medication in the way that the formal caregiver has set up in a medication organizer (if the organizer has been loaded correctly), the caregiver is not considered responsible for the error.

Medication administration errors are a problem among organizations providing health services. The Associated Press reported that in a study of 36 hospitals and nursing homes in Colorado and Georgia, researchers found that over 40 potentially harmful drug errors, which included overdoses and failure to follow prescription directions, occurred per day. Errors were estimated to be one out of five doses in a hospital with a 300-bed capacity. That study pointed to medication administration errors committed by nurses or other staff after the doctor has correctly prescribed the drug. The most common mistakes included giving the medication at the wrong time or completely omitting a dose (Associated Press, September 9, 2002).

Of the 265 reports of medication errors received by the Food and Drug Administration from hospitals, nursing homes, adult day care services, and home health services in May 2001, the majority (42%) of the causes were attributed to human factors. Human factors errors included knowledge deficits and performance deficits (Thomas, Holquist, & Phillips, Oct. 2001).

1.6. Informal Caregivers and Errors

Approximately 64% of community-dwelling older people who need long-term care depend on informal caregivers (Family Caregiver Alliance, Sept. 2001). The number of family members, friends, and neighbors that serve as informal caregivers for people age 65 and over ranges between 5.8 and 7 million (Family Caregiver Alliance, Oct. 2001). A caregiver may provide assistance with instrumental activities of daily living such as housework, laundry, shopping, and taking medicine or with activities of daily living such as feeding, bathing, and dressing (Kaiser Family Foundation, Harvard School of Public Health, United Hospital Fund of New York, & Visiting Nurse Service of New York, Jun. 2002). Of these caregivers, 40% help administer medications and almost 20% administer five or more medications, while 12% administer over ten medications (Donelan, Hill, Hoffman, Scoles, Feldman, Levine *et al.*, 2002).

Informal caregivers may set up medication in an organizer or assist with self-administration. If the care recipient does not take the medication in the way that the informal caregiver has set up in a medication organizer (if the organizer has been loaded correctly), the caregiver is not considered responsible for the error.

According to Van Cott (1994), medication administration errors in home health care settings are "at least as likely to occur" as administration errors in hospitals. Donelan, Hill, Hoffman, Scoles, Feldman, Levine, *et al*. (2002) point out that "of particular concern is the degree of activity that is apparently unaccompanied by formal training or instruction." Many informal caregivers have never received any training in administering medication. According to a June 2002 survey of long-term caregivers, 18% of caregivers who help give medicines reported that they received no special instructions about how to give the medicine (Kaiser Family Foundation, Harvard School of Public Health, United Hospital Fund of New York, & Visiting Nurse Service of New York, Jun. 2002). According to the 1998 national survey of informal caregivers titled, *Long Term Care from the Caregiver's Perspective*, almost one in eight caregivers reported that they were aware of a mistake they had made in administering medication (Donelan, Hill, Hoffman, Scoles, Felman, Levine, *et al*., 2002).

In a study by Travis, Bethea, and Winn (2000), twenty-three family caregivers were interviewed and asked to share their experiences of being responsible for the medication regimens of elderly care recipients. The study revealed problems encountered by family caregivers in managing complex drug regimens, which ranged from 1 to 14 drugs per day. Of the 122 medication administration hassles that were recorded, 29.5% involved scheduling logistics. Problems with scheduling logistics included giving medications on time, scheduling multiple medications throughout the day, and working administration schedules into care routines. Of the caregivers interviewed, 32% reported problems with administration procedures, which included knowing how to make up for missed doses. Problems in areas such as scheduling logistics and administration procedures could lead to medication errors. The authors stated that their analysis illuminates medication administration hassles that have not been the focus of family caregiving literature. (Travis, Bethea, & Winn, 2000).

Some informal caregivers belong to community organizations that are responsible for pairing the caregiver with the recipient. These community service organizations may form support groups to allow caregivers to share their experiences with one another. Informal caregivers may receive only unofficial training in how to administer medications and how to deal with stress.

# CHAPTER II

# OBJECTIVES, HYPOTHESES, & MATERIALS

## 2.1. Problem Statement

Care recipients' health can be negatively impacted when medication regimens are not followed. Almost 90% of medication nonadherence is due to elders taking less medication than instructed. Omission errors may be due to forgetting to take the medicine or not understanding how much medicine should be taken (Cooper, Love, & Raffoul, 1982).

Penalties of nonadherence include the wasting of medication doses and the inefficient use of hospital beds due to patients being readmitted because of over or under medication (Lundin, Eros, Melloh, & Sands, 1980). On the other hand, the benefits of adhering to a medication regimen include enhanced patient treatment because physicians can prescribe more complicated regimens that will further improve the patient.

According to Travis, Bethea, and Winn (2000), administering medicine and managing medication regimens can contribute to increased stress levels among caregivers. The caregivers' stress level would be reduced when the drug regimen is followed because the number of decisions to be made about how to make up for missed doses is reduced (Szeto & Giles, 1997). In order for adherence to occur, caregivers must be able to understand (*comprehension*) the drug regimen and be able to remember (*memory*) when the medications should be given (Morrell, Park, & Poon, 1989).

## 2.2. Objectives

The objectives are to:

- Determine a more effective method of providing prescription information to formal and informal caregivers of elderly care recipients.
- Reduce errors in administering prescription drug regimens.
- Determine if the multiple resource hypothesis holds in the context of prescription drug instructions by evaluating the effect that a voice prescription label has on memory and comprehension of prescription drug instructions under varying task condition, training level, and instruction format.

## 2.3. Hypotheses

1. Sound condition, instruction format, task condition, and training level are expected to significantly affect the dependent variables.
2. The multiple resource hypothesis will hold true. The additional information-processing channel is expected to improve recall and comprehension of the prescription instructions (Navon & Gopher, 1979).
3. As task condition changes from 3 pill-types to 8 pill-types and as training level decreases, it is expected that memory and comprehension will decline.
4. The matrix format will be superior to the list format (Day, 1988).

### *2.3.1. Multiple Resource Hypothesis*

Past research has shown that when information is presented simultaneously in two sensory channels, it is more easily recalled (Lewandowski & Kobus, 1993). The multiple resource hypothesis states that maximum sensory encoding takes places when information is presented in more than one information-processing channel, as opposed to a single information-processing channel (Navon & Gopher, 1979). Kobus, Moses, and Bloom (1994) conducted a study to examine how the mode, or format, of a stimulus affected recall in a classroom environment. Participants included 289 undergraduates who were randomly assigned to the following groups: 1. printed word, 2. spoken word, 3. picture, 4. printed word and spoken word, 5. picture and spoken word, 6. picture and printed word, 7. printed word, picture, and spoken word. Each group was presented thirty items at 5-second intervals and then asked to recall in writing as many items as they could within 5 minutes. Performance was optimal among students who received printed word, picture, and spoken word (group 7).

Moreno and Mayer (2002) studied whether students learned material more deeply when the explanations were presented to them in both visual and auditory modalities versus a single modality. They found that students remembered significantly more when the verbal material was redundant than when it was not. Results showed that students better comprehended the words presented both auditorily and visually. These findings are consistent with prior verbal redundancy effects on memory and comprehension that state that words presented in both visual and auditory modalities enhance learning as compared to words presented in only one modality. Verbal redundancy is defined as the simultaneous presentation of written words and narration of identical words (Moreno & Mayer, 2002).

Campbell, Rogers, and Fisk (2000) did a study to determine the impact that adding video information to pre-existing audio information had on the ability of young and old adults to load a medication organizer. Dependent variables included time to load the organizer, the accuracy of loading the organizer, and memory of the medication regimen. Subjects also rated mental workload using the NASA Task Load Index (TLX).

The NASA TLX determines a total workload score from six subscales including mental demand, physical demand, temporal demand, performance, effort, and frustration level. It was found, through univariate analysis of variance, that the additional video channel did not significantly affect accuracy of loading the pill organizer, the time needed to load the pill organizer, or memory of the regimen. However, the trend was for people in the video group to have better memory of the special instructions that accompanied the medicine. People with the additional video channel rated mental workload significantly lower than those in the audio group. The additional video channel appeared to be beneficial for workload and memory of special instructions, but not for task performance.

*2.3.2. Training Level*

Hagen and Mays (1981) define human error as “a failure on the part of the human to perform a prescribed act within specified limits of accuracy, sequence, or time, which could result in disruption of scheduled operations.” The complexity of a task can overload human memory, leading to performance decrements (Park & Jones, 1997). Error is reduced when people are provided training to acquire skill (Hagen & Mays, 1981). It is expected that formal caregivers make less errors than informal caregivers because formal caregivers have received training in administering medications. Formal caregivers are likely have completed more years of education than informal caregivers.

*2.3.3. Instruction Format (List or Matrix)*

A study by Ruth Day (1988) compared two representations of a drug regimen: a physician’s list format and a matrix format. The list format was a representation of medication instructions typically given to patients by their physicians as the patient was discharged from the hospital. This list gives the drug names in a column down the left side and across from each drug name, it gives the number of pills to take and when to take them. The matrix format lists the drug names in association with daily events, including breakfast, lunch, dinner, and bedtime. The matrix format is designed to make it easier to determine when to take the pills and to make it easier to know what pills should be taken at the same time during the day.

Day (1988) presented participants with either a list or matrix format of instructions for 6 prescriptions. Each participant viewed the medications in the same order either in the list or the matrix format. Participants were given 20 seconds per drug to study the instructions. Then, the experimenter asked the subjects 7 factual questions and 5 inferential questions about the list or matrix format of instructions that they studied. The factual questions were taken directly from information presented in the list or matrix format. The inferential questions created scenarios and were not explicitly taken from the list or matrix format. The subjects were divided into two conditions: one group did not have the list or matrix in front of them as they answered the questions (assessment of memory) and the other group did have the list or matrix in view as they answered the questions (assessment of comprehension). The questions were read aloud and subjects were given 10 seconds to write down their answers to each of the 12 questions. Therefore, even in the comprehension assessment, there may be some memory aspects to consider due to time limitations. In scoring, the group that did not have the list or matrix in front of them did not get credit deducted for spelling errors when the answers were identifiable and differentiable from other medication names. Credit was deducted when the answer was a combination of medication names.

Day (1988) concluded that when a set of information has two factors (e.g., medication names and times) the matrix format was a more effective representation of the drug regimen than the physician's list. The matrix format was found to improve memory and comprehension of the drug regimen. The matrix may be superior because it unites drug information like the name of the drug and number of pills to take, with an event during the day such as breakfast, lunch, dinner, or bedtime (Day, 1988).

However, Day's (1988) study did not address variety in training level or task condition. Neither a pill-loading task nor audio instructions were involved. Day's study was conducted using young individuals. Hence, it is not clear if the findings will transfer to this present study. While the caregivers involved in the present research give care to individuals age 65 and older, the caregivers themselves may be any age. According to the Family Caregiver Alliance (Oct. 2001), the average age of family caregivers is 46.

## 2.4. Materials

The materials used in this study consisted of eight prescription drugs, standard medicine bottles, voice prescription labels (VPLs), and 28-compartment pill organizers.

### *2.4.1. Prescription Drugs*

A listing of the top 50 drugs (as counted by number of prescriptions) used by people age 65 and older was complied by the Pharmaceutical Research in Management Economics (PRIME) Institute, University of Minnesota from data published by the

Pennsylvania Pharmaceutical Assistance Contract for the Elderly (McClosekey, Jun. 2002). The same drugs but with varying milligram dosages (strengths) were listed independently. No two medications with the same name but different strengths were chosen for this study. Injectables and inhalers were eliminated from the selection. Medications taken by women only or men only were also eliminated. Medications were selected based on how many times per day they were to be taken so that there was a variety of complexity.

The following eight drugs were chosen: Pepcid, Cozaar, Detrol, Lanoxin, Zocor, Vioxx, Paxil, and Glucophage. Larry M. Boone, Registered Pharmacist at Boone's Pharmacy in Poplarville, Mississippi was consulted to determine if there were any interactions among the eight drugs selected. Dr. Robert Collins of the Mississippi State University John C. Longest Student Health Center also reviewed the eight selected drugs for possible dangerous combinations. No dangerous interactions exist among the selected drugs.

The number of pills of each drug needed was determined by multiplying the number of times per day the drug is to be taken by 7 (for 7 days in the week). In order to allow for extra pills so that possible errors could be made in the pill-loading task, each pill quantity was increased by 50%. Fractions were rounded to the nearest whole number (rounded up if greater than or equal to 0.5, rounded down if less than 0.5). The number of pills of each drug needed is shown in Table 2.1. After the completion of this project, all of the pills were returned to Boone's Pharmacy for proper disposal.

Table 2.1. Number of Pills of each Drug

| Drug | Quantity |
|---|---|
| Lanoxin 0.125mg | 11 |
| Zocor 20mg | 11 |
| Vioxx 25mg | 21 |
| Paxil 20mg | 11 |
| Glucophage 500mg | 32 |
| Pepcid 20mg | 21 |
| Cozaar 50mg | 21 |
| Detrol 2mg | 21 |

### *2.4.2. Standard Medicine Bottle*

The standard medicine bottles were 9-dram and amber in color. The label was 2 inches high and 3 inches long and wrapped around the bottle. The label included the patient's name, prescription number, name of drug, directions for use, special instructions, physician's name, date issued, number of refills remaining, and the pharmacy's name, address, and phone number, and the pharmacist's initials. The instructions on the label were given in the same order for each bottle. The bottles were filled with actual prescription drugs. Participants viewed the bottles exactly as they were received from the pharmacy. No alterations were made to the instructions listed on the bottle.

### *2.4.3. Voice Prescription Label (VPL)*

The voice prescription label (VPL) is an electronic device that provides an audio representation of prescription instructions. It was developed to aid in the self-administration of prescription medications for people who are visually impaired. Since the VPL is a new technology, it has not been involved in many studies. The studies that have been performed draw participants from the visually impaired population. Engelhardt, Allnatt, Mariano, and Gao (Nov. 2001) evaluated the VPL's functionality and acceptability among 25 visually impaired veterans. For that study, a pharmacist recorded each prescription's instructions on the VPL and trained the participants in how to use the VPL. The participants used the device at home for one week. If any problems occurred, the participant or his/her caregiver was told to call the pharmacist. At the end of one week, the participants returned the VPL to the pharmacist and completed a 10-item questionnaire. The items on the questionnaire concerned the difficulty locating or hearing the VPL or understanding information presented by the VPL. Participants rated each question using a Likert-type scale that ranged from 1 (strongly disagree) to 5 (strongly agree). The participants were asked to compare the VPL to their other methods of using prescriptions labels and were given an opportunity to offer suggestions for improving the VPL.

Results of the study showed that 88% of participants understood the VPL's operating instructions. While 80% of the participants stated that they preferred the VPL to their previous methods of using prescription labels, the study determined that the VPL's voice clarity needed improvement. Participants suggested that the VPL should also remind them of the purpose for which the medication was taken. The authors point out that the study did not address using the VPL for a person's complete medication regimen (Engelhardt, Allnatt, Mariano, & Gao, Nov. 2001).

A VPL called ALOUD is commercially available, but was not used to deliver the audio instructions for this study to save time in switching between audio labels. Instead, a tape recorder was used. The ALOUD consists of a recorder/playback unit and audio labels, which hold up to 60 seconds of information. Only one recorder/playback unit is needed, but one audio label per medication is needed. The experimenter demonstrated the ALOUD to subjects during the debriefing session as an example of available voice technology. A picture of the ALOUD is shown in Figure 2.1. Please see Appendix A for a more complete description of the ALOUD.


Figure 2.1. ALOUD Device

The ALOUD was chosen for demonstration in this study because it allows caregivers to record the instructions in their own voice, and it is more affordable than other devices that provide audio instructions. It uses natural instead of synthetic speech. In a study to compare memory recall in older and younger adults under natural and synthetic speech conditions, it was found that both groups performed better under the natural speech condition (Smither, 1993).

*2.4.3.1. Limitations of Current Devices that Present Audio Instructions*

Another version of a voice prescription label is ScripTalk, manufactured by EnVision America. It uses computer-generated speech and requires that the pharmacy print a label with a microchip containing the voice message. Patients use a ScriptReader to scan the label and hear the instructions. The software to print the labels costs pharmacies $1500 (Bryant, Summer 2001) and the reader costs the patient $175. People would be limited in where they could get prescriptions filled since all pharmacies might not have the software capabilities to print the label. Each label costs the patient $1 (Lorentzen, September 5, 2002).

Talking RX is a self-contained recorder/playback unit that allows the caregiver to record up to 60 seconds of audio instructions but requires one entire unit per medication (Bryant, Summer 2001). The cost is $39.95 each (Medication Reminders, 2003).

Forget-me-not is another device that records an audio message up to 20 seconds in length, but is not physically associated with the medicine bottle. It senses motion and plays the audio reminder about medications if motion is detected. Its cost is $49.95 (Medication Reminders, 2003).

The Beep 'N Tell is a device that can record 60 seconds of audio instructions and allows the caregiver to set a timer on the bottle cap such that the device beeps when it is time for the medication. This device requires that the medicine be removed from its original bottle, which contains instructions on the label, and be placed in a bottle that is part of the device. It costs $49.95 and one is needed for each medication (Medication Reminders, 2003).

These devices do not allow for recording of information longer than 1 minute. The audio instructions for the matrix format will require the capability of recording over 1 minute. Furthermore, these devices are intended to be used for one medication, not an entire medication regimen.

*2.4.3.2. Limitations of Current Devices for Multiple Medication Regimens*

The MedMinder is a prototype designed by Andrew Szeto and James Giles Jr. of San Diego State University to help manage multiple medication regimens. It is a microprocessor-powered device that has multiple drug compartments and reminds the patient when drugs should be taken. The goal of MedMinder is to improve oral medication compliance. MedMinder has compartments for five medication containers. This device is connected to a personal computer for programming. It accepts what time the medication should be taken and how many. It gives the current time and the time of the next scheduled dose to assure the patient that the device is working. When it is time to take a medication, a short-duration intermittent tone sounds. The device displays the current time and "take 1 from 1." When the patient removes the correct drug container, the MedMinder responds "correct med taken." If the wrong container or multiple containers are removed from the device, it responds "wrong container" and continues with the error message until the error is corrected. This device has not been tested in field trials and needs to be redesigned for manufacturability. Using a MedMinder should improve oral medication compliance (Szeto & Giles, 1997).

While MedMinder does aid with a multiple medication regimen, it is limited to only 5 medications. It does not allow the caregiver to record the purpose of taking the medicine nor special instructions that accompany the medicine. MedMinder is helpful in that it tells whether or not the correct medicine has been taken. However, it does not contain information about what should be done if a dose is missed.

CompuMed is another device that manages a multiple medication regimen. It employs a liquid crystal display (LCD) screen and allows the caregiver to program when medication is to be given along with special instructions. When it is time to take a pill, the alarm sounds and the appropriate pill is dispensed into a drawer. The LCD screen displays the special instructions that go along with that particular pill. If a dose is missed, the screen displays the message that a medication time has passed. It does not double the dose. The cost is $895 (Medication Reminders, 2003).

The drawback of CompuMed is that it does not indicate to the caregiver what to do if a dose is missed. Furthermore, it does not allow the caregiver to record the purpose of taking the medicine.

*2.4.4. Pill Organizer*

Park, Morrell, Frieske, Blackburn, and Birchmore (1991) studied three medication organizers to determine their effect on medication compliance. They examined a 7 day/no times organizer with 7 compartments, a wheel organizer with 12 compartments, and a 7 day/times organizer with 28 compartments. The 28-compartment organizer had the fewest errors in loading and appeared to have potential to improve compliance. The

28-compartment pill organizer used in the present study is shown in Figure 2.2. It has 7 columns, one for each day of the week, beginning with Sunday. It has 4 rows, one for each time of day including morning, noon, evening, and bedtime. The compartments are transparent pink and have snapping lids.


Figure 2.2. Pill Organizer

# CHAPTER III

# METHODOLOGY

## 3.1. Participants

Participants consisted of a total of 96 caregivers. This number was chosen to achieve statistical power, while considering that the experimenter would have to travel to the participants to collect the data. To be included in this study, participants had to assist the care recipient with at least one of the following: loading a pill organizer, arranging medicine bottles according to schedule, ensuring medicine was taken and documenting the time medication was taken, or administering medicine in pre-filled pill cups.

The total number of participants was divided in half to include 48 formal caregivers who have received at least 1 year of training from a Licensed Practical Nurse (LPN) program and provide paid services in the scheduling and administering of medication for individuals age 65 years and older. Formal caregivers included registered nurses (RNs) and LPNs who work in a nursing home, home health care, personal care home, assisted living facility, or geriatric ward in a hospital. Formal caregivers ranged in age from 28 to 70 years ($M = 45.17$, $SD = 11.29$) and had an average of 16 years of experience caring for someone age 65 and older. All 48 formal caregivers were female. Of the 29 health care facilities that were asked to take part in this research, almost 40% agreed to have some of their employees participate. The reasons for not participating included: waiting on an accreditation examination, lack of interest, and being too busy.

The remaining 48 participants were informal caregivers who provide services to individuals age 65 years and older in taking their medication (without the help of a formal caregiver) and who have not received official training. Informal caregivers included family members and friends of care recipients, volunteers from community organizations, personal care assistants, and nurse's aids. Informal caregivers ranged in age from 20 to 87 years (M = 56.67, SD = 15.50) and had an average of 8 years of experience caring for someone age 65 and older.

Six males and 42 females composed the group of informal caregivers. The director of the Golden Triangle Planning and Development District Area Agency on Aging selected 21 informal caregivers in the areas surrounding Starkville, Mississippi for potential participation. Final arrangements for participation were made between the informal caregiver and the experimenter after the experimenter received contact information from the director. The South Mississippi Planning and Development District Area Agency on Aging's Raine Street "Save the Children" Center Caregiver Support Program provided a listing of 38 informal caregivers in the areas surrounding Poplarville, Mississippi. The informal caregiver group was to be comprised of 75% female and 25% male. Travis, Bernard, McAuley, Thornton, and Kole (in preparation) used a similar proportion of males and females in their efforts to develop a medication hassles scale for family caregivers. This sample is representative of the informal caregiving population because according to the National Study of Families and Households (Health and Human Services, 1998), about three quarters of the people who give care to elderly family members and friends are women. Males did comprise 25% of the informal caregivers as listed by the Starkville Area Agency on Aging and the Raine Street Caregiver Support Program; however, only 12% of the males participated in the study. Reasons for not participating included not authorizing that their contact information be released or not providing medication assistance to the care recipient. The results of the current study must be interpreted carefully and may not be generalizable to the population as a whole. Table 3.1 gives a summary of participant's characteristics.

Table 3.1. Participant Characteristics

| **Characteristic** | **Formal Caregivers** | **Informal Caregivers** |
|---|---|---|
| Average age | 45 years | 57 years |
| Average number of years of caregiving experience | 16 years | 8 years |
| Average highest level of education completed | 2 years of college | 12th grade |

3.2. Procedure

Participants were tested individually, except in the cases of formal caregivers with limited time who were tested in pairs. They volunteered to participate and were told they would receive a summary of the results in early Spring 2003. The summary is found in Appendix B. The order in which informal and formal caregivers were tested was randomized. Participants were randomly assigned to a sound condition (audio or non-audio), instruction format (list or matrix) and task condition (3, 5, or 8 pill-types).

Randomization was accomplished using Excel's RAND function, which generates uniformly distributed random numbers.

At the start of the experiment session, the investigator explained to the participants that the purpose of the experiment was to help improve medication adherence in elderly care recipients. Participants were asked their age, highest level of education completed, years of caregiving experience, and how many prescription drugs their care recipient(s) take per day.

Next, participants completed the Word Familiarity Survey to assess verbal ability/intelligence (Gardner & Monge, 1977). The Word Familiarity Survey is found in Appendix C. This short vocabulary test consisting of 30 multiple-choice questions was developed by Eric Gardner and Rolf Monge for adults age 20-79. It was scored by summing the number of correct answers given (Gardner & Monge, 1977). The highest score possible was 30. The Word Familiarity Survey took under 10 minutes to administer. Scores on the Word Familiarity Survey had a significant effect on the number of omission errors in pill-loading tasks in a study done by Park, Morrell, Frieske, Blackburn, and Birchmore (1991). Furthermore, Morrell, Park, and Poon (1989) found that participants with higher vocabulary scores made fewer errors answering questions from memory about medication instructions that they had studied.

Then, participants in the audio group heard a practice recording of a news article, and the volume was adjusted to suit them (Clark & Knowles, 1973). Next, participants answered the Medication Familiarity Questionnaire, located in Appendix D, which asked questions about the purpose, color, and shape of the medications used in the present study. The Medication Familiarity Questionnaire assessed how much the participant knew already about the medicines. The highest possible score was 24.

Participants in the task conditions of 3 pill-types, 5 pill-types, or 8 pill-types had a total of 4, 6, or 9 minutes, respectively, to study the drug regimen. The experimenter gave the participants one medicine bottle at a time. Each participant saw the bottles in the same order. The order of the bottles followed the order of medications given in the organized instructions. The audio recording followed the same order as given in the organized instructions. Since different groups of people were used for each condition, order effect is not an issue. Results are not presented by drug, but are presented by sound condition, instruction format, task condition, and training level. Participants had 20 seconds per drug to study the medicine bottle (Morrell, Park, & Poon, 1989). Then participants were given the organized instructions. They had 20 seconds per drug to study the organized instructions (Day, 1988). For the remainder of the 4, 6, or 9 minutes, the participant studied the medicine bottles and organized instructions together and heard the audio recording twice if assigned to the audio group. It was decided that participants would hear the audio recording twice because of the Morrow (2000) study, which examined the design of automated telephone messages for older adults to help them remember their scheduled doctor's appointments. Young and old adults heard 3 messages of varying length and order. Morrow found that one repetition reduced age-related and ability-related differences between the groups. He concluded that messages should be short and should be repeated. Please see Appendix E for a detailed explanation of study times.

A 4-minute distraction task consisting of personal interpretation questions about prescription instructions (Mazzollo, Lasagna, & Griner, Mar. 1974; Hurd & Butkovich, 1986) was completed to allow some memory loss to occur (Day, 1988). The Personal Interpretation Questionnaire is found in Appendix F.

Participants answered 10 questions about the instructions they studied to assess their memory of the drug regimen. Participants did not have access to the medicine bottles, organized instructions, or audio during the Memory Questionnaire. Then, participants were allowed to view the medicine bottles and organized instructions and if applicable hear the audio instructions as they loaded a 28-compartment pill organizer with one week's worth of medicine to assess their comprehension of the drug regimen.

Participants were debriefed and the experimenter demonstrated how to use the ALOUD. The testing procedure actually took about 30-45 minutes. A timeline for the experiment session is located in Appendix G.

## 3.3. Independent Variables

The independent variables included: sound condition, instruction format, task condition, and training level. Sound condition was divided into either audio, those who heard the prescription instructions, and non-audio, those who did not hear the instructions. Instruction format was divided into either list or matrix format of organized prescription instructions. Task condition was divided into 3, 5, or 8 pill-types. Training level was divided into either formal or informal. See Figure 3.1 that diagrams the experimental design and Figure 3.2 that illustrates the variables and hypotheses.

| | |
|---|---|
| 12 informal caregivers<br>receive standard medicine bottles and list on paper<br>4 people—3 pill-types<br>4 people—5 pill-types<br>4 people—8 pill-types | 12 formal caregivers<br>receive standard medicine bottles and list on paper<br>4 people—3 pill-types<br>4 people—5 pill-types<br>4 people—8 pill-types |
| 12 informal caregivers<br>receive standard medicine bottles and matrix on paper<br>4 people—3 pill-types<br>4 people—5 pill-types<br>4 people—8 pill-types | 12 formal caregivers<br>receive standard medicine bottles and matrix on paper<br>4 people—3 pill-types<br>4 people—5 pill-types<br>4 people—8 pill-types |
| 12 informal caregivers<br>receive standard medicine bottles, list on paper, and an audio recording in list format<br>4 people—3 pill-types<br>4 people—5 pill-types<br>4 people—8 pill-types | 12 formal caregivers<br>receive standard medicine bottles, list on paper, and an audio recording in list format<br>4 people—3 pill-types<br>4 people—5 pill-types<br>4 people—8 pill-types |
| 12 informal caregivers<br>receive standard medicine bottles, matrix on paper, and an audio recording in matrix format<br>4 people—3 pill-types<br>4 people—5 pill-types<br>4 people—8 pill-types | 12 formal caregivers<br>receive standard medicine bottles, matrix on paper, and an audio recording in matrix format<br>4 people—3 pill-types<br>4 people—5 pill-types<br>4 people—8 pill-types |

Figure 3.1. Experimental Design

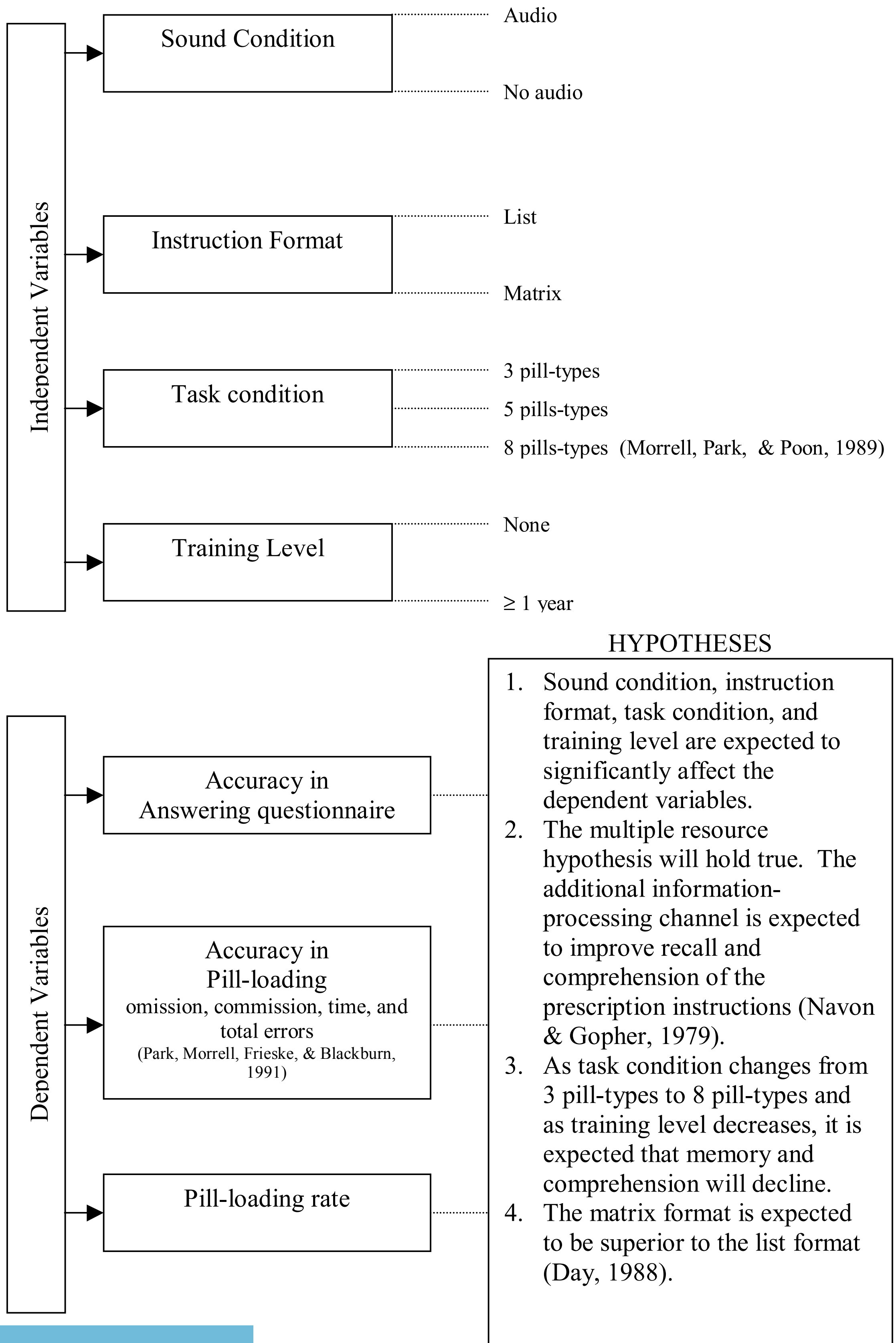



Figure 3.2. Illustration of Variables and Hypotheses

*3.3.1. Sound Condition*

A tape recorder, operated by the experimenter, was used in the present study to serve as the voice prescription label. The tape recording for the list format included the following information: name of drug, dose, directions for use, special instructions, and what the drug is taken for (Morrell, Park, and Poon, 1989). The veterans, in the study conducted by Engelhardt *et al.* (Nov. 2001), suggested that the audio label also include what the drug was taken for.

Currently there is no commercial product available to support recording of the matrix format. The existing VPLs are not appropriate because they are designed only for one medication and do not allow for recording messages over 60 seconds in length. They are not designed to give instructions for multiple medicines taken at a certain time of day. A tape recorder was used to provide participants with the audio label of the matrix instruction format. The matrix format was recorded by row and by column. The audio recording of the matrix format included the following information: name of drug, dose, directions for use, special instructions, and what the drug is taken for (Morrell, Park,& Poon, 1989; Engelhardt *et al*., Nov. 2001).

The audio recordings also included the information contained in the scenario that each participant received. Please see Appendix H for the exact wording of the audio recordings. Audio recordings were made with a normal rate of speech of 140 words per minute, and the words were spoken by a female native speaker of English (Tun, Wingfield, Stine, & Mecsas, 1992). A rate of 140 words per minute was chosen based on the Tun, Wingfield, Stine, and Mecsas (1992) study, which examined age differences in speech processing under varying loads. Young and old participants were divided into two conditions: recall of passages and recall of passages while performing a picture recognition task. Participants heard passages in three rates of speech: 140, 182, and 280 words per minute. Both young and old participants showed a decline in recall with increased speech rate.

### *3.3.2. Instruction Format*

The present study used a modified version of the physician's list format used by Day (1988). Although Day (1988) did not include the purpose of the drug, Morrell, Park, and Poon (1989) found that the optimal prescription label format for comprehension and memory included the name of the drug, the dose, directions for use, special instructions, and the purpose of the drug. Therefore, the list and matrix format for this study also included what the drug is taken for. The present study also employed a modified version of Day's (1988) matrix format that included morning, noon, evening, and bedtime, rather than breakfast, lunch, dinner, and bedtime to accommodate prescription instructions that require medicine to be taken on an empty stomach and so that the matrix corresponded to the labeling of the pill organizer compartments. The sample of the list format and matrix format used are shown in Figures 3.3 and 3.4, respectively. The list and matrix versions for varying task condition are included in the scenarios in Appendix I.

| | |
|---|---|
| Pepcid | 1 tablet twice daily to treat ulcers and acid reflux |
| Lanoxin | 1 tablet once daily to treat heart failure |
| Zocor | 1 tablet at bedtime to lower cholesterol |
| Detrol | 1 tablet twice daily to treat overactive bladder |
| Glucophage | 1 tablet 3 times daily to treat sugar diabetes |

Figure 3.3. Sample of List Format

| | Morning | Noon | Evening | Bedtime |
|---|---|---|---|---|
| Pepcid to treat ulcers and acid reflux | X | | X | |
| Lanoxin to treat heart failure | X | | | |
| Zocor to lower cholesterol | | | | X |
| Detrol to treat overactive bladder | X | | X | |
| Glucophage to treat sugar diabetes | X | X | X | |

Figure 3.4. Sample of Matrix Format

*3.3.3. Task condition*

Morrell, Park, and Poon (1989) used 3, 5, or 8 medications in their study that examined the effects of labeling techniques on memory and comprehension of prescription information in young and old adults. Blackwell (1979) found that increasing the number of medications past three sharply increased nonadherence. According to the Blue Cross Blue Shield Blue Care Network of Michigan, older Americans take an average of 5 prescription drugs at any one time. In this present study, there are three task conditions: 3, 5, or 8 pill-types.

Park and Jones (1997) define regimen complexity as "how many medication events are prescribed for a patient in a day, and it can be a function of either taking many medications or taking only a few medications that have complex schedules and must be taken three or four times a day." A review of the literature has found three methods for calculating regimen complexity. The author feels that the Medication Complexity Index (MCI) (Opperman Kelley, 1988) method is the most comprehensive approach to determine drug regimen complexity. See Appendix J for drug regimen complexity calculation methods. The present research uses the term drug regimen condition, as opposed to drug regimen complexity, because as the number of pill-types increases, extra study time is allowed.

*3.3.4. Training Level*

In order to legally administer medications, formal caregivers must be licensed practical nurses (LPN). The LPN program is a 1-year vocational program that is completed at the junior college level. A licensure examination must also be passed (M. Fortenberry, personal communication, September 24, 2002). Informal caregivers have not received official training. However, they may receive some unofficial training through patient counseling with their physician, nurse, or pharmacist or through community-sponsored caregiver support programs.

3.4. Dependent Variables

The dependent variables included: memory questionnaire accuracy, pill-loading accuracy, and pill-loading rate (minutes per pill). Memory questionnaire accuracy is a measure of recall of the drug regimen. Pill-loading accuracy and pill-loading rate are a measure of comprehension of the drug regimen. Pill-loading accuracy included omission errors, commission errors, and time errors. See Figure 3.2, which illustrates the variables.

*3.4.1. Memory Questionnaire Accuracy*

Participants completed a 10-item questionnaire to assess their memory of the drug regimen they viewed. The items required participants to recall information that was stated clearly in the format they viewed (Day, 1988). The medication names were not listed on the memory questionnaire to help with spelling because doing so could confound the effect of the auditory information. All participants completed the same memory questionnaire. There are specified right answers on 7 questions. This coincides with the number of factual questions in Day's (1988) study. The remaining 3 questions (time of day questions) asked which medication should be taken at noon, evening, and bedtime. Answers given for time of day questions by the group receiving the list format of instructions varied. The Memory Questionnaire is found in Appendix K.

Memory questionnaire score was calculated as the number of incorrect answers, with the highest score being 10. It is not of concern in the present study to score the memory questionnaire items internally. To score the time of day questions, either all or no credit was given. The scoring of the time of day questions for the group that received the list format of instructions depended on how the participant loaded the pill-organizer because there is flexibility in how the time of day medications can be scheduled. To be counted as correct, the answers given on the time of day questions had to correspond to how the pill organizer was loaded, whether correct or incorrect. Spelling errors were dealt with in the same manner as Day's (1988) study. While the completion of the questionnaire was self-paced, as was done in Morrell, Park, and Poon's study (1990), there was a maximum of 10 minutes allowed to answer the questions. The limit was imposed to control the duration of the experiment.

It is important to note the interpretation of the second question on the Memory Questionnaire, which asked, "Which pill(s) are *only* taken in the evening?" None of the other time of day questions included the word "only." The correct answer for all of the task conditions with the matrix format would be "none." All of the medicines given in the evening are also given at other times during the day. The answer to that question could be Lanoxin for the task condition of 5 pill-types or 8 pill-types with the list format. Only two people, out of the 96 total participants, answered the question correctly. However, others interpreted the question as, "Which pill(s) are taken in the evening?" Credit was given for both interpretations as long as the answer corresponded to the way the pill organizer was loaded.

*3.4.2. Pill-loading Accuracy*

Errors were classified into the following categories, based on error categories used by Park, Morrell, Frieske, Blackburn, and Birchmore (1991): time errors, omission errors, and commission errors. Time errors occurred when participants placed pills in the incorrect time of day compartment of the pill organizer. Omission errors occurred when participants excluded doses. Commission errors occurred when participants included extra doses.

### *3.4.3. Pill-loading Rate*

The pill-loading task was self-paced but timed. Timing of the pill-loading task began when the participant received the pill organizer and stopped when the participant snapped all the lids closed. Pill-loading rate is calculated by dividing the total time taken to load the pill organizer by the total number of pills loaded. The units for pill-loading rate are minutes per pill.

# CHAPTER IV

# ANALYSES

## 4.1. Introduction

The following data was collected: memory questionnaire errors, omission errors, commission errors, time errors, and pill-loading rate. The raw data is included in Appendix L. The data was standardized and transformed prior to being analyzed. A multivariate analysis of variance (MANOVA) was performed to determine the effect of the independent variables on the combined dependent variables. Canonical discriminant analysis was used to find linear combinations of the dependent variables that contributed to differences between levels of each independent variable. Follow-up univariate analyses of variance (ANOVAs) and nonparametric tests were performed to further interpret the results of the multivariate analysis of variance. Furthermore, correlation coefficients were calculated among the dependent variables, Word Familiarity Survey score, and Medication Familiarity Questionnaire score. The results of the Personal Interpretation Questionnaire were also summarized.

## 4.2. Standardizing Data

The dependent variables memory questionnaire errors, omission errors, commission errors, time errors, and pill-loading rate data were standardized. To standardize the data, the mean of each dependent variable was determined. The mean was subtracted from each data point and that number was divided by the standard deviation for that dependent variable. For example, the mean of the memory questionnaire errors data set was determined. The mean of the memory questionnaire errors data set was subtracted from each data point in the memory questionnaire data set. Then, that number was divided by the standard deviation of the memory questionnaire error data set. The same technique was used to standardize the other dependent variables. After standardization, each dependent variable has a mean of zero and a standard deviation of 1.

## 4.3. Transforming Data

The data were checked for normality using PROC UNIVARIATE in the SAS (Statistical Analysis Software) Program. PROC UNIVARIATE computes the skewness value, which deals with symmetry of the distribution, and the kurtosis value, which deals with the peakedness of the distribution. Data that are normal have skewness and kurtosis values of zero. PROC UNIVARIATE also produces a normal probability plot that allows the normality of the data to be assessed graphically (Cody & Smith, 1997; Tabachnick & Fidell, 2001). Memory questionnaire errors, omission errors, commission errors, time errors, and pill-loading rate data were found not to be normal because of high kurtosis and skewness values. Square root, log, and inverse transformations were tried on the data. A constant was added to each data point to bring the lowest value to 1 to avoid taking the square root, log, or inverse of zero. The inverse transformation reduced the kurtosis and skewness values, improving normality for memory questionnaire errors, omission errors, commission errors, time errors, and pill-loading rate data.

4.4. Analysis of Word Familiarity Survey and Medication Familiarity Questionnaire

The average Word Familiarity Survey score (highest possible score: 30) for formal caregivers is 16 (SD = 4.73) and is 9 (SD = 4.88) for informal caregivers. The average Medication Familiarity Questionnaire score (highest possible score: 24) for formal caregivers is 12 (SD = 3.67) and is 7 (SD = 4.95) for informal caregivers. A univariate analysis of variance (ANOVA) tests whether there is a significant difference between treatment groups. The null hypothesis states that all of the treatment groups have the same mean. An ANOVA using education level as the independent variable and Word Familiarity Survey score as the dependent variable shows a significant difference ($F [15, 80] = 4.92$, $p < 0.0001$). People with higher education have a higher verbal intelligence than people with less education.

An ANOVA with training level as the independent variable and Word Familiarity Survey score as the dependent variable is also significant ($F [1, 94] = 55.11$, $p < 0.0001$). Formal caregivers have higher education than the majority of informal caregivers and, in turn, have a higher verbal intelligence.

Park, Morrell, Frieske, Blackburn, and Birchmore (1991) found that low verbal ability contributed to higher omission error rates in loading a pill organizer. An ANOVA revealed that Word Familiarity Survey score significantly affects the number of omission errors made while loading the pill organizer ($F [24, 71] = 2.19$, $p = 0.0059$). People who have a higher verbal intelligence made fewer omission errors. Furthermore, Morrell, Park, and Poon (1989) found that participants with higher Word Familiarity Survey scores made fewer errors answering questions from memory about the medication instructions. An ANOVA revealed that higher Word Familiarity Survey scores resulted in significantly fewer memory questionnaire errors ($F [24,71] = 1.75$, $p = 0.0371$).

An ANOVA with training level as the independent variable and Medication Familiarity Questionnaire score as the dependent variable shows a significant difference ($F [1, 94] = 37.19$, $p < 0.0001$). Formal caregivers know more about the purpose, color, and shape of the pills than the informal caregivers.

Formal caregivers indicated that their care recipients take an average of 7 prescription drugs daily. Informal caregivers indicated their care recipients take an average of 6 prescription drugs daily.

## 4.5. MANOVA

A multivariate analysis of variance (MANOVA) allows testing of the relationship between independent variables and more than one dependent variable. Five dependent variables (omission errors, commission errors, time errors, memory questionnaire errors, and pill-loading rate) were subjected to a 2 x 2 x 2 x 3 MANOVA. The MANOVA used Wilk's criterion test statistic with training level (formal or informal), sound condition (audio or no audio), instruction format (matrix or list), and task condition (3, 5, or 8 pill-types) treated as independent variables. Wilk's criterion is commonly used when there are more than two groups formed by the independent variables. It measures the difference between groups of the vector of means on the independent variables. A smaller Wilk's lambda value indicates a greater difference (Garson, Spring 2003). The MANOVA revealed that all of the independent variables significantly affect the combined dependent variables. Contrast statements were written in SAS to determine if levels of task condition are significantly different from one another. It was found that the task condition of 3 pill-types does not differ significantly from 5 pill-types. The 3 pill-types task condition differs significantly from the 8 pill-types. Furthermore, the 5 pill-types condition differs significantly from the 8 pill-types. No interactions were found to be significant at the 0.05 level. Please see Appendix M for a listing of MANOVA interactions results. The results of the MANOVA are shown in Table 4.1.

Table 4.1. Results of MANOVA

| **Independent Variable** | **Wilk's Lambda** | **F Value** | **df** | **p** |
|---|---|---|---|---|
| Training level | 0.4984 | 13.69 | 5 | < 0.0001 |
| Instruction format | 0.6578 | 7.08 | 5 | < 0.0001 |
| Task condition | 0.5817 | 4.23 | 10 | < 0.0001 |
| Sound condition | 0.8361 | 2.67 | 5 | 0.0293 |

4.6. Combined Score

A combined score was calculated using standardized data. Standardization was accomplished using the technique described in Section 4.2. The combined score is the sum of the memory questionnaire errors, omission errors, commission errors, time errors, and pill-loading rate. The disadvantage in calculating a combined score is that the individual variance for each dependent variable is lost. The lower the combined score, the more desirable, indicating fewer errors and a faster pill-loading rate. Since there is no clear justification for weighing the dependent variables differently, they are all weighted equally. Box and whiskers plots using combined score are included in Appendix N.

To determine which of the independent variables contributed significantly to the combined score, a univariate analysis of variance was performed with the independent variables being training level, task condition, sound condition, and instruction format and the dependent variable being combined score. It was found that 44% of the variation in combined score was explained by the variance in the independent variables. More specifically, training level ($p < 0.0001$) and task condition ($p = 0.0482$) contributed significantly to the combined score. Combined scores are significantly lower among formal caregivers than informal caregivers. Combined scores are not significantly lower among participants in the audio condition than the non-audio condition. Combined scores are not significantly lower among participants with the matrix format than the list format. The combined score decreased significantly as the number of pill-types decreased from 8 to 3 and from 8 to 5. Over half of the variability in combined score is explained by other factors of complex human behavior than the variability in the independent variables.

4.7. Canonical Discriminant Analysis

Canonical discriminant analysis is used to find linear combinations of quantitative variables (canonical variables) that provide differences between levels of an independent variable. SAS has a PROC CANDISC procedure that performs a one-way MANOVA to test the null hypothesis that the levels' mean vectors are equal. It was determined by the results of the MANOVA that training level, instruction format, task condition, and sound condition significantly affect the combination of memory questionnaire errors, omission errors, commission errors, time errors, and pill-loading rate (caregiver performance). Canonical discriminant analysis allows a canonical correlation to be calculated that gives the percentage of variance in caregiver performance explained by the independent variable (SAS Institute, 1999). The percentage of variation in caregiver performance explained by each independent variable is shown in Table 4.2. The highest percentages of variation in caregiver performance can be attributed to the amount of variability in training level, instruction format, and task condition.

Table 4.2. Percentage of Variance Explained by Independent Variables

| **Independent Variable** | **Variance in Caregiver Performance** |
|---|---|
| Training level | 42% |
| Instruction format | 27% |
| Task condition | 25% |
| Sound condition | 10% |

Canonical discriminant analysis also calculates raw and standardized canonical coefficients to show the relative weights of each dependent variable that separate the levels of the independent variable most effectively. Standardized coefficients are used when variables are not measured in the same units (SAS Institute, 1999). The standardized canonical coefficients associated with each dependent variable for each independent variable are shown in Table 4.3. From Table 4.3, it can be seen that the number of omission errors, commission errors, and pill-loading rate are affected by most by task condition followed by instruction format. Time errors are affected most by sound condition and instruction format. Memory questionnaire errors are most affected by task condition and training level.

Table 4.3. Standardized Canonical Coefficients

| Dependent Variable | Training Level | Sound Condition | Instruction Format | Task condition |
|---|---|---|---|---|
| Omission errors | -0.2170 | -0.0456 | -0.6401 | -0.9416 |
| Commission errors | 0.3193 | 0.1639 | 0.6519 | 0.6537 |
| Time errors | 0.1443 | 0.9686 | 0.8550 | -0.3792 |
| Memory questionnaire errors | 0.6245 | -0.2072 | -0.3611 | -1.0042 |
| Pill-loading rate | 0.6577 | -0.1117 | 0.6665 | 1.3625 |

Finally, canonical discriminant analysis calculates the means on the canonical variables for each level of the independent variable (SAS Institute, 1999). The means on canonical variables for each level of the independent variables are shown in Table 4.4. Table 4.4 provides a way to examine the order of the levels of the independent variables. Recall, that the task conditions of 3 pill-types and 8 pill-types were found to be significantly different and the task conditions of 5 pill-types and 8 pill-types were found to be significantly different from one another. Remember the data has been inversely transformed. Therefore, a higher mean indicates better caregiver performance, i.e. fewer errors and faster pill-loading rate. Best performance occurred among formal caregivers with 8 pill-types in the audio condition with the matrix format of instructions.

Table 4.4. Means on Canonical Variables

| **Independent Variable Level** | | **Mean** |
|---|---|---|
| Training level: | Formal | 0.8395 |
| Training level: | Informal | -0.8395 |
| Sound condition: | Audio | 0.3384 |
| Sound condition: | Non-audio | -0.3384 |
| Instruction format: | Matrix | 0.5976 |
| Instruction format: | List | -0.5976 |
| Task condition: | 3 pill-types | -0.4552 |
| Task condition: | 5 pill-types | -0.3566 |
| Task condition: | 8 pill-types | 0.8118 |

4.8. Follow-up ANOVAs

Since the MANOVA indicated that the null hypothesis should be rejected, that is, there was a difference in the means of the dependent variables for all of the independent variables, follow-up ANOVAs were performed to determine which levels of independent variables are significantly different from others at the 0.05 level. A 2 x 2 x 2 x 3 ANOVA with training level (formal or informal), sound condition (audio or no audio), instruction format (matrix or list), and task condition (3 pill-types, 5 pill-types, or 8 pill-types) as independent variables was performed on each of the following dependent variables: memory questionnaire errors, omission errors, commission errors, time errors, and pill-loading rate. Table 4.5 shows the significant findings from the follow-up ANOVAs. Table 4.5 gives the degrees of freedom, sum of squares error, mean square error, F value, and p-value.

Table 4.5. ANOVA Summary Table Showing Significant Findings

| **Dependent Variable** | **Source** | **df** | **SS** | **MS** | **F** | **p** |
|---|---|---|---|---|---|---|
| Memory questionnaire errors | Training level | 1 | 1.31 | 1.31 | 57.25 | < 0.0001 |
| | Task condition | 2 | 0.42 | 0.21 | 9.27 | 0.0003 |
| Omission errors | Training level | 1 | 0.12 | 0.12 | 15.51 | 0.0002 |
| Commission errors | Training level | 1 | 0.02 | 0.02 | 8.58 | 0.0045 |
| | Instruct. format | 1 | 0.01 | 0.01 | 5.47 | 0.0222 |
| | Train x format | 1 | 0.01 | 0.01 | 5.79 | 0.0186 |
| Time errors | Training level | 1 | 0.05 | 0.05 | 4.21 | 0.0438 |
| | Task condition | 2 | 0.12 | 0.06 | 4.65 | 0.0126 |
| | Sound | 1 | 0.17 | 0.17 | 13.14 | 0.0005 |
| | Instruct. format | 1 | 0.35 | 0.35 | 27.23 | < 0.0001 |
| Pill-loading rate | Training level | 1 | 0.18 | 0.18 | 29.95 | < 0.0001 |

*4.8.1. Memory Questionnaire Errors*

Training level and task condition significantly affect the number of memory questionnaire errors made. Formal caregivers made fewer memory questionnaire errors than informal caregivers. A post hoc comparison using Duncan's multiple range test suggests that memory questionnaire error means generated in the 3 pill-types and 5 pill-types task condition and means generated in 3 pill-types and 8 pill-types task condition are statistically different, with 3 pill-types yielding the fewest memory questionnaire errors.

*4.8.2. Omission Errors*

Training level significantly affects the number of omission errors made while loading the pill organizer. Formal caregivers made fewer omission errors than informal caregivers.

*4.8.3. Commission Errors*

Training level and instruction format significantly affect the number of commission errors made. Formal caregivers made fewer commission errors than informal caregivers. People with the matrix format made fewer commission errors than those with the list format. There was an interaction between training level and instruction format for commission errors. Follow-up ANOVAs with instruction format as the independent variable and commission errors as the dependent variable were performed on the formal and informal caregivers separately. Instruction format significantly affected commission errors among informal caregivers, but not among formal caregivers.

*4.8.4. Time Errors*

Training level, task condition, instruction format, and sound condition significantly affect the number of time errors. Formal caregivers made fewer time errors than informal caregivers. A post hoc comparison using Duncan's multiple range test suggests that time error means for task conditions of 5 pill-types and 8 pill-types are statistically different. Participants with the matrix format made fewer time errors in loading the pill organizer compared to those who received the list format. Participants in the audio condition made fewer time errors than those in the non-audio condition.

*4.8.5. Pill-loading Rate*

Training level significantly affects the pill-loading rate. Formal caregivers had a faster pill-loading rate than the informal caregivers.

4.9. Nonparametric Test

After transforming the omission, commission, and time error data by taking the inverse of each data point (this transformation improved normality the most), normality was still in question. It was common for formal caregivers to make zero omission, commission, or time errors. The normality of the data was questionable due to the large number of zeros in the data set. To use MANOVAs or ANOVAs the normality assumption must be met. Therefore, the Wilcoxon rank-sum test, a nonparametric test, which does not assume a normal distribution of data, was also performed in addition to the ANOVAs to see if the findings conflicted with the findings of the ANOVAs. Wilcoxon rank-sum tests were performed using matrix and list data separately. The independent variables were training level, sound condition, and task condition. The dependent variables were omission, commission, and time errors. The conclusions from the nonparametric tests were the same as the findings of the ANOVAs. Training level significantly affected each dependent variable. Sound condition significantly affected the number of time errors made. Instruction format significantly affected the number of commission errors and time errors. It seems that the ANOVA technique was robust. Therefore, analyses were continued assuming normality.

4.10. Correlation

Correlations were determined using the PROC CORR procedure in SAS. PROC CORR computes pairwise correlation coefficients (r) between variables. A positive correlation indicates that as one variables increases, the other variable increases. A negative correlation indicates that as one variables increases, the other variable decreases. It is important to remember that the data has been inversely transformed. A smaller number of errors results in a higher number after being inversely transformed.

As the number of commission errors increases, the number of omission errors also increases. As memory questionnaire errors increase, omission errors, commission errors, and pill-loading rate also increase. As Word Familiarity Survey scores and Medication Familiarity Questionnaire scores increase, fewer memory questionnaire errors and fewer omission errors are made and pill-loading rate is faster.

By examining the correlation coefficients, it is evident that as training and education level increase, which leads to increased Word Familiarity Survey scores and Medication Familiarity Questionnaire scores, and as memory of the drug regimen is improved, errors are reduced. Selected correlation coefficients along with their associated p-values are shown in Table 4.6. The smaller the p-value, the less likely that the correlation is found by chance (Cody & Smith, 1997). The complete listing of correlation coefficients is located in Appendix O.

Table 4.6. Correlation Coefficients

| **Variables** | | **r** | **p-value** |
|---|---|---|---|
| Commission errors | Omission errors | 0.3928 | < .0001 |
| Memory questionnaire errors | Omission errors | 0.4459 | < .0001 |
| Memory questionnaire errors | Commission errors | 0.3485 | 0.0005 |
| Memory questionnaire errors | Pill-loading rate | 0.4949 | < .0001 |
| Word Familiarity score | Omission errors | 0.4559 | < .0001 |
| Medication Familiarity score | Omission errors | 0.4428 | < .0001 |

4.11. Personal Interpretation Questionnaire

The Personal Interpretation Questionnaire asked eight questions about how the caregiver would interpret prescription instructions. Since this questionnaire was used as a distraction task before the Memory Questionnaire was completed, participants only had four minutes to complete it, and some did not answer all of the questions. All of the formal caregivers completed all of the questions. Of the informal caregivers, forty-six completed question #3, forty-seven completed question #6, and forty-three completed question #7. All informal caregivers completed all other questions.

The answers given by both the formal and informal caregivers for the majority of the questions were similar. For example, 94% of formal caregivers indicated that medicine to be taken "once a day" would be given in the morning, and 85% of informal caregivers said it should be taken in the morning as well. The question about how medicine would be given for the instruction, "Take one tablet every 12 hours" was answered correctly by 98% of the formal caregivers, while 70% of the informal caregivers gave times that were 12 hours apart. Approximately the same percentage of informal caregivers answered the question "How would you suggest taking Drugs A and B if they were both to be taken twice a day?" with "stagger" (41%) or "together" (46%). It seems that some informal caregivers try to avoid giving more than one medication at a time. The informal caregivers may not know that certain medicines can be taken together and that it would simplify their drug administration schedule if they were taken together. The question with the most varied interpretation was for the instruction, "Take one capsule with meals." Seventy-nine percent of the formal caregivers indicated that the capsule should be taken three times per day, while 75% of the informal caregivers indicated that the capsule should be taken only once per day.

The results are in Table 4.7, which shows the percentage of answers given by formal and informal caregivers for each instruction. These results highlight the need for specific instructions so that there is no question about how the drug should be administered. According to Morrell, Park, and Poon (1989), "Compliance with a medical regimen cannot occur if patients do not understand what to do when they read the instruction on the label." Medication errors would be reduced if caregivers understood prescription instructions and administered medicine as intended.

Table 4.7. Results of Personal Interpretation Questionnaire

| Instruction | Formal Caregivers | Informal Caregivers |
|---|---|---|
| Take once a day | 94% morning | 85% morning |
| | 6% depends on drug | 8% night & evening, 6% other |
| Take twice daily | 100% twice daily | 98% twice daily |
| | | 2% once daily |
| Take one tablet every 12 hours | 98% 12 hrs apart | 70% 12 hrs apart |
| | 2% four times daily | 26% once daily, 4% other |
| Take one capsule with meals | 79% three times daily | 75% once daily |
| | 21% once daily | 21% 3 times/day, 4% twice/day |
| Take one capsule once a day on an empty stomach | 46% upon rising | 85% morning |
| | 40% before a meal | 8 % night |
| | 14% other | 4% lunch, 2% 8am 8pm |
| Take one tablet four times a day | 100% four times daily | 98% four times daily |
| | 25% 9am, 1pm, 5pm, 9pm | 2% five times daily |
| Does your care recipient take pills at different times on the weekend than weekdays? | 90% no | 98% no |
| | 10% yes | 2% yes |
| How would you suggest taking Drugs A and B if they were both to be taken twice a day? | 65% together | 46% together |
| | 31% depends on drug | 41% stagger |
| | 4% stagger | 12% depends on drug |

4.12. Summary of Analyses

The MANOVA indicated that training level, task condition, sound condition, and instruction format significantly affected the combination of memory questionnaire errors, omission errors, commission errors, time errors, and pill-loading rate. It was found that 44% of the variability in the combined score was explained by the variability in the independent variables. Canonical discriminant analysis indicated that memory questionnaire errors, omission error, and pill-loading rate are most affected by task condition. Commission errors are most affected by task condition and instruction format. Furthermore, time errors are most affected by sound condition and instruction format. Follow-up ANOVAs revealed the following:

- Training level affects each dependent variable.
- Time errors and commission errors are reduced with the matrix format of instructions.
- Hearing the audio instructions reduces the number of time errors.
- Task condition significantly affects memory questionnaire errors and time errors.

Nonparametric tests yielded the same findings as the ANOVAs. Personal Interpretation Questionnaire results illuminated the need for prescription instructions to be more specific.

CHAPTER V

# RESULTS AND CONCLUSIONS

## 5.1. Results

Hypothesis 1 states that sound condition, instruction format, task condition, and training level are expected to significantly affect the dependent variables. According to findings of the MANOVA, sound condition, instruction format, task condition, and training level contribute to memory and comprehension of the drug regimen. The findings of the present study are contrary to the findings of Campbell, Rogers, and Fisk (2000), although they did not consider the effect of the independent variables on all the dependent variables combined.

Hypothesis 2 states that the multiple resource hypothesis will hold true. The additional information-processing channel is expected to improve recall and comprehension of the prescription instructions (Navon & Gopher, 1979). The MANOVA results indicate that the additional information-processing channel (audio) impacted caregivers' memory and comprehension of the drug regimen. Results of the follow-up ANOVA indicate that memory questionnaire accuracy is not significantly affected by the additional information-processing channel, as found in the Campbell *et al.* (2000) study. The additional audio information does significantly affect the number of time errors that were made while loading the pill organizer. It is possible that people who heard the audio picked up on the statement that "Mrs. Johnson does not eat breakfast" and the special instructions that Glucophage must be taken with food or milk and that Vioxx must be taken with food. As found in the Campbell *et al*. (2000) study, the people with the additional information-processing channel had increased memory of the medicines' special instructions. Finally, according to the follow-up ANOVA, pill-loading rate is not affected by the additional information-processing channel, as found in the Campbell *et al*. (2000) study.

Hypothesis 3 states that as task condition changes from 3 pill-types to 8 pill-types and as training level decreases, it is expected that memory and comprehension will decline. According to follow-up ANOVAs, that hypothesis is correct for memory questionnaire errors. Omission errors, commission errors, and pill-loading rate are not significantly affected by task condition. However, 5 pill-types yield the fewest time errors. Park, Morrell, Frieske, Blackburn, and Birchmore (1991) found that subjects with more pills did not make more errors loading the pill organizer. Morrell, Park, and Poon (1989) found that participants in higher drug load conditions were able to complete a 24-hour medication plan with fewer errors than people in the lower drug load conditions. They suggested that people whose task involved fewer medications viewed their task as easy, were more careless, and made more errors than people whose task involved more medications. It is important to emphasize that people who had more pills also had more time to study the instructions. Another explanation could be offered to explain why people with fewer medications made more errors, that is, people with fewer medications had less time to study the instructions. It is possible that people who had more medications made fewer errors because they had more time to study the instructions.

Hypothesis 4 states that the matrix format will be superior to the list format (Day, 1988). Instruction format is found, in the canonical discriminant analysis, to be among the top two independent variables that most affect the number of errors made while loading the pill organizer. Instruction format significantly affects the number of commission errors and time errors as revealed in the follow-up ANOVAs. The trend among memory questionnaire errors and pill-loading rate is that the matrix format is superior to the list format. The matrix format is more specific than the list format and reduces variation in instruction interpretation.

When examining omission error means, the participants with the list format of instructions made fewer omission errors than those with the matrix. Also, participants in the non-audio condition made fewer omission errors than those in the audio condition. These findings do not coincide with the findings for the commission and time errors. There were three times more omission errors made than commission errors, which could occur because some participants did not know how to load a pill organizer and did not load it for the entire week, as directed. The data for omission errors could have been skewed because of the number of participants who were not familiar with using a pill organizer, regardless of instruction format or sound condition. It would have been beneficial to collect data on whether nor not participants normally use a pill organizer. The fact that more omission errors occurred than commission errors is consistent with other research (Cooper, Love, & Raffoul, 1982).

It is recognized from the means on canonical variables that a higher number of pill-types yield fewer errors than a lower number of pill-types. While each participant had 20 seconds per medicine bottle to study (Morrell, Park, & Poon, 1989) and 20 per drug on the organized instructions to study (Day, 1988), the additional time may offset the effect of increasing the number of pill-types.

5.2. Conclusions

As hospital stays are shorter, there is a shortage of nurses, and people are living longer, more Americans will take on the caregiving role (Donelan *et. al*, 2002). These informal caregivers need training, as evidenced by the results of this research, in how to schedule medicine. Something as seemingly simple as loading a pill organizer can be complicated for someone who has never used a pill organizer before. Some participants confused the columns with the rows on the pill organizer even though they are clearly labeled. Informal caregivers may need training from a pharmacist, pharmacy technician, doctor, nurse, or other qualified person to understand what pills to put in what compartment of the pill organizer. For example, “twice a day” does not mean that two of the same pills should be put in the same compartment of a 28-compartment organizer.

When a caregiver receives prescription medication from a pharmacy, the caregiver must understand the instructions printed on the label to administer it properly. It was evident in the results of the Personal Interpretation Questionnaire that instructions can be interpreted differently. Caregivers should be encouraged to ask their care recipient’s doctor or pharmacist more specifically how the medication should be given.

While the additional audio information was found to be helpful among formal and informal caregivers, it could be especially beneficial for someone who cannot read.

Informal caregivers ranged in education level from none to the completion of a master's degree. Illiteracy may be a problem among informal caregivers with little or no education. The Word Familiarity Survey may not provide enough information about a person's verbal intelligence because there is no way to know if the person is merely making accurate guesses. Future work could employ other methods of screening verbal intelligence. It is expected that presenting audio instructions to caregivers with a low reading level would greatly improve their ability to administer medicines in the way prescribed.

There is evidence that the multiple resource hypothesis holds in the context of prescription drug instructions. The matrix format of instructions and the additional information-processing channel are supportive of a reduction in the number of errors made.

It was found that the combination of memory questionnaire accuracy, pill-loading accuracy, and pill-loading rate was significantly affected by training level, task condition, sound condition, and instruction format. The difference in training level is highlighted by the fact that formal caregivers made fewer memory questionnaire errors, fewer errors loading the pill organizer, and had a faster pill-loading rate than the informal caregivers. Additional audio information improves caregivers' memory of the special instructions that accompany the medicine, which leads to fewer errors in loading the pill organizer. Furthermore, the matrix format of instructions is superior to the list format in reducing errors made while loading the pill organizer.

5.3. Who would be interested in the results of this study?

It is expected that all states would be interested in the results of this study because it illuminates the need for informal caregivers to receive training from professionals in how to schedule and administer medications. Perhaps Caregiver Support Programs could provide training for informal caregivers.

Doctors and pharmacists might also be interested in knowing how to organize prescription instructions to facilitate comprehension and memory of the drug regimen. Furthermore, nurses with Home Health Care Agencies have indicated interest in the outcome. Home Health Care nurses who participated said they felt it would be beneficial for their agency to provide patients with a matrix-organized format of instructions.

The National Institute on Aging (NIA) might also be interested in this project. NIA has issued an ongoing solicitation for proposals to investigate issues related to medication use and older people. Goals for the research include investigating interventions to improve medication adherence and strategies for reducing medication errors and increasing compliance. The roles of caregivers in improving or hindering medication adherence and tools to facilitate understanding or medication instructions are also areas of interest (S. Stahl, personal communication, July 12, 2002).

# CHAPTER VI

# SUGGESTIONS FOR FUTURE WORK

## 6.1. Measuring Mental Workload

Future research could be done to determine a mental workload rating of participants with varied instruction format and sound condition. It would be interesting to see if participants with the matrix format and audio instructions had a lower mental workload than those with the list format and no audio instructions. Thermography could be used to detect temperature differences in the face that have been linked to mental workload.

## 6.2. Tracking Eye Movement

Also, an eye tracker could be used to determine where the participants are focusing their attention while the audio instructions are being heard. For example, are they reading along with the instructions as the audio plays, are they just concentrating on the audio, or are they reading the prescription label on the bottles? When text and narration of the same words are presented at the same time, memory and comprehension of the information is improved (Moreno & Mayer, 2002).

## 6.3. Developing a Medication Scheduling Management System

Caregivers may be faced with several decisions on an on-going basis.

For example, if a care recipient takes multiple medications, the following questions could arise about how to schedule the medications:

- When do I give these medicines?
- Which medicine should be given first?
- What do I do if the care recipient missed a dose?
- Is it too late to give this missed dose?

*6.3.1. Theoretical Issues in Scheduling and Human Performance*

The goal of scheduling theory is to determine optimal or adequate solutions when determining order of tasks (Dessouky, Moray, & Kijowski, 1995). Dessouky *et al.* (1995) suggest that determining a schedule for tasks involves the following steps:

- Define the tasks to be scheduled, objectives, resources, and constraints
- Assign tasks to resources
- Develop a sequence for processing the tasks
- Define start and finish times
- Determine if task sequence meets objectives

The aforementioned steps can be adapted to medication scheduling. The first step in scheduling medications is to determine which medicines need to be given, their interactions with other medicines given (constraint), and the time they should be given. The objective function of a medication-scheduling task is to ensure that all medications are administered when they are due. Next, tasks are assigned to resources, which in this case is the care recipient. Then, a sequence is developed for taking the medicines according to time of day and special instructions, such as take with food. Next, determine at what time each medication is to be given and at what times missed doses should be reincorporated into the schedule or skipped. The final step is to check to see that all medications have been scheduled according to prescription instructions and that all are scheduled before they are due.

*6.3.2. Introduction of the Medication Scheduling Management System*

The present research found that presenting instructions in a matrix format and providing audio instructions reduced the number of errors made by both formal and informal caregivers. The findings of the present research could lead to the development of a Medication Scheduling Management Systems (MSMS), in the form of a computer program for use with personal computers, to address the problems reported by the Associated Press (2002) article, and problems reported by family caregivers in the Travis, Bethea, and Winn (2000) article. A proof of concept design could be developed using ten medications commonly taken by elderly people (age 65 and older), which include Pepcid, Cozaar, Detrol, Lanoxin, Zocor, Vioxx, Paxil, Glucophage, K-Dur 20, and Synthroid (McCloskey, 2002). It might also be possible to access the MSMS on the Internet. There are databases currently available on the Internet (i.e., www.drugs.com) that allow the user to input drug names to check for food and other drug interactions. The MSMS could be incorporated into existing databases so that the database also included a matrix format of instructions and audio instructions. A pharmaceutical company or organization associated with providing care or services for elderly people could sponsor the MSMS and allow caregivers to use it for free.

The MSMS would contain the medications to be administered and information about their interactions. The system would develop a sequence for administering the medications that could evaluate new information (such as a missed dose) that was input into the system and make changes to the sequence, accommodating the new information (Dessouky, Moray, & Kijowski, 1995). For example, if Glucophage is prescribed three times daily at morning, noon, and evening and if the care recipient forgets the noon dose but remembers it at 5 p.m., the caregiver can refer to the scheduling system to revise the upcoming schedule. The scheduling system would contain the decision rule for Glucophage that states if a dose is missed, it should be taken as soon as possible, but if it is almost time for the next dose, skip the missed dose because two doses cannot be taken simultaneously. Since the current time is 5 p.m. and the next scheduled dose is evening, the system would instruct the caregiver to not to give the missed dose at evening, but schedule it at bedtime.

The output of the scheduling system would be in matrix format and would be accompanied by an audio message of the instructions. This system has the potential to save the caregiver time in organizing medication regimens. It could also reduce the number of decisions the caregiver would have to make if a dose was missed. The MSMS has the potential to aid caregivers in reducing medication administration errors and to improve medication adherence among their care recipients.

The intention of the MSMS is to improve the way that caregivers schedule and administer medicine. The MSMS would be different from other available technologies in that it would:

- Give audio instructions of longer than 1 minute to allow instructions to be recorded in matrix format
- Contain decision-making rules about what to do if a dose is missed

*6.3.3. Caregiver Interaction with MSMS*

The following is a description of how the caregiver would interact with the MSMS. The MSMS would ask the caregiver to select on the computer screen which medications the care recipient is taking from the list of ten medications. The caregiver would simply click on the medication names to select them. The MSMS would keep track of the current time and ask the caregiver to input when their care recipient wakes up, eats meals, and goes to bed. The MSMS needs to know the current time and specific times for meals so that if a dose is missed it can compare the current time with the scheduled dosage time. The MSMS would display the instructions for the selected medications in matrix format accompanied by an audio recording of the instructions.

The MSMS would ask the caregiver if a dose has been missed. The caregiver would indicate yes or no. If yes is indicated, the system would show the caregiver the list of ten medications and the caregiver could click on the name of the missed medication. The MSMS would ask what time the dose was missed and the caregiver would input the time.

The MSMS would contain decision rules based on the "how to use" instructions for each medicine. For example, some medications' instructions state that if making up the missed dose is within 2 hours of the next scheduled dose, the missed dose should be skipped. Therefore, the MSMS would not reschedule the missed dose. However, if the missed dose is not within 2 hours of the next scheduled dose, MSMS would reschedule it. Other medications require that if a dose is missed, it must be taken as soon as possible. The MSMS would schedule the missed dose immediately. The MSMS would continue to ask the caregiver if another dose has been missed until the caregiver indicates that all missed doses have be input. After the caregiver has input all missed doses, the MSMS would produce the updated matrix format with accompanying audio instructions. Please see Appendix P for more information about how the MSMS could function.

There could be some concern about people who are not computer savvy and their ability to use the MSMS. People who do not have computers or do not feel comfortable using them might rely on pharmacies that could print a matrix format instruction sheet for them. Also, Home Health Care facilities might be able provide a matrix format of instructions. Computer use is increasing in today's work place. The employees of today are the caregivers of tomorrow and will most likely have computer experience.

According to Travis, Bethea, and Winn (2000), "It is probably unrealistic to propose that long term care giving is ever going to be hassle free. Especially when family caregivers are expected to develop and follow medication administration schedules." However, the Medication Scheduling Management System could help caregivers organize multiple medications and would

- Save caregivers time in organizing medication regimens
- Reduce the number of decisions caregivers would have to make if a dose was missed
- Improve caregivers' memory and comprehension of the drug regimen

The MSMS has the potential to reduce medication administration errors.

APPENDIX A

DESCRIPTION OF ALOUD

The ALOUD was initially developed to aid people with visual impairments who had problems identifying medications and their instructions. It was prototyped and presented in September 1999 at a meeting of the National Center for the Blind (Bryant, Summer 2001). The ALOUD device is an audio labeling system developed by the ASKO Corporation located in Stamford, New York. The system is composed of three components:

- Audio label, which attaches to the bottom of a prescription bottle and contains the recorded prescription information.
- Recording microphone that the qualified caregiver/individual speaks prescription information into.
- Player/recorder, which is used in recording and playing back the prescription information.

The ALOUD can record a message up to 60 seconds in length. The qualified caregiver/individual attaches the prescription bottle to the audio label with an adhesive disk. To record a message, the qualified caregiver/individual inserts the prescription bottle with attached audio label into the player/recorder applying slight downward pressure. Then, he/she attaches the microphone to the player/recorder. The qualified caregiver/individual can record the message by holding down the microphone's button and speaking into the open end of the microphone. After the microphone has been disconnected, the message cannot be altered or erased until the microphone is reattached. Audio labels can be reused multiple times (Product Description & Operating Instructions brochure). A caregiver would need only one player/recorder for each care recipient, but would require one audio label for every medication that the care recipient is taking.

To replay a message, the qualified caregiver/individual inserts the audio label into the player/recorder, applying and maintaining slight downward pressure through the duration of the message. If pressure is not maintained, the message stops. When pressure is reapplied, the message starts over from the beginning. There is no limit to the number of times the message can be replayed (Product Description & Operating Instructions brochure).

The ALOUD uses an AC adapter or built-in rechargeable battery. It is portable and is maintenance-free. It also beeps at the beginning of a replayed message to indicate that the battery is low. The ALOUD model 200 audio labeling system costs $88.50 and includes player/recorder, microphone, 3 audio labels, 12 adhesive pads, battery charger, earbud (for private listening), and instruction sheet (The Talking Prescription brochure).

APPENDIX B

SUMMARY OF RESULTS SENT TO PARTICIPANTS

Summary of Results of Project to Reduce Medication Administration Errors
among Caregivers of Elderly
Project conducted: January-February 2003
Conducted by: Department of Industrial Engineering
Mississippi State University
Starkville, MS

You are receiving this information because you participated in a project conducted by the Department of Industrial Engineering of Mississippi State University that aimed to reduce the number of medication administration errors that are made by caregivers of people age 65 and older. Participants included 48 formal caregivers (licensed practical nurses and registered nurses) and informal caregivers (people who have not had formal medical training). Participants studied the prescription label of 3, 5, or 8 different medicines. Participants also studied either a list or matrix format of organized instructions. Some participants heard an audio representation of the instructions and some did not. Participants then answered questions (to assess memory) about the prescription labels and organized instructions and loaded a pill organizer (to assess comprehension). The task of loading the pill organizer was divided into omission errors (leaving pills out), commission errors (adding extra pills), and time errors (putting pills in a compartment in the wrong time of day). The time to load the pill organizer was also recorded.

The **purpose** of the study was to determine whether the list or matrix format improved the caregivers' memory and comprehension of the prescription instructions and whether hearing the instructions, as well as seeing them, improved memory and comprehension.

**Results:** Formal caregivers made fewer errors on the memory questionnaire, fewer errors loading the pill organizer, and had a faster pill-loading rate than the informal caregivers. People with the matrix format had fewer memory questionnaire errors, commission errors, time errors, and had a faster pill-loading rate than people with the list format. People who heard the audio instruction had fewer commission errors and time errors than people who did not hear the audio instructions.

**Conclusion:** The study results show the following under the given test conditions. Training improves caregivers' memory and comprehension of the drug regimen. Viewing the matrix format of instructions and hearing the audio instructions facilitates memory and comprehension of the drug regimen. An example of the matrix format is shown below with Xs indicating when the drug should be taken.

| | Morning | Noon | Evening | Bedtime |
|---|---|---|---|---|
| Drug A and its usage | X | | X | |
| Drug B and it usage | X | | | |
| Drug C and its usage | | | | X |
| Drug D and its usage | X | | X | |
| Drug E and its usage | | X | X | X |

The drug's usage (what the drug is taken for) should be included beside the drug name.

Please contact Amanda Boone, 937 S. Main St., Poplarville, MS, 39470 or email: acb10@msstate.edu if you have other questions or desire more information.
Thank you again for your participation in this project!

APPENDIX C

WORD FAMILIARITY SURVEY

(Gardner & Monge, 1977)

Directions: For each of the items below, select the numbered word or phrase that most nearly corresponds in meaning to the word in CAPITAL LETTERS and circle it.

---

CAPSIZE:
1) Leak
2) Race
3) Grow
4) Overturn
5) Measure

PROLONG:
1) Prompt
2) Decrease
3) Difficult
4) Extend
5) Waste

SUCCULENT:
1) Juicy
2) Raw
3) Cooked
4) Spoiled
5) Spicy

AGITATED:
1) Hungry
2) Excited
3) Agile
4) Tired
5) Sick

FRUGAL:
1) Sparing
2) Huge
3) Tasty
4) Fashionable
5) Musical

MOLEST:
1) Purchase
2) Muffle
3) Lowest
4) Annoy
5) Groom

WEIGHTY:
1) Sly
2) Serious
3) Shabby
4) Spry
5) Innocent

FANATIC:
1) Follower
2) Strange
3)Untrustworthy
4) Sly
5) Zealous

BUSTLE:
1) Tree
2) Ornament
3) Bureau
4) Movement
5) Cluster

LASCIVIOUS:
1) Lustful
2) Liberal
3) Final
4) Loser
5) Inclined

RECAPITULATE:
1) Surrender
2) Brief
3) Rebuild
4) Relay
5) Restate

REMUNERATE:
1) Check
2) Count
3) Replete
4) Compensate
5) Satisfy

APATHY:
1) Understanding
2) Leniency
3) Rage
4) Indifference
5) Danger

BRAVADO:
1) Celebrity
2) Outlaw
3) Boasting
4) Turmoil
5) Salutation

CURSORY:
1) Hasty
2) Dilatory
3) Intrinsic
4) Profane
5) Dire

INDIGENT:
1) Obnoxious
2) Moody
3) Sleep
4) Nasty
5) Poor

LOQUACIOUS:
1) Garrulous
2) Ostentatious
3) Frivolous
4) Limpid
5) Dowdy

HIATUS:
1) Break
2) Swamp
3) Fence
4) Disgust
5) Flower

BANAL:
1) Evil
2) Trite
3) Prohibitory
4) Jovial
5) Decaying

EFFECTUATE:
1) Praise
2) Accomplish
3) Dissimulate
4) Nullify
5) Pretend

DIAPHANOUS:
1) Nocturnal
2) Quarrelsome
3) Morbid
4) Logical
5) Ethereal

SPLEEN:
1) Grudge
2) Caprice
3) Impetuosity
4) Melancholy
5) Malice

HORDE:
1) Greed
2) Bully
3) Harvest
4) Crowd
5) Content

HIRSUTE:
1) Woman
2) Shaggy
3) Chamber
4) Quaint
5) Sorrowful

CAUDAL:
1) Brutal
2) Careful
3) Posterior
4) Nervy
5) Recent

GUIDON:
1) Miniature
2) Hat
3) Hero
4) Flag
5) Achiever

TEDIUM:
1) Dilatory
2) Anxiety
3) Exhaustion
4) Weakening
5) Dull

VICISSITUDE:
1) Direction
2) Generosity
3) Hardship
4) Ceremony
5) Ferocity

LASSITUDE:
1) Contempt
2) Convenience
3) Permissiveness
4) Lethargy
5) Levity

SEVERALLY:
1) Unkindly
2) Respectively
3) Continuously
4) Abruptly
5) Harshly

APPENDIX D

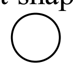
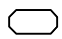
MEDICATION FAMILIARITY QUESTIONNAIRE

(L. Boone, personal communication, October 7, 2002)

DIRECTIONS: Please circle the correct answer. If you do not know the correct answer, mark "I don't know." Shapes are NOT shown actual size.

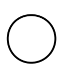
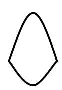
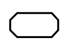
What is Lanoxin 0.125mg taken for?
A. bladder control  B. heart failure  C. hypertension  D. I don't know

What color is Lanoxin 0.125mg?
A. blue  B. white  C. yellow  D. I don't know

What shape is Lanoxin 0.125mg?
A.   B.   C.   D. I don't know

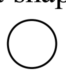
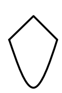
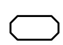
What is Glucophage 500 mg taken for?
A. sugar diabetes  B. osteoporosis  C. edema  D. I don't know

What color is Glucophage 500 mg?
A. green  B. purple  C. white  D. I don't know

What shape is Glucophage 500 mg?
A.   B.   C.   D. I don't know

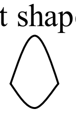
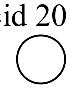
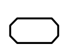
What is Zocor 20 mg taken for?
A. cholesterol B. ulcers  C. sugar diabetes  D. I don't know

What color is Zocor 20 mg?
A. pink  B. orange  C. white  D. I don't know

What shape is Zocor 20 mg?
A.   B.   C.   D. I don't know

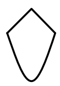
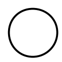
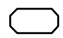
What is Pepcid 20 mg taken for?
A. hypertension  B. acid reflux  C. cholesterol  D. I don't know

What color is Pepcid 20 mg?
A. blue  B. cream  C. red  D. I don't know

What shape is Pepcid 20 mg?
A.   B.   C.   D. I don't know

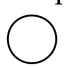
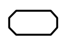
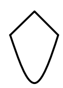
What is Vioxx 25 mg taken for?
A. stroke B. osteoarthritis C. depression D. I don't know

What color is Vioxx 25 mg?
A. green B. yellow C. purple D. I don't know

What shape is Vioxx 25 mg?
A.  B.  C.  D. I don't know

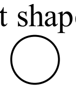
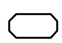
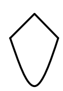
What is Cozaar 50 mg taken for?
A. acid reflux B. osteoporosis C. high blood pressure D. I don't know

What color is Cozaar 50 mg?
A. cream B. pink C. greenish blue D. I don't know

What shape is Cozaar 50 mg?
A.  B.  C.  D. I don't know

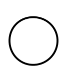
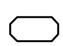
What is Detrol 2mg taken for?
A. edema B. bladder control C. heart failure D. I don't know

What color is Detrol 2mg?
A. yellow B. green C. white D. I don't know

What shape is Detrol 2mg?
A.  B.  C.  D. I don't know

What is Paxil 20 mg taken for?
A. bladder control B. depression C. acid reflux D. I don't know

What color is Paxil 20 mg?
A. purple B. white C. pink D. I don't know

What shape is Paxil 20 mg?
A.  B.  C.  D. I don't know

APPENDIX E

EXPLANATION OF STUDY TIMES

For Audio:

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| | Study time with bottles (min) | Study time with instruc-tions (min) | Number of words in audio recording | Number of words/ 140 wpm | Time to hear audio twice (min) | Total time needed (min) | Total time allow-ed (min) | Time with bottles & instr. before audio (min) |
| 3 List | 1.00 | 1.00 | 109 | 0.78 | 1.56 | 3.56→ | 4.00 | 0.44 |
| 5 List | 1.67 | 1.67 | 125 | 0.89 | 1.79 | 5.13→ | 6.00 | 0.87 |
| 8 List | 2.67 | 2.67 | 166 | 1.19 | 2.37 | 7.71→ | 9.00 | 1.29 |
| 3 Matrix | 1.00 | 1.00 | 135 | 0.96 | 1.93 | 3.93→ | 4.00 | 0.07 |
| 5 Matrix | 1.67 | 1.67 | 153 | 1.09 | 2.19 | 5.53→ | 6.00 | 0.47 |
| 8 Matrix | 2.67 | 2.67 | 197 | 1.41 | 2.81 | 8.15→ | 9.00 | 0.85 |

Column 1 = Study time for medication bottles = 20 sec/bottle (Morrell, Park, & Poon, 1989).
Column 2 = Study time for list or matrix format = 20 sec/drug (Day, 1988).
Column 3 = The total number of words used in the audio recording.
Column 4 = The total number of words used in the audio recording divided by the rate of speech of 140 words per minute (wpm) (Tun, Wingfield, Stine, & Mecsas, 1992).
Column 5 = Column 4 multiplied by two because the audio recording will be heard twice (Morrow, 2000).
Column 6 = Column 1 + Column 2 + Column 5
Column 7 = Column 6 rounded up to the nearest minute
Column 8 = Column 7 – Column 6

For Non-audio:

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| | Study time with bottles (min) | Study time with instruc-tions (min) | Study time with bottles and instruc-tions (min) | Total time allowed (min) |
| 3 List | 1.00 | 1.00 | 2.00 | 4.00 |
| 5 List | 1.67 | 1.67 | 2.66 | 6.00 |
| 8 List | 2.67 | 2.67 | 3.66 | 9.00 |
| 3 Matrix | 1.00 | 1.00 | 2.00 | 4.00 |
| 5 Matrix | 1.67 | 1.67 | 2.66 | 6.00 |
| 8 Matrix | 2.67 | 2.67 | 3.66 | 9.00 |

Column 1 = Study time for medication bottles = 20 sec/bottle (Morrell, Park, & Poon, 1989).
Column 2 = Study time for list or matrix format = 20 sec/drug (Day, 1988).
Column 3 = Column 4 – (Column 1 + Column 2).
Column 4 = Same as for audio condition.

APPENDIX F

PERSONAL INTERPRETATION QUESTIONNAIRE

(Mazzollo, Lasagna, & Griner, Mar. 1974; Hurd & Butkovich, 1986)

We are interested in the effective communication between a physician and a caregiver. To help us understand the clarity of some common prescription drug instructions, please answer as many of the following questions as possible in 4 minutes. It is understood that the physician's instructions would be reflected in the way the prescription reads. The previously studied medication instructions should **not** be used to complete this portion of the questionnaire.

1. If a physician tells your care recipient to take a prescription drug once a day, what time would you most likely suggest taking the medicine?

   ________________________________________

2. If the prescription reads "Take twice daily," at what times of the day would you suggest taking the drug?____________________________________________________
3. If the prescription reads "Take one tablet every twelve hours," at what times of the day would you suggest taking the drug?________________________________________
4. If the prescription reads "Take one capsule with meals," at what times of the day would you suggest taking the drug?_____________________________________________
5. If the prescription reads "Take one capsule once a day on an empty stomach," what time would you suggest taking the drug? (Please be specific.) ___________________
6. If the prescription reads "Take one tablet four times a day," at what times of the day would you suggest taking the drug?_______________________________________
7. Does your care recipient take pills at different times on weekends than weekdays because of a change in schedule? Yes/No (Circle one) If yes, please explain the differences________________________________________________________
8. If your care recipient was told to take Drug A and Drug B twice a day how would you suggest coordinating the 2 drugs?
   a. I would suggest taking both at the same time.
   b. I would suggest staggering the drugs to avoid taking both at once.

   If you answered b, explain how you would suggest taking Drug A & B.

   ________________________________________________________________

APPENDIX G

TIMELINE FOR EXPERIMENT SESSION

| | |
|---|---|
| • Introduction-meet/greet & explanation of purpose | (2 minutes) |
| • Answer questions about experience and background | (3 minutes) |
| • Set tape recorder volume | (1 minute) |
| • Complete Word Familiarity Survey | (10 minutes) |
| • Complete Medication Familiarity Questionnaire | (1.5 minutes) |
| • Time to study regimen | (4, 6, or 9 minutes) |
| • Distraction task | (4 minutes) |
| • Complete Memory Questionnaire | (10 minutes) |
| • Pill-loading task | (10 minutes) |
| • Debriefing | (2 minutes) |
| Total | 47.5, 49.9, or 52.5 minutes |

APPENDIX H

AUDIO VERSIONS OF INSTRUCTIONS

Audio version of list for 3 pill-types

Mrs. Johnson is 73 years old. She has type II diabetes and high cholesterol in her family. You are her caregiver. Her doctor prescribed the following medications to treat her condition and provided her with organized instructions.

Pepcid. Directions: Take one tablet twice daily to treat ulcers and acid reflux.

Zocor. Directions: Take one tablet at bedtime to lower cholesterol.
Do not take Zocor with grapefruit juice.

Glucophage. Directions: Take one tablet three times daily to treat sugar diabetes. Glucophage must be taken with food or milk.

As Mrs. Johnson's caregiver, you know that Mrs. Johnson does not eat breakfast. She always drinks a glass of milk before bed.

Audio version of list for 5 pill-types

Mrs. Johnson is 73 years old and has congestive heart failure. You are her caregiver. Her doctor prescribed the following medications to treat her condition and provided her with organized instructions.

Pepcid. Directions: Take one tablet twice daily to treat ulcers and acid reflux.

Lanoxin. Directions: Take one tablet once daily to treat heart failure.

Zocor. Directions: Take one tablet at bedtime to lower cholesterol.
Do not take Zocor with grapefruit juice.

Detrol. Directions: Take one tablet twice daily to treat overactive bladder.

Glucophage. Directions: Take one tablet three times daily to treat sugar diabetes. Glucophage must be taken with food or milk.

As Mrs. Johnson's caregiver, you know that Mrs. Johnson does not eat breakfast. She always drinks a glass of milk before bed.

Audio version of list for 8 pill-types

Mrs. Johnson is 73 years old and has recently had a heart attack. You are her caregiver. Her doctor prescribed the following medications to treat her condition and provided her with organized instructions.

Pepcid. Directions: Take one tablet twice daily to treat ulcers and acid reflux.

Cozaar. Directions: Take one tablet twice daily to treat high blood pressure.

Detrol. Directions: Take one tablet twice daily to treat overactive bladder.

Lanoxin. Directions: Take one tablet once daily to treat heart failure.

Zocor. Directions: Take one tablet at bedtime to lower cholesterol.
Do not take Zocor with grapefruit juice.

Vioxx. Directions: Take one tablet twice daily to treat osteoarthritis.
Vioxx must be taken with food.

Paxil. Directions: Take one tablet in the morning to treat depression.

Glucophage. Directions: Take one tablet three times daily to treat sugar diabetes. Glucophage must be taken with food or milk.

As Mrs. Johnson's caregiver, you know that Mrs. Johnson does not eat breakfast. She always drinks a glass of milk before bed.

Audio version of matrix for 3 pill-types

Mrs. Johnson is 73 years old. She has type II diabetes and high cholesterol in her family. You are her caregiver. Her doctor prescribed the following medications to treat her condition and provided her with organized instructions.

Take Pepcid in the morning and evening to treat ulcers and acid reflux.

Take Zocor at bedtime to lower cholesterol.
Do not take Zocor with grapefruit juice.

Take Glucophage at noon, evening, and bedtime to treat sugar diabetes. Glucophage must be taken with food or milk.

Take this drug in the morning: Pepcid

Take this drug at noon: Glucophage

Take these drugs in the evening: Pepcid and Glucophage

Take these drugs at bedtime: Zocor and Glucophage

As Mrs. Johnson's caregiver, you know that Mrs. Johnson does not eat breakfast. She always drinks a glass of milk before bed.

Audio version of matrix for 5 pill-types

Mrs. Johnson is 73 years old and has congestive heart failure. You are her caregiver. Her doctor prescribed the following medications to treat her condition and provided her with organized instructions.

Take Pepcid in the morning and evening to treat ulcers and acid reflux.

Take Lanoxin in the morning to treat heart failure.

Take Zocor at bedtime to lower cholesterol.
Do not take Zocor with grapefruit juice.

Take Detrol in the morning and evening to treat overactive bladder.

Take Glucophage at noon, evening, and bedtime to treat sugar diabetes.
Glucophage must be taken with food or milk.

Take these drugs in the morning: Pepcid, Lanoxin, and Detrol

Take this drug at noon: Glucophage

Take these drugs in the evening: Pepcid, Detrol, and Glucophage

Take these drugs at bedtime: Zocor and Glucophage

As Mrs. Johnson's caregiver, you know that Mrs. Johnson does not eat breakfast. She always drinks a glass of milk before bed.

Audio version of matrix for 8 pill-types

Mrs. Johnson is 73 years old and has recently had a heart attack. You are her caregiver. Her doctor prescribed the following medications to treat her condition and provided her with organized instructions.

Take Pepcid in the morning and evening to treat ulcers and acid reflux.

Take Cozaar in the morning and at bedtime to treat high blood pressure.

Take Detrol in the morning and evening to treat overactive bladder.

Take Lanoxin in the morning to treat heart failure.

Take Zocor at bedtime to lower cholesterol.
Do not take Zocor with grapefruit juice.

Take Vioxx at noon and evening to treat osteoarthritis. Vioxx must be taken with food.

Take Paxil in the morning to treat depression.

Take Glucophage at noon, evening, and bedtime to treat sugar diabetes. Glucophage must be taken with food or milk.

Take these drugs in the morning: Pepcid, Cozaar, Detrol, Lanoxin, and Paxil.

Take these drugs at noon: Vioxx and Glucophage

Take these drugs in the evening: Pepcid, Detrol, Vioxx, and Glucophage

Take these drugs at bedtime: Cozaar, Zocor, and Glucophage

As Mrs. Johnson's caregiver, you know that Mrs. Johnson does not eat breakfast. She always drinks a glass of milk before bed.

APPENDIX I

SCENARIOS

Scenario for 3 pill-types and list

Mrs. Johnson is 73 years old. She has type II diabetes and high cholesterol in her family. You are her caregiver. Her doctor prescribed the following medications to treat her condition and provided her with organized instructions.

Organized instructions:

| | |
|---|---|
| Pepcid | 1 tablet twice daily to treat ulcers and acid reflux |
| Zocor | 1 tablet at bedtime to lower cholesterol |
| Glucophage | 1 tablet 3 times daily to treat sugar diabetes |

As Mrs. Johnson's caregiver, you know that Mrs. Johnson does not eat breakfast. She always drinks a glass of milk before bed.

Scenario for 5 pill-types and list

Mrs. Johnson is 73 years old and has congestive heart failure. You are her caregiver. Her doctor prescribed the following medications to treat her condition and provided her with organized instructions.

Organized instructions:

| | |
|---|---|
| Pepcid | 1 tablet twice daily to treat ulcers and reflux |
| Lanoxin | 1 tablet once daily to treat heart failure |
| Zocor | 1 tablet at bedtime to lower cholesterol |
| Detrol | 1 tablet twice daily to treat overactive bladder |
| Glucophage | 1 tablet 3 times daily to treat sugar diabetes |

As Mrs. Johnson's caregiver, you know that Mrs. Johnson does not eat breakfast. She always drinks a glass of milk before bed.

Scenario for 8 pill-types and list

Mrs. Johnson is 73 years old and has recently had a heart attack. You are her caregiver. Her doctor prescribed the following medications to treat her condition and provided her with organized instructions.

Organized instructions:

| | |
|---|---|
| Pepcid | 1 tablet twice daily to treat ulcers and acid reflux |
| Cozaar | 1 tablet twice daily to treat high blood pressure |
| Detrol | 1 tablet twice daily to treat overactive bladder |
| Lanoxin | 1 tablet once daily to treat heart failure |
| Zocor | 1 tablet at bedtime to lower cholesterol |
| Vioxx | 1 tablet twice daily to treat osteoarthritis |
| Paxil | 1 tablet in the morning to treat depression |
| Glucophage | 1 tablet 3 times daily to treat sugar diabetes |

As Mrs. Johnson's caregiver, you know that Mrs. Johnson does not eat breakfast. She always drinks a glass of milk before bed.

Scenario for 3 pill-types and matrix

Mrs. Johnson is 73 years old. She has type II diabetes and high cholesterol in her family. You are her caregiver. Her doctor prescribed the following medications to treat her condition and provided her with organized instructions.

Organized instructions:

| | Morning | Noon | Evening | Bedtime |
|---|---|---|---|---|
| Pepcid to treat ulcers and acid reflux | X | | X | |
| Zocor to lower cholesterol | | | | X |
| Glucophage to treat sugar diabetes | | X | X | X |

As Mrs. Johnson's caregiver, you know that Mrs. Johnson does not eat breakfast. She always drinks a glass of milk before bed.

Scenario for 5 pill-types and matrix

Mrs. Johnson is 73 years old and has congestive heart failure. You are her caregiver. Her doctor prescribed the following medications to treat her condition and provided her with organized instructions.

Organized instructions:

| | Morning | Noon | Evening | Bedtime |
|---|---|---|---|---|
| Pepcid to treat ulcers and acid reflux | X | | X | |
| Lanoxin to treat heart failure | X | | | |
| Zocor to lower cholesterol | | | | X |
| Detrol to treat overactive bladder | X | | X | |
| Glucophage to treat sugar diabetes | | X | X | X |

As Mrs. Johnson's caregiver, you know that Mrs. Johnson does not eat breakfast. She always drinks a glass of milk before bed.

Scenario for 8 pill-types and matrix

Mrs. Johnson is 73 years old and has recently had a heart attack. You are her caregiver. Her doctor prescribed the following medications to treat her condition and provided her with organized instructions.

Organized instructions:

| | Morning | Noon | Evening | Bedtime |
|---|---|---|---|---|
| Pepcid to treat ulcers and acid reflux | X | | X | |
| Cozaar to treat high blood pressure | X | | | X |
| Detrol to treat overactive bladder | X | | X | |
| Lanoxin to treat heart failure | X | | | |
| Zocor to lower cholesterol | | | | X |
| Vioxx to treat osteoarthritis | | X | X | |
| Paxil to treat depression | X | | | |
| Glucophage to treat sugar diabetes | | X | X | X |

As Mrs. Johnson's caregiver, you know that Mrs. Johnson does not eat breakfast. She always drinks a glass of milk before bed.

APPENDIX J

DRUG REGIMEN COMPLEXITY CALCULATION METHOD

Method 1: Drug regimen complexity is the sum of the number of medication events scheduled in a 24-hour period. It is calculated using the following equation:

$$y = \Sigma\, x_1 + \tfrac{1}{2}(x_1)(x_2)$$

Where y = complexity, $x_1$ = frequency of dosing of each medication, and $x_2$ = the number of additional times $x_1$ occurred in the patient's drug regimen (Martin & Mead, 1982). This method is useful in calculating complexity of a regimen that involves two pills of the same medication to be taken simultaneously. However, the regimens used in this study did not involve two of the same medication to be taken simultaneously. The calculations for the drug regimens used in this study are as follows:

| | | |
|---|---|---|
| 3 pill-types | 2+1+3 | = 6 |
| 5 pill-types | 2+1+1+2+3 | = 9 |
| 8 pill-types | 2+2+2+1+1+2+1+3 | = 14 |

Method 2: A complexity score is calculated by summing different dosage intervals, which are weighted for frequency. Each medication is assigned a value corresponding to the number of times per day that medication is taken. Dosage interval enters the calculation only once unless the dosage intervals do not coincide (Kroenke & Pinholt, 1990).

| | | |
|---|---|---|
| 3 pill-types | 2+1+3 | = 6 |
| 5 pill-types | 2+1+3+1 | = 7 |
| 8 pill-types | 2+2+1+1+2+3 | = 11 |

The complexity score for 3 pill-types is the same as the drug regimen complexity calculation because none of the medications have coinciding dosage intervals.

The complexity score for 5 pill-types is less than the drug regimen complexity calculation because Pepcid and Detrol are both administered in the morning and evening. The complexity score for 8 pill-types is less than the drug regimen complexity calculation because Pepcid and Detrol are both administered in the morning and evening and because Lanoxin and Paxil are both administered in the morning.

Method 3: The Medication Complexity Index (MCI) takes into account the number of medications taken, the frequency of the doses, and the actions necessary to carry out administration. It also assigns a value to special instructions such as take with food or milk or take at bedtime. The MCI score is determined by summing the values given for each action and decision necessary to administer the medications over a 24-hour period (Opperman Kelley, 1988).

<u>3 pill-types</u>

| | |
|---|---|
| Pepcid score | = 2(twice-per-day administration) |
| Zocor score | = 1(once-per-day administration) |
| | 1(no grapefruit juice) |
| | 1(take at bedtime) |
| Glucophage score | = 3(three-times-per-day administration) |
| | <u>1(take with food or milk)</u> |
| TOTAL | = 9 |

<u>5 pill-types</u>

| | |
|---|---|
| Pepcid score | = 2(twice-per-day administration) |
| Lanoxin score | = 1(once-per-day administration) |
| Zocor score | = 1(once-per-day administration) |
| | 1(no grapefruit juice) |
| | 1(take at bedtime) |
| Detrol score | = 2(twice-per-day administration) |
| Glucophage score | = 3(three-times-per-day administration) |
| | <u>1(take with food or milk)</u> |
| TOTAL | = 12 |

<u>8 pill-types</u>

| | |
|---|---|
| Pepcid score | = 2(twice-per-day administration) |
| Cozaar score | = 2(twice-per-day administration) |
| Detrol score | = 2(twice-per-day administration) |
| Lanoxin score | = 1(once-per-day administration) |
| Zocor score | = 1(once-per-day administration) |
| | 1(no grapefruit juice) |
| | 1(take at bedtime) |
| Vioxx score | = 2(twice-per-day administration) |
| | = 1(take with food) |
| Paxil score | = 1(once-per-day administration) |
| | 1(take in the morning) |
| Glucophage score | = 3(three-times-per-day administration) |
| | 1(take with food or milk) |
| TOTAL | = 19 |

The MCI scores differ from the drug regimen complexity calculations because of the value added to Zocor for the special instructions of take at bedtime and do not take with grapefruit juice, the value added to Vioxx for the special instruction of take with food, the value added to Paxil for the special instruction of take in the morning, and the value added to Glucophage for the special instruction take with food or milk.

APPENDIX K

MEMORY QUESTIONNAIRE

(Day, 1988)

1. What is Zocor taken for?

_______________________________________________

2. Which pill(s) are only taken in the evening?

_______________________________________________

3. How many times per day is Glucophage taken?

_______________________________________________

4. Which pill is used to treat acid reflux?

_______________________________________________

5. How many Zocor should be taken each day?

_______________________________________________

6. What is Gluchophage taken for?

_______________________________________________

7. Which pill(s) are taken at bedtime?

_______________________________________________

8. What pill is used to lower cholesterol?

_______________________________________________

9. Which pill(s) do you take at noon?

_______________________________________________

10. How many times per day is Pepcid taken?

_______________________________________________

APPENDIX L

RAW DATA

| # | Training level | Task condition | Sound condition | Instruction format | MQ errors | OM errors | COM errors | Time errors | Pill-load rate (min/pill) |
|---|---|---|---|---|---|---|---|---|---|
| 1 | F | **3** | **NA** | **L** | 1 | 0 | 0 | 7 | 0.0493 |
| 2 | I | **8** | **A** | **M** | 9 | 60 | 0 | 0 | 0.1161 |
| 3 | F | **8** | **A** | **L** | 3 | 0 | 0 | 0 | 0.0604 |
| 4 | F | **3** | **NA** | **L** | 0 | 0 | 0 | 7 | 0.0586 |
| 5 | I | **5** | **NA** | **M** | 1 | 0 | 0 | 0 | 0.0625 |
| 6 | I | **3** | **A** | **L** | 9 | 22 | 15 | 4 | 0.2634 |
| 7 | I | **5** | **NA** | **M** | 8 | 0 | 0 | 7 | 0.2127 |
| 8 | I | **8** | **NA** | **M** | 3 | 0 | 0 | 0 | 0.0806 |
| 9 | I | **5** | **NA** | **L** | 8 | 12 | 1 | 0 | 0.1525 |
| 10 | F | **5** | **A** | **L** | 1 | 9 | 0 | 0 | 0.1239 |
| 11 | I | **3** | **NA** | **L** | 2 | 0 | 0 | 7 | 0.0617 |
| 12 | F | **5** | **A** | **M** | 2 | 0 | 0 | 0 | 0.0706 |
| 13 | I | **5** | **A** | **M** | 7 | 1 | 3 | 0 | 0.0929 |
| 14 | F | **8** | **NA** | **M** | 4 | 0 | 0 | 28 | 0.0633 |
| 15 | I | **8** | **NA** | **L** | 6 | 0 | 0 | 14 | 0.0580 |
| 16 | I | **5** | **NA** | **M** | 9 | 57 | 0 | 2 | 0.5983 |
| 17 | I | **3** | **NA** | **L** | 8 | 7 | 17 | 14 | 0.0962 |
| 18 | F | **8** | **NA** | **M** | 3 | 14 | 0 | 0 | 0.0776 |
| 19 | I | **8** | **NA** | **M** | 7 | 84 | 0 | 1 | 0.6186 |
| 20 | F | **8** | **NA** | **M** | 1 | 7 | 0 | 0 | 0.0946 |
| 21 | F | **3** | **NA** | **L** | 1 | 0 | 0 | 7 | 0.0707 |
| 22 | I | **5** | **A** | **L** | 9 | 0 | 14 | 7 | 0.0599 |
| 23 | F | **8** | **A** | **M** | 3 | 0 | 0 | 0 | 0.0741 |
| 24 | I | **5** | **A** | **L** | 9 | 56 | 3 | 2 | 1.0130 |
| 25 | F | **8** | **NA** | **L** | 3 | 0 | 0 | 7 | 0.0612 |
| 26 | F | **3** | **NA** | **M** | 0 | 0 | 0 | 0 | 0.0564 |
| 27 | I | **3** | **A** | **M** | 8 | 21 | 1 | 0 | 0.1136 |
| 28 | F | **8** | **NA** | **L** | 2 | 0 | 0 | 21 | 0.0477 |
| 29 | I | **3** | **A** | **M** | 6 | 21 | 0 | 14 | 0.0938 |
| 30 | F | **3** | **A** | **L** | 3 | 0 | 0 | 0 | 0.0783 |
| 31 | I | **8** | **NA** | **M** | 8 | 1 | 0 | 42 | 0.0961 |
| 32 | F | **8** | **NA** | **L** | 4 | 0 | 0 | 21 | 0.0847 |
| 33 | F | **8** | **A** | **M** | 4 | 0 | 0 | 0 | 0.0627 |
| 34 | I | **5** | **A** | **L** | 6 | 2 | 1 | 1 | 0.1208 |
| 35 | I | **5** | **NA** | **M** | 5 | 0 | 0 | 0 | 0.1714 |
| 36 | F | **8** | **A** | **M** | 3 | 0 | 0 | 0 | 0.0660 |
| 37 | F | **3** | **A** | **M** | 1 | 0 | 0 | 0 | 0.0719 |
| 38 | I | **5** | **A** | **L** | 3 | 7 | 0 | 7 | 0.1402 |
| 39 | I | **5** | **A** | **M** | 1 | 0 | 0 | 0 | 0.0598 |
| 40 | F | **3** | **A** | **L** | 1 | 0 | 0 | 7 | 0.0660 |
| 41 | F | **3** | **A** | **L** | 1 | 0 | 0 | 7 | 0.0600 |
| 42 | F | **8** | **NA** | **M** | 4 | 0 | 0 | 0 | 0.0623 |
| 43 | I | **8** | **A** | **L** | 4 | 0 | 2 | 15 | 0.0360 |

| # | Training level | Task condition | Sound condition | Instruction format | MQ errors | OM errors | COM errors | Time errors | Pill-load rate (min/pill) |
|---|---|---|---|---|---|---|---|---|---|
| 44 | I | 3 | A | M | 4 | 36 | 0 | 1 | 0.4917 |
| 45 | I | 3 | | M | 5 | 0 | 0 | 0 | 0.0688 |
| 46 | F | 5 | NA | M | 1 | 0 | 0 | 0 | 0.0519 |
| 47 | I | 3 | NA | L | 1 | 0 | 2 | 7 | 0.0848 |
| 48 | F | 5 | A | M | 2 | 0 | 0 | 0 | 0.0603 |
| 49 | I | 5 | NA | L | 7 | 0 | 0 | 7 | 0.1184 |
| 50 | F | 5 | NA | M | 2 | 0 | 0 | 0 | 0.0544 |
| 51 | F | 8 | NA | L | 3 | 0 | 0 | 14 | 0.1034 |
| 52 | F | 5 | NA | L | 4 | 0 | 0 | 7 | 0.0976 |
| 53 | F | 8 | A | M | 1 | 0 | 0 | 0 | 0.0380 |
| 54 | I | 3 | NA | L | 7 | 0 | 0 | 7 | 0.2298 |
| 55 | F | 3 | NA | M | 2 | 0 | 0 | 0 | 0.0724 |
| 56 | F | 3 | NA | M | 2 | 0 | 0 | 0 | 0.0540 |
| 57 | I | 3 | NA | M | 6 | 0 | 1 | 7 | 0.0740 |
| 58 | F | 8 | A | L | 3 | 0 | 0 | 14 | 0.0801 |
| 59 | I | 5 | NA | L | 2 | 0 | 0 | 7 | 0.0922 |
| 60 | I | 3 | A | L | 6 | 36 | 0 | 1 | 0.5750 |
| 61 | F | 5 | A | L | 1 | 0 | 0 | 0 | 0.0576 |
| 62 | I | 5 | A | M | 2 | 2 | 0 | 0 | 0.2110 |
| 63 | I | 8 | A | L | 7 | 0 | 0 | 7 | 0.0837 |
| 64 | F | 5 | A | M | 2 | 0 | 0 | 0 | 0.0467 |
| 65 | I | 8 | A | L | 4 | 0 | 0 | 14 | 0.1132 |
| 66 | F | 5 | A | M | 1 | 0 | 0 | 0 | 0.0548 |
| 67 | I | 3 | A | L | 2 | 0 | 0 | 0 | 0.1536 |
| 68 | I | 8 | NA | L | 10 | 68 | 111 | 5 | 0.0511 |
| 69 | F | 5 | NA | L | 4 | 0 | 0 | 0 | 0.0878 |
| 70 | F | 8 | A | L | 3 | 0 | 0 | 0 | 0.0869 |
| 71 | F | 3 | NA | M | 2 | 0 | 0 | 0 | 0.0962 |
| 72 | F | 3 | A | L | 2 | 0 | 0 | 7 | 0.0824 |
| 73 | I | 8 | NA | M | 4 | 0 | 1 | 21 | 0.0818 |
| 74 | I | 8 | A | M | 4 | 0 | 3 | 0 | 0.1257 |
| 75 | I | 3 | A | L | 3 | 0 | 0 | 7 | 0.1310 |
| 76 | F | 5 | A | L | 1 | 0 | 0 | 7 | 0.0873 |
| 77 | I | 3 | NA | M | 4 | 0 | 0 | 14 | 0.0874 |
| 78 | F | 8 | A | L | 3 | 0 | 0 | 7 | 0.0590 |
| 79 | I | 8 | A | L | 9 | 0 | 0 | 0 | 0.1331 |
| 80 | I | 3 | NA | M | 3 | 0 | 0 | 0 | 0.1093 |
| 81 | I | 8 | NA | L | 8 | 7 | 7 | 14 | 0.0728 |
| 82 | I | 5 | NA | L | 8 | 35 | 19 | 14 | 0.2302 |
| 83 | F | 5 | NA | L | 2 | 0 | 0 | 0 | 0.0635 |
| 84 | I | 3 | NA | M | 1 | 0 | 0 | 0 | 0.0460 |
| 85 | F | 5 | A | L | 2 | 0 | 0 | 0 | 0.0603 |
| 86 | I | 8 | A | M | 6 | 0 | 0 | 0 | 0.0422 |
| 87 | F | 5 | NA | L | 1 | 0 | 0 | 7 | 0.0611 |

| # | Training level | Task condition | Sound condition | Instruction format | MQ errors | OM errors | COM errors | Time errors | Pill-load rate (min/pill) |
|---|---|---|---|---|---|---|---|---|---|
| 88 | I | **8** | **A** | **M** | 8 | 84 | 0 | 4 | 0.4221 |
| 89 | F | **5** | **NA** | **M** | 5 | 0 | 1 | 7 | 0.0748 |
| 90 | I | **8** | **NA** | **L** | 1 | 0 | 0 | 14 | 0.0505 |
| 91 | F | **3** | **A** | **M** | 0 | 0 | 0 | 0 | 0.0521 |
| 92 | F | **3** | **NA** | **L** | 1 | 0 | 0 | 7 | 0.0374 |
| 93 | F | **5** | **NA** | **M** | 2 | 0 | 0 | 0 | 0.0532 |
| 94 | F | **3** | **A** | **M** | 0 | 0 | 0 | 0 | 0.0543 |
| 95 | I | **5** | **A** | **M** | 6 | 0 | 0 | 0 | 0.1217 |
| 96 | F | **3** | **A** | **M** | 1 | 0 | 0 | 0 | 0.0479 |

F = Formal caregiver
I = Informal caregiver
A = Audio
NA = Non audio
L = List
M = Matrix
WFS = Word Familiarity Survey
MFQ = Medication Familiarity Questionnaire
MQ = Memory Questionnaire errors
OM = Omission errors
COM = Commission errors

APPENDIX M

MANOVA INTERACTIONS RESULTS

| Independent Variable | Wilk's Lambda | F Value | df | p |
|---|---|---|---|---|
| Training level x Task condition | 0.8363 | 1.27 | 10 | 0.2527 |
| Training level x Sound | 0.9408 | 0.86 | 5 | 0.5159 |
| Training x Instruction format | 0.8873 | 1.73 | 5 | 0.1401 |
| Task condition x Sound | 0.8550 | 1.11 | 10 | 0.3606 |
| Task condition x Instruction format | 0.8893 | 0.82 | 10 | 0.6085 |
| Sound x Instruction format | 0.9094 | 1.36 | 5 | 0.2521 |
| Training x Task condition x Sound | 0.9143 | 0.62 | 10 | 0.7921 |
| Training x Task condition x Instruct. | 0.7878 | 1.72 | 10 | 0.0816 |
| Training x Sound x Instruction | 0.9099 | 1.35 | 5 | 0.2554 |
| Task condition x Sound x Instruction | 0.9246 | 0.54 | 10 | 0.8567 |
| Train x Task condition x Sound x Instr. | 0.8664 | 1.01 | 10 | 0.4375 |

APPENDIX N

BOX AND WHISKER PLOTS

The boxes consist of (from left to right) the lower quartile, the median, and the upper quartile. The minimum value is to the left of the box and the maximum value is to the right of the box. When the boxes overlap, the data sets are not significantly different. When the boxes do not overlap, it is likely that differences are significant. A smaller box indicates less variability in the data (Nelson, n.d.). Figure N.1 indicates that training level significantly affects combined score.

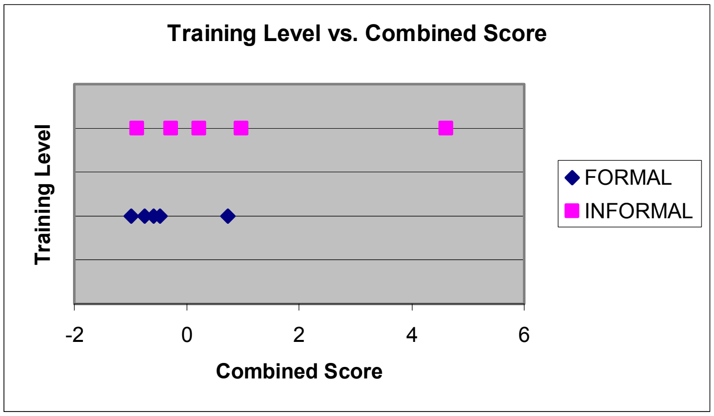



Figure N.1. Training Level vs. Combined Score

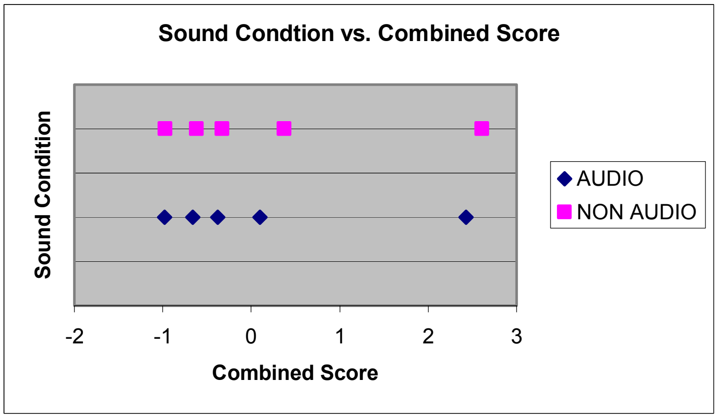



Figure N.2. Sound Condition vs. Combined Score

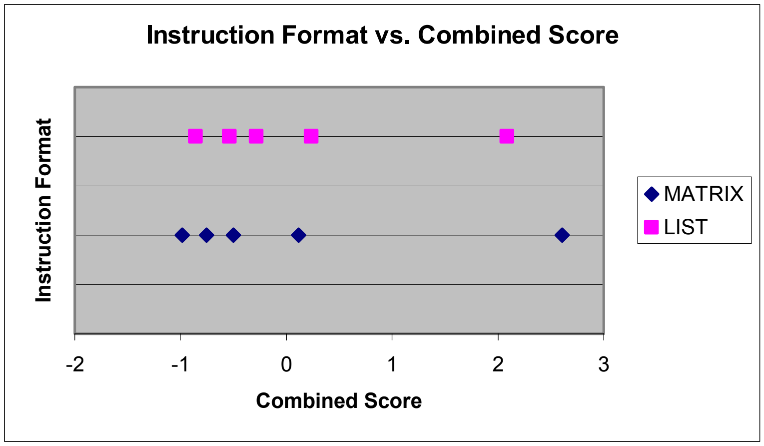



Figure N.3. Instruction Format vs. Combined Score

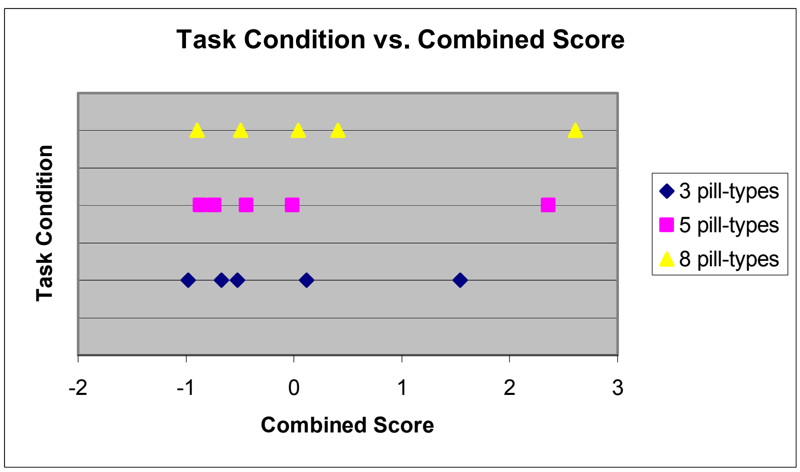



Figure N.4. Task Condition vs. Combined Score

APPENDIX O

COMPLETE LISTING OF CORRELATION COEFFICIENTS

| | MQ | OM | COM | TIME | RATE | MFQ | WFS |
|---|---|---|---|---|---|---|---|
| | 1.00000 | 0.44592 *** | 0.34850 *** | 0.21211 * | 0.49490 **** | 0.54562 **** | 0.41185 **** |
| **OM** | 0.44592 **** | 1.00000 | 0.39282 **** | -0.03667 | 0.70958 **** | 0.44278 **** | 0.45588 **** |
| **COM** | 0.34850 *** | 0.39282 **** | 1.00000 | 0.19542 | 0.06667 | 0.22001 * | 0.23979 * |
| **TIME** | 0.21211 * | -0.03667 | 0.19542 | 1.00000 | -0.03676 | -0.00608 | 0.13917 |
| **RATE** | 0.49490 **** | 0.70958 **** | 0.06667 | -0.03676 | 1.00000 | 0.53859 **** | 0.48824 **** |
| **MFQ** | 0.54562 **** | 0.44278 **** | 0.22001 * | -0.00608 | 0.53859 **** | 1.00000 | 0.26539 ** |
| **WFS** | 0.41185 **** | 0.45588 **** | 0.23979 * | 0.13917 | 0.48824 **** | 0.26539 ** | 1.00000 |

MQ = Memory Questionnaire
OM = Omission errors
COM = Commission errors
TIME = Time errors
RATE = Pill-loading rate
MFQ = Medication Familiarity Questionnaire
WFS = Word Familiarity Survey

* = $r < 0.05$
** = $r < 0.01$
*** = $r < 0.001$
**** = $r < 0.0001$

APPENDIX P

MORE INFORMATION ON HOW MSMS FUNCTIONS

The opening computer screen would contain a disclaimer statement like the one shown below:

Disclaimer: This program is not meant to replace the advice of a doctor or pharmacist. Always consult your qualified health professional before making changes to a medication regimen.

The computer would keep up with the current time of day.

Computer asks:
Please enter the following information about your care recipient's daily routine. Enter time in this format xx:xx. Indicate a.m. or p.m. after each time.

- What time does your care recipient wake up?
- Does your care recipient eat breakfast? Y or N
    - (If yes is given) What time is breakfast?
- Does your care recipient each lunch? Y or N
    - (If yes is given) What time is lunch?
- Does your care recipient eat supper? Y or N
    - (If yes is given) What time is supper?
- What time does your care recipient go to bed?

The computer shows the output of the daily routine information. The computer asks if the information is correct and allows the caregiver to make changes if necessary. The computer would create the following time schedule.

| | |
|---|---|
| Morning | = wake up time until 11:00am |
| Noon | = 11:01am until 3:59pm |
| Evening | = 4:00pm until supper time |
| Bedtime | = supper time + 1 minute until bedtime |

Computer asks: Please click on the medicines that your care recipient takes.

Pepcid
Cozaar
Detrol
Lanoxin
Vioxx
Zocor
Paxil
Glucophage
K-Dur 20
Synthroid

The computer shows the following schedule: (based on selection of all ten medicines). An audio recording is also played. The caregiver can record their own voice saying the instructions and re-play the audio as many times as desired.

| | **Morning** | **Noon** | **Evening** | **Bedtime** |
|---|---|---|---|---|
| **Pepcid** to treat ulcers and acid reflux | X | | X | |
| **Cozaar** to treat high blood pressure | X | | X | |
| **Detrol** to treat overactive bladder | X | | X | |
| **Lanoxin** to treat heart failure | | | | X |
| **Vioxx** to treat osteoarthritis | X | | X | |
| **Zocor** to lower cholesterol | | | | X |
| **Paxil** to treat depression | X | | | |
| **Glucophage** to treat sugar diabetes | X | X | X | |
| **K-Dur** 20 to treat low blood potassium levels | X | | | |
| **Synthroid** to treat hypothyroidism | X | | | |

Computer asks:
How many doses have been missed? Caregiver enters the number of missed doses.

Computer asks: Please click on the missed dose. Computer continues to ask for missed doses and allows the caregiver to input information as many times as the number of missed doses.

Computer shows new updated schedule and asks:
Do you want to start over? Y or N
If yes is given, computer shows initial screen with disclaimer statement. If no, computer continues to display current screen.

<u>By default the computer knows:</u>

Once daily = morning
Twice daily = morning, evening
Three times daily = morning, noon, evening

K-Dur 20 = once daily
Synthroid = once daily
Lanoxin = bedtime
Zocor = bedtime
Paxil = morning
Pepcid = twice daily
Cozaar = twice daily
Detrol = twice daily
Vioxx = twice daily

Glucophage = three times daily
Computer would highlight in color medicines that should be taken with food (Glucophage, Vioxx, and K-Dur 20). Computer would schedule these medicines only during times when care recipient eats.

Rules for reincorporating doses:

Paxil –take as soon as possible that same day, otherwise skip
Zocor – if realized that night take it, otherwise skip
Lanoxin – take as soon as possible that same day
Pepcid – move both doses into next time interval (e.g. morn, eve becomes noon, bed)
Cozaar - move both doses into next time interval (e.g. morn, eve becomes noon, bed)
Detrol - move both doses into next time interval (e.g. morn, eve becomes noon, bed)
Vioxx - move both doses into next time interval (e.g. morn, eve becomes noon, bed)
Glucophage – move doses into next time interval
K-Dur 20 – reschedule if remembered within two hours of skipped dose
Synthroid – take as soon as possible that same day, otherwise skip

The computer knows never to double up a dose to make up for it.

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