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Effects of information emphasis and representational format on memory and comprehension for medication schedules

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on Memory and Comprehension
for Medication Schedules
by
Robert A. Lipinski

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Abstract

This study examined the effects of information emphasis and representational format on memory and comprehension for medication schedules. Participants received list or matrix medication schedules that emphasized time of day or drug name information. Memory and comprehension tests contained 3 types of questions: inferential questions, and factual questions assessing time of day or drug name information. Participants given list schedules emphasizing drug names, demonstrated better memory and comprehension for drug name questions, than participants given list schedules emphasizing time of day information. Overall, the matrix formats produced slightly better performance for the inferential questions, while the list formats produced slightly better performance for the factual time of day questions. Implications of these results are discussed.
Introduction and Literature Review

Nonadherence to prescription drug regimens is a major problem in the national health care system (Hammond & Lambert, 1994; Kazis, & Friedman, 1988; Morrow, Leirer, & Sheikh, 1988; Morrow, Leirer, Altieri, & Tanke, 1991). The term nonadherence refers to the failure to take medication correctly, as it is prescribed (O’Brien, Petrie, & Raeburn, 1992; Park, Morrell, Frieske, and Kincaid, 1992; Reid, 1985). An individual who takes medication at the wrong times, takes too many pills, or does not take any medication at all, would be described as nonadherent (Jernigan, 1984; Park et al., 1992). The consequences of nonadherence are often severe, with patient nonadherence frequently leading to serious health complications, or even death (Hammond & Lambert, 1994). It has been estimated that as many as 125,000 deaths occur each year because of medication nonadherence (Jackson & Huffman, 1990).

Although nonadherence is a problem for adults of all ages (Boczkowski & Zeichner, 1985; Heiby & Carlson, 1986; Morrell, Park, & Poon, 1989), it is an especially significant problem for older adults, who are more likely to be placed on complicated drug regimens, and for whom physiological changes associated with aging make negative consequences of nonadherence more likely (Kazis & Friedman, 1988; Morrow et al., 1988).

Factors Underlying Nonadherence

Adherence to a medication regimen relies upon the successful completion of a number of steps, involving a variety of cognitive and motivational components
Individuals must first gather relevant medication information (e.g., when and how long to take medication) from physicians, pharmacists, and reference materials. Once gathered, medication information must be successfully comprehended in order for an individual to form a goal of the adherence task and a plan to complete it. Once information has been gathered and comprehended, an individual must be able to recall important medication information (e.g., time and dose information) when necessary. After information has been comprehended and remembered, an individual must perform the prospective memory task of remembering to take medication at the correct time. In addition to these components, adherence also depends upon meta-cognitive ability, involving an individual’s ability to monitor how well medication instructions have been understood and remembered (Park et al., 1994; Morrow et al., 1996). Finally, adherence to a medication regimen requires motivation (Park et al., 1994; Reid, 1985), which depends upon factors such as beliefs regarding the value of the treatment, and judgments regarding one’s ability to perform the adherence task (Janz & Becker, 1984). Hence, medication adherence represents a complex, multifaceted health behavior, encompassing a variety of cognitive and motivational components (Leirer, Morrow, Pariante, & Sheikh, 1988; Leirer, Morrow, Tanke, & Pariante, 1991). A breakdown in any of these components may cause nonadherence to occur.

Although many factors underlie medication nonadherence, one factor
implicated as a cause of nonadherence, involves medication instructions that are
difficult to comprehend and remember (Boyd, Covington, Stanaszek, & Coussons,
1974; Kimminau & Wright, 1981; Morrell et al., 1989; Mustard & Harris, 1989; Reid,
1985; Sharpe & Mikeal, 1974). As indicated previously, comprehension and memory
for medication instructions represent two early links in the chain of behaviors necessary
for medication adherence. Although other cognitive components such as prospective
memory are important, these components cannot be supported unless medication
instructions are easy to understand and remember in the first place (Morrow, Leirer,
& Andrassy, 1996). For example, remembering to take medication at a specific time is of
little use, if vague or ambiguously worded medication instructions cause an individual
to misunderstand, or fail to remember this important piece of information. Similarly,
vague or ambiguously worded medication instructions may fail to support motivational
components of adherence (Morrow et al., 1988). For example, individuals may be
unwilling to devote the effort necessary to adhere to a medication regimen when
medication instructions fail to clearly and explicitly outline important medication
information (Morrow et al., 1988; Park et al., 1994). However, medication instructions
that are clear and explicit, may not only enhance comprehension and memory for
important medication information, but may also motivate individuals to adhere to a
medication regimen (Morrow et al., 1988; Park et al., 1994). Thus, medication
instructions that are easy to comprehend and remember play an important role in
supporting cognitive and motivational components of adherence.
Factors that Aid Memory and Comprehension

It is unfortunate therefore that medication instructions as they are typically provided by physicians, pharmacies, and health care providers, are not designed so as to optimize comprehension and memory for their content (Morrell et al., 1989; Morrow et al., 1988; Mustard & Harris, 1989; Reid, 1985). The greatest fault of medication instructions is that information is often presented in a vague and ambiguous manner that forces patients to infer how they should take their medication (Morrow et al., 1988). This results in variable, frequently incorrect interpretations. For example, instructions often contain vague phrases such as "take twice a day", that fail to explicitly state specific times for taking medication (Morrell et al., 1989; Reid, 1985). This forces patients to infer specific times to take medication, and different patients interpret these instructions differently (Morrow et al., 1989). A related problem, is that such phrases are also ambiguous (Morrow et al., 1988). For example, most patients assume that the phrase "take three times a day", means that a medication should be taken with meals. However, such instructions generally mean that the medication should be taken every eight hours (Morrow et al., 1988). The problem of vague and ambiguously worded medication instructions is compounded by the lack of consistency displayed from one set of medication instructions to another (Morrell et al., 1989). For example, some medication instructions give time and dose information in terms of the number of pills per day, others in terms of the amount of time since last pill, while others associate pill taking with everyday events such as meals (Reid, 1985). This lack
of consistency makes adhering to a medication regimen particularly difficult for individuals taking multiple medications. A consequence of these problems with medication instructions is that patients frequently experience difficulty comprehending and remembering how to take their medications correctly (Morrell, Park, & Poon, 1990; Morrow et al., 1988; Mustard & Harris, 1989; Reid, 1985). In light of these problems, studies have identified explicitness and familiarity as two factors associated with improved comprehension and memory for medication instructions.

**Explicitness.** One factor associated with improved comprehension and memory for medication instructions is the use of medication instructions that are explicit and unambiguous. For example, in a series of three experiments, Morrell et al. (1989) examined the comprehension and memory of older and younger adults for prescription drug labels. The procedure for these three experiments was identical except for variation in study time and the type of prescription labels employed. Participants received either 3, 5, or 8 medicine bottles with instruction labels taped to one side. In experiments 1 and 2 the instruction labels were explicit and unambiguous, while in experiment 3, everyday conditions were approximated by using vague and ambiguous instruction labels taken from an actual pharmacy (e.g., the pharmacy labels used vague phrases such as “take every 12 hours”, vs explicit phrases like “take at 8 a.m. and 8 p.m.”). The bottles were presented sequentially, with participants given a set amount of time to study the label on each bottle. Study time was 20 seconds per bottle in experiment 1 and unlimited in experiments 2 and 3. For the memory task, the
investigator handed participants a drug sheet that listed the drug names and physical descriptions of the medications they had studied. Participants were asked to provide the following information for each drug listed on the drug sheet: time of day to take medicine, amount of medicine to be taken, reason for taking the medication or diagnosis, and any additional special instructions from the labels. Following this, participants completed the comprehension task. Participants were informed that in an everyday situation an individual would probably devise a 24-hour plan to help them comply with a medication regimen. Participants were shown two new sample labels and a 24-hour plan designating when and how to take these two new medications. The investigator reviewed the plan with each participant until the participant understood how the plan was constructed. The original 3, 5, or 8 medicine bottles from the memory task were then returned to the participant for reference. The participant was then instructed to devise a written plan indicating how they would take these medications over a 24-hour period.

Results indicated that older adults demonstrated poorer memory and comprehension than younger adults across all three experiments, whether study time was limited to 20 seconds per label or unlimited (Morrell et al., 1989). An interesting finding was that despite their poorer memory performance, older adults did not take full advantage of the unlimited study time in experiments 2 and 3 by studying the instruction labels longer than the younger adults. Morrell et al. (1989) cite this finding as an indication that at least part of the age-difference in memory could be attributed to
the fact that the older adults did not recognize when they had studied the material long enough to remember it. However, both older adults and younger adults did increase their study time as drug load increased, indicating that they were responsive to the increasing task demands. A second finding was that older and younger adults were equally disadvantaged by the increased amount of information they had to remember in the high drug load conditions, with both older and younger adults remembering less as the information was increased. Thus, remembering large amounts of medication information appears to be equally difficult for older and younger adults. The third and most striking finding, was that both older and younger adults had difficulty comprehending prescription labels obtained from an actual pharmacy. In experiments 1 and 2 where explicit and unambiguous prescription labels were used, the comprehension of older and younger adults was near ceiling. However, in experiment 3 that used vague and ambiguous prescription labels obtained from an actual pharmacy, comprehension levels were lower, with older adults and younger adults appearing to be equally disadvantaged. Thus, although the older adults demonstrated poorer memory and comprehension than the younger adults, they appeared equally capable of benefiting from explicit prescription labels.

A beneficial effect of explicit format was also found by Morrow, Leirer, and Altieri (1995), who examined the comprehension and memory of older adults for medication instructions organized in list or paragraph formats. Participants received information about a single medication in three different instruction formats: a
categorized list, a simple list, and a paragraph. The instruction formats were similar in that each outlined the steps necessary to take the medication correctly. However, the instruction formats differed in how explicitly they outlined these steps. The categorized list was the most explicit, because it emphasized both the order and grouping of these steps by presenting each step on a separate line, and grouping related steps together. The simple list was less explicit, because it emphasized the order of the steps, but did not emphasize their grouping. The paragraph format was the least explicit, because it emphasized neither the order or grouping of the steps.

Each participant viewed all three instruction formats, and were tested for comprehension and memory of each. For the comprehension task, participants answered questions while looking at the instruction sheets. Then, participants completed the memory task in which they were asked to recall everything they could remember about the instruction sheet they had previously viewed.

Results indicated that with unlimited study time, older adults found the medication instructions easiest to understand when they were presented in the two list formats, than when they were presented as a paragraph (Morrow et al., 1995). There was no effect of instruction format on recall with unlimited study time. However, with limited study time, older adults demonstrated better comprehension and recall for the simple list than for either the categorized list or paragraph. Apparently, this result occurred because participants were able to read more of the simple list instruction during the study period. Participants were also aware of the benefits of the list
instructions, and preferred these instructions over the paragraph. Thus, these results indicate that explicit list instructions may not only be beneficial for memory and comprehension, but may encourage older adults to take their medications correctly. An unanswered question concerns the effect of explicit list instructions on the memory and comprehension of younger adults.

**Familiarity.** A second factor associated with improved comprehension and memory for medication instructions, is the use of medication instructions that are familiar to patients (Morrow et al., 1988). For example, Morrow et al. (1996, 1991) found that older and younger adults share a schema for taking medication. When asked to order and group 10 pieces of important medication information, participants consistently grouped this information into three categories that were ordered in terms of how to accomplish the medication taking task: (1) General Information: Doctor Name, Medication Name, and Purpose; (2) How to take: Dose, Schedule, Duration, and Warnings; and (3) Possible outcomes: Mild side-effects, Severe side-effects, and Emergency information. This order and grouping was identical for older and younger adults, except that for younger adults doctor name and warning items switched group membership. Morrow et al. (1996, 1991) tested whether medication instructions compatible with this schema were better remembered and preferred to less compatible instructions. Participants were presented with three types of instructions: standard instructions, category instructions, and scrambled instructions. The standard instructions followed the schema outlined above. The category instructions were
compatible with the schema in grouping but presented the categories in a nonstandard order ("How to," "General," and "Outcome"). The scrambled instructions were least consistent with the schema because all 10 items of information appeared in nonpreferred positions. Participants were given 90 seconds to read each instruction format. Following a four minute filler task, participants were given two minutes to recall all the information from the instruction sheet. Participants then rated how well they thought they recalled the instruction sheet. Finally, recall was directly probed by asking questions focused on the pieces of information in the instruction sheets.

Results indicated that instructions more compatible with the schema were more accurately recalled than instructions that presented information in other orders. Compatible instructions were better recalled than category instructions, and category instructions were better recalled than scrambled instructions. The absence of an age x instruction interaction, indicated that both older and younger adults benefitted from the schema-compatible instructions, although younger adults recalled more information than older adults. Moreover, both older and younger adults were aware of the beneficial effect of the schema-compatible instructions for memory performance, and preferred these instructions. Thus, medication instructions were most effective when they matched the way participants viewed the medication taking task. These results are consistent with findings indicating a beneficial effect for medication instructions that make use of familiar concepts (Morrow et al., 1988). For example, medication instructions that link taking medication to events in a patients daily routine (e.g.,
mealtimes and bedtime), tend to be better understood and remembered (Heiby & Carlson, 1986; Morrow et al., 1988).

**Summary.** In short, medication instructions that are explicit and familiar to patients, are better comprehended and remembered. Moreover, both older and younger adults appear to benefit from explicit and familiar medication instructions. However, most research has examined comprehension and memory for medication instructions pertaining to single medications. Relatively little research has examined comprehension and memory for medication instructions pertaining to multiple medications (but see Day, 1988; Park et al., 1994). This relative lack of focus on instructions for multiple medications is surprising, since multiple drug regimens pose greater demands on comprehension and memory than single drug regimens, making them ideal targets for cognitive interventions. Moreover, the need to take multiple medications is a common real-world problem, particularly for older adults.

**Multiple Medications**

A focus on instructions that pertain to multiple medications is particularly important for individuals on multiple drug regimens (Park et al., 1994). Such individuals must not only be able to comprehend and remember time and dose schedules for individual medications, but must also be able to form a plan for taking medication that coordinates time and dose schedules across multiple medications (Morrell et al, 1989, 1990). Generally, it is left to patients to construct such plans for themselves (Park et al., 1994). However, evidence indicates that individuals experience
difficulty constructing these plans when presented with prescription labels taken from an actual pharmacy (Morrell et al., 1989). Presumably, the problems with typical prescription labels (e.g., vague, ambiguous, inconsistent) that impact negatively on comprehension and memory for single medication regimens, are compounded when individuals attempt to organize time and dose information in order to form a plan that coordinates this information across multiple medications. Given this difficulty, health care providers can assist individuals on multiple drug regimens, by providing them with written plans for taking their medications (Kazis & Friedman, 1988; Reid, 1985). Such plans can reduce patient errors, and allow patients to adhere to their medication regimens more effectively.

However, such instruction plans can only do so if they avoid the pitfalls associated with typical medication instructions. For example, an instruction sheet provided by an actual doctor to an older patient is displayed on the top portion of figure 1 (Day, 1988). Although these instructions were intended to serve as a helpful guide, they exemplify the problems of medication instructions discussed previously. Specifically, instructions for the medications are vague and ambiguous. They generally fail to specify exactly when the medications should be taken, and they generally possess more than one interpretation. Moreover, the manner in which instructions are given for the different medications is inconsistent (i.e., number of pills per day, amount of time since last pill, or in association with meals). Not surprisingly, the patient given this instruction plan experienced difficulty adhering to his medication regimen (Day,
Figure 1

List Format

Inderal - 1 tablet 3 times a day

Lanoxin - 1 tablet every a.m.

Carafate - 1 tablet before meals and at bedtime

Zantac - 1 tablet every 12 hours (twice a day)

Quinaglute - 1 tablet 4 times a day

Coumadin - 1 tablet a day

<table>
<thead>
<tr>
<th></th>
<th>Breakfast</th>
<th>Lunch</th>
<th>Dinner</th>
<th>Bedtime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lanoxin</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inderal</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td></td>
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<tr>
<td>Quinaglute</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td>Carafate</td>
<td>✓</td>
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<tr>
<td>Zantac</td>
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<td>✓</td>
</tr>
<tr>
<td>Coumadin</td>
<td></td>
<td></td>
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<td>✓</td>
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</tbody>
</table>
1988). However, when the list format designed by the doctor was modified into a matrix format similar to the one shown on the bottom portion of figure 1, the patient’s ability to adhere to his medication regimen improved.

Day (1988) examined the comprehension and memory of younger adults for the list and matrix formats displayed in figure 1. She found that the two formats produced different effects on performance. Participants who studied the matrix format demonstrated better memory and comprehension than participants who studied the list format. She concluded that the matrix instructions were superior to the list instructions because they emphasized the union of drug and time information (i.e., when to take what). However, an unanswered question concerns the relative contribution of the matrix format itself vs. the use of consistent and explicit instructions across medications (Day, 1988). Aside from the difference in representational format, the matrix differs from the list through the use of instructions that consistently and explicitly anchor times for taking medication to meals and bedtime. Past research has documented the effectiveness of medication instructions that follow an explicit list format (e.g., Morrow et al., 1988; 1995). Thus, it is possible that the list instructions could be as effective, or more effective than the matrix instructions, if they were modified to match the matrix instructions in consistency and explicitness. This experiment was partly designed to address this question.

The Present Study

A modified form of the doctor’s list instructions is displayed on the left side of
figure 2. Like the matrix instructions in figure 1, this list consistently and explicitly anchors times for taking medication to meals and bedtime for all of the medications. Hence, a comparison of these list instructions with an equivalent set of instructions in a matrix format, should allow the relative contribution of the matrix format vs. the use of consistent instructions across medications to be examined. However, an additional question concerns the best way to design the list and matrix instructions. Should the instructions be designed to emphasize drug names, or time of day information? An interesting possibility is that the answer to this question might depend on the types of questions participants are asked to answer. For example, if participants are asked questions that focus on drug names, such as “How many Lanoxin do you take per day?”, it might be better to design instruction sheets that emphasize drug names. However, if participants are asked questions that focus on time of day information, such as “How many pills do you take with breakfast?”, it might be better to design instruction sheets that emphasize time of day information. To examine this possibility two types of matrix format and two types of list format were used in this study. One type of each format emphasized drug names, and one type of each format emphasized time of day information. The type of information emphasized was arbitrarily defined by what information appeared at the top of each display. It is important to note that although this designation was fairly straightforward for the list formats, it was not so clear cut for the matrix formats, because participants had the option of referencing these displays from top to bottom, or from left to right. An example of the two types of
list format and two types of matrix format are displayed in figures 2 and 3 respectively. It was expected that participants who studied a list or matrix format emphasizing drug names, would demonstrate an advantage for questions that focused on drug names, whereas participants who studied a list or matrix format emphasizing time of day information, would demonstrate an advantage for questions that focused on time of day information.

In addition to the effects of information emphasis, we were also interested in the effects of different question types on participant's memory and comprehension performance. Much of the previous research on memory and comprehension for medication instructions has used factual questions that assess memory and comprehension for information that can be found directly within a drug label or instruction sheet (Park et al., 1994). For example, experimental participants are often asked questions that focus on the number of pills that should be taken within a specified time interval. Answering such questions does not require participants to go beyond the information provided, because the answers to such questions can be found directly within the drug label or instruction sheet. However, taking medication often requires people to make inferences, that is, drawing conclusions or making an interpretation when the needed information is not explicitly stated in the instructions (Park et al., 1994). For example, if the instructions for a medication state that one pill should be taken at breakfast, lunch, and dinner, how many pills should a patient bring with them if they leave home after breakfast and will not be back home until dinner the
Figure 2: List Formats

List with Drug Name Emphasis

Lanoxin
Breakfast- 1 tablet

Inderal
Breakfast- 1 tablet
Lunch- 1 tablet
Dinner- 1 tablet

Quinaglute
Breakfast- 1 tablet
Lunch- 1 tablet
Dinner- 1 tablet
Bedtime- 1 tablet

Carafate
Breakfast- 1 tablet
Lunch- 1 tablet
Dinner- 1 tablet
Bedtime- 1 tablet

Zantac
Lunch- 1 tablet
Bedtime- 1 tablet

Coumadin
Bedtime- 1 tablet

List with Time of Day Emphasis

Breakfast
Lanoxin- 1 tablet
Inderal- 1 tablet
Quinaglute- 1 tablet
Carafate- 1 tablet

Lunch
Inderal- 1 tablet
Quinaglute- 1 tablet
Carafate- 1 tablet
Zantac- 1 tablet

Dinner
Inderal- 1 tablet
Quinaglute- 1 tablet
Carafate- 1 tablet

Bedtime
Quinaglute- 1 tablet
Carafate- 1 tablet
Zantac- 1 tablet
Coumadin- 1 tablet
Figure 3: Matrix Formats

Matrix Emphasizing Drug Name Information

<table>
<thead>
<tr>
<th></th>
<th>Lanoxin</th>
<th>Inderal</th>
<th>Quinaglute</th>
<th>Carafate</th>
<th>Zantac</th>
<th>Coumadin</th>
</tr>
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<tbody>
<tr>
<td>Breakfast</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>Lunch</td>
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<tr>
<td>Dinner</td>
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<td>Bedtime</td>
<td>1</td>
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</table>

Matrix Emphasizing Time of Day Information

<table>
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<tr>
<th></th>
<th>Breakfast</th>
<th>Lunch</th>
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<th>Bedtime</th>
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<tr>
<td>Lanoxin</td>
<td>1</td>
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<tr>
<td>Inderal</td>
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<td>Quinaglute</td>
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<tr>
<td>Carafate</td>
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<tr>
<td>Zantac</td>
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<td>1</td>
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<tr>
<td>Coumadin</td>
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<td>1</td>
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</table>
next day? Day (1988) found that participants had more difficulty answering these questions correctly, because in order to do so, they were required to go beyond the information explicitly provided by the medication instructions. For this reason, we decided to examine memory and comprehension for both factual and inferential questions. Factual questions tested information explicitly provided by the instruction sheets, while inferential questions required participants to go beyond the information explicitly provided by the instruction sheets, and to make inferences regarding their content. It was expected that participant's memory and comprehension would be higher for the factual questions than for the inferential questions.

Finally, the decision to include both a memory task and a comprehension task in this study, was motivated by the theoretical distinction between memory and comprehension. It has been suggested that memory and comprehension represent distinct cognitive operations (Findahl & Hoijer, 1985; Gates, 1986; Ortony, 1978; Woodall, Davis, & Sahin, 1983). Whereas memory is primarily involved with the storage and retrieval of information, comprehension is believed to involve the application of knowledge stored in memory to make sense of new incoming information (Findahl & Hoijer, 1985; Gates, 1986; Woodall et al., 1983). This distinction between memory and comprehension raises the possibility that information can be remembered without being comprehended, or comprehended without being remembered (Ortony, 1978). Thus, separate measures of memory and comprehension were included in this study, to address the possibility that participants might remember
the instructions without understanding them, or might comprehend the instructions without remembering them. By using separate measures of memory and comprehension, we also hoped to gain greater insight into how these two processes were influenced by the experimental manipulations. If memory and comprehension represent distinct cognitive operations, then it is possible that memory and comprehension might be influenced differently by the experimental manipulations examined in this study. Thus, separate measures of memory and comprehension were included to address the possibility that the experimental manipulations might have different effects on memory and comprehension.

**Hypotheses tested.** The first hypothesis of this study was that individuals who studied the list instructions, and individuals who studied the matrix instructions, would display different levels of memory and comprehension for time and dose information. Day (1988) found that a matrix format produced better memory and comprehension than a list format. However, aside from a difference in representational format, her matrix format differed from her list format through the use of instructions that consistently and explicitly anchored times for taking medication to meals and bedtime. List instructions are probably more familiar than matrix instructions to most people, and this greater familiarity with list instructions raises the possibility that list instructions could be as effective, or more effective than matrix instructions, if they matched matrix instructions in consistency and explicitness. Thus, it was predicted that individuals who studied the list instructions would demonstrate better memory and
comprehension than individuals who studied the matrix instructions.

A second hypothesis was that the effect of the two types of instructions (drug name emphasis, time of day emphasis) would differ depending on the types of questions participants were asked to answer. It was predicted that participants who studied instruction sheets emphasizing drug names would demonstrate better memory and comprehension for questions that focused on drug names, whereas participants who studied instruction sheets emphasizing time of day information, would demonstrate better memory and comprehension for questions that focused on time of day information.

A third hypothesis was that participants would demonstrate different levels of memory and comprehension for the factual and inferential questions. It was predicted that participant’s memory and comprehension would be higher for the factual questions than for the inferential questions.
Method

Participants. Seventy one young adults: 67 males, 4 females ($M = 19.34$ Yr., $SD = 1.12$) participated. All participants were drawn from the University participant pool and received course credit for participating.

All participants completed a survey including a self-assessment of health status, a self-rating of their ability to follow medication instructions, years of formal education, and number of prescription medications currently taken. They first rated their ability to follow medication instructions on a 4 point scale where 4 = very good, 3 = good, 2 = fair, and 1 = poor. Most participants reported their ability to follow medication instructions as good. Participants rated their health status using a similar scale. Most participants rated their health status as good. Participants then listed the number of prescription medications taken. The majority of participants were not taking any prescription medications. Participants had completed an average of 14 ($SD = 1.22$) years of education.

Design. This experiment was analyzed as a two-way factorial design, with representational format (list or matrix) and information emphasis (time of day information or drug names) as between subjects factors. The number of participants in each experimental condition were: list format with time of day emphasis = 19, list format with drug name emphasis = 17, matrix format with time of day emphasis = 16, matrix format with drug name emphasis = 19. Analyses were conducted for three dependent variables: factual questions focusing on drug names, factual questions...
focusing on time of day information, and inferential questions. Because each
participant completed both a memory task and a comprehension task, a total of six
dependent measures were collected for each participant.

Materials. The experimental stimuli were adapted from Day (1988), and were formed
from a six drug regimen prescribed by a doctor to an older adult. Using these six drugs,
four instruction sheets were constructed which conveyed the manner in which these
drugs needed to be taken over a one day period. These instruction sheets followed
either a matrix or list format. There were two types of matrix format, and two types of
list format. One type of each format was designed to emphasize drug names, while one
type of each format was designed to emphasize time of day information. The result of
this process was the construction of four instruction sheets which conveyed the same
information, but differed due to the format in which this information was presented (list
vs. matrix), as well as the type of information emphasized (drug names vs. time of day
information). Because two instruction sheets were needed for each participant (one for
the memory task and one for the comprehension task), a second set of four instruction
sheets was constructed by substituting different drug names (from the same class of
drugs) for the drug names used in the first set of instruction sheets.

Tests assessing memory and comprehension for the instruction sheets all
contained 17 questions (see Appendix for sample test sheet). These questions were
either factual or inferential. Factual questions tested information explicitly provided by
the instruction sheets, while inferential questions required participants to go beyond
material explicitly provided by the instruction sheets, and to make inferences regarding their content. Factual questions were divided into questions that focused on drug names, and those that focused on time of day information. An example of a factual question focusing on a drug name would be “When do you take Lanoxin?”, whereas an example of a factual question focusing on time of day information would be “How many pills do you take at breakfast?”. An example of an inferential question would be “If you leave home after lunch, and will not be back home until bedtime the next day, how many Quinaglute should you bring along?”. For each question, participants were asked to circle the best answer or answers from the answer choices presented on the test sheet.

Initially, a pool of 34 questions was created for both drug regimens (i.e., each set of four instruction sheets). These pools were then split to create two tests of 17 questions for each drug regimen. Each test contained 6 inferential questions and 11 factual questions, with 6 of the factual questions focusing on drug names, and 5 of the factual questions focusing on time of day information. The tests were scored based on the number of test questions participants answered correctly. Participants received one point for each correct answer. For questions in which the correct answer choice had more than one piece of information, participants were required to correctly circle all pieces of information in order to receive credit. The maximum scores on each test were 6 for the inferential questions, 6 for the factual drug questions, and 5 for the factual time of day questions.
Procedure. Participants were tested individually or in groups ranging from 2 to 6 individuals. Before beginning the experiment the participant(s) completed a survey assessing medication experience, and ability to follow medication instructions, by self-report. Participants were asked to pretend that they were a patient who had just completed a visit to their doctor. During this visit their doctor had prescribed six medications for them to take. As a guide intended to aid compliance with this regimen, their doctor had provided them with an instruction sheet outlining the number of each pill to take, as well as the times of day that each pill needed to be taken. In order to ensure that all participants understood the experimental procedure, participants were given a sample instruction sheet, accompanied by an explanation of the tasks they would be performing, and were given the opportunity to ask questions. This procedure appeared to be effective in clearing up any misunderstandings.

Participants first completed the memory portion of the experiment. Participants were handed an instruction sheet and asked to study it. After two minutes the instruction sheet was taken away, and participants completed a filler task for 2½ minutes. Participants were then handed a question sheet and given five minutes to complete it by circling the correct answer or answers to each question. Following this, participants completed the comprehension portion of the experiment. A second instruction sheet was handed to them and they were given five minutes to complete a question sheet similar to that used for the memory task. However, participants were instructed to answer these questions by referring directly to the information presented
in the instruction sheet. The two instruction sheets used for the memory and
comprehension tasks were counterbalanced across blocks of participants. The two
question sheets used to test memory and comprehension for each drug regimen were
also counterbalanced across blocks of participants.
Results and Discussion

As noted above, a similar question sheet was administered twice to each of the participants during the experiment: once to assess memory without the instruction sheet available and again to assess comprehension with the instruction sheet present. Therefore, two sets of dependent measures were obtained for the three question types (factual time of day, factual drug, inferential) examined in this experiment (see Tables 1 to 6 for descriptive data). Separate analyses were conducted on the memory data and comprehension data.

Memory analyses. Initially, the three dependent variables were subjected to a 2 x 2 multivariate analysis of variance (MANOVA), Wilk's criterion, with representational format (list vs matrix) and information emphasis (time of day information vs drug names) treated as independent variables. The MANOVA yielded a significant effect for representational format only, $F(3, 65) = 2.94, p = .040$. Results of a discriminant analysis indicated that the difference between the list and matrix formats was best characterized by a linear combination of the dependent variables, $F(3, 67) = 3.11, p = .032$ (eigenvalue = 0.14; standardized score coefficients = -0.12, 0.80, and -0.59 for the factual drug, time of day, and inferential questions respectively). Stepwise backward selection of the dependent variables indicated that only the time of day questions and inferential questions contributed significantly to group separation, $F(2, 68) = 4.69, p = .012$.

Thus, the nature of group differences appear to be best explained in terms of a
performance difference between the time of day questions and the inferential questions for the list and matrix formats. In effect, the standardized score coefficients presented above define a new dependent variable reflecting a difference between the time of day questions and the inferential questions. This interpretation is reasonable in light of the distinction between factual questions and inferential questions. The time of day questions were factual in nature, and provided a test for information that could be found directly within the medication schedules. For example, "How many lanoxin do you take per day?". The inferential questions required participants to go beyond the information explicitly provided within the medication schedules, and make inferences regarding their content. For example, "If you leave home after breakfast, and will not be home until lunch time the next day, how many lanoxin should you take along?". Both questions require knowledge of time of day information for lanoxin (i.e., the time of day that lanoxin is taken), but the factual time of day question can be answered by merely referring to the display, while answering the inferential question requires that time of day information for lanoxin is first referenced, then used to infer how many pills need to be taken over a 24 hour period.

Participants who studied the matrix formats demonstrated better performance on average for the inferential questions than for the time of day questions (76% correct vs. 59% correct). In contrast, participants who studied the list formats demonstrated better performance on average for the time of day questions than for the inferential questions (71% correct vs 67% correct). Thus, it appears that the list format was
slightly more helpful for the time of day questions than for the inferential questions, while the matrix format was slightly more helpful for the inferential questions than for the time of day questions. However, this conclusion must be qualified by the fact that it was only participants who studied the list with time of day emphasis that demonstrated better performance for the time of day questions than for the inferential questions (71% correct vs 60% correct). Participants in the list with drug name emphasis, did not demonstrate this pattern (72% correct vs 75% correct). This difference between the two list formats accounts for there being only a small overall advantage for the time of day questions (71% correct) over inferential questions (67%) for those participants studying the list formats. In contrast to this difference between the list format with time of day emphasis, and the list format with drug name emphasis, participants who studied the matrix format with time of day emphasis, and participants who studied the matrix format with drug name emphasis, both demonstrated better performance for the inferential questions (75% correct, 76% correct respectively) than for the time of day questions (61% correct, 58% correct respectively). This similarity between the two matrix formats accounts for there being a larger overall advantage for inferential questions (76% correct) than for factual time of day questions (59% correct) for those participants who studied the matrix formats. Although somewhat equivocal, these results indicate that the question of which representational format is superior may depend on whether factual questions or inferential questions are examined. Although the overall difference between the two formats is small, the matrix format appears to be
superior for inferential questions, while the list format appears to be superior for factual
questions.

Neither the main effect for information emphasis nor the interaction between
information emphasis and representational format was significant.

Univariate analyses. The dependent measures included in the MANOVA were
then individually subjected to univariate ANOVAs with representational format and
information emphasis as independent variables. The decision to follow the MANOVA
with univariate analyses was motivated by a fundamental distinction between the two
factors examined in this study. For representational format, it was possible that either
the list or matrix instructions would prove superior for all three dependent variables.
There was no a priori reason for believing that the effect of representational format
would depend on which specific dependent variable was examined. Because list
instructions are probably more familiar than matrix instructions to most people, it was
predicted that list instructions would produce better memory and comprehension than
matrix instructions on all three dependent variables. Thus, the effect of representational
format was tested with a MANOVA that examined all three dependent variables
simultaneously.

In contrast, for information emphasis, it was predicted that participants who
studied instruction sheets emphasizing drug names would demonstrate better memory
and comprehension for questions that focused on drug names, whereas participants who
studied instruction sheets emphasizing time of day information, would demonstrate
better memory and comprehension for questions that focused on time of day information. That is, it was predicted that the effects of each level of information emphasis would depend on which dependent variable was examined. Thus, given the nature of these predictions, the effect of information emphasis was tested with univariate analyses that provided more powerful tests of the specific hypotheses we were interested in.

Although the interaction was not significant in the MANOVA, the univariate analyses indicated a significant interaction between representational format and information emphasis for the factual drug questions, $F(1, 67) = 5.99, p = .017$ (see Table 1 for means). Participants who studied the list format emphasizing drug names demonstrated better performance on the factual drug questions than participants who studied the list format emphasizing time of day information, $F(1, 67) = 7.26, p = .009$. Thus, for the list format, the effect of information emphasis was consistent with the second hypothesis. As predicted, studying an instruction sheet that emphasized drug names facilitated performance on questions that focused on drug name information.

However, this was not the case for the matrix format. Rather, there was no significant difference between participants who studied the matrix format emphasizing drug names and participants who studied the matrix format emphasizing time of day information, $F(1, 67) = .61, p = .44$. Although this result appears contradictory, it must be remembered that the designation of information emphasis was not as clear cut for the matrix format as it was for the list format, because participants could choose to study
the matrix from top to bottom or from left to right. It is possible that this allowed participants to apply a single learning strategy to both matrices. For example, if individuals follow a strategy where they attempt to link drug names with the times of day that these drugs should be taken, this would predict that individuals would study the matrix organized by drug names from top to bottom, and the matrix organized by time of day information from left to right. Thus, this interaction between representational format and information emphasis may reflect the fact that the matrix format gave participants freedom to follow a preexisting learning strategy, whereas the list format did not.

It is interesting to note that the main effect of representational format approached significance for the factual time of day questions, \( F (1, 67) = 3.90, p = .052 \) (see table 2 for means). As demonstrated by the marginal means, participants who studied the list format demonstrated better performance on the factual time of day questions than participants who studied the matrix format. Thus, although not significant, this result indicates a tendency for performance to be affected by representational format as well as information emphasis.

No significant main effect or interaction was found for the inferential questions (see Table 3 for means).

**Comprehension Analyses.** The comprehension data were subjected to analyses identical to those conducted on the memory data. Initially, the three dependent variables were subjected to a 2x2 multivariate analysis of variance (MANOVA), Wilk's criterion, with
representational format (list vs matrix) and information emphasis (time of day information vs drug names) as independent variables. Neither of the main effects nor the interaction was significant. Following the same rationale discussed above, the dependent measures included in the MANOVA were then individually subjected to univariate ANOVAs with representational format and information emphasis as independent variables.

**Univariate Analyses.** The univariate analyses indicated a significant main effect of information emphasis for the factual drug questions, $F(1, 67) = 6.78, p = .011$ (see Table 4 for means). As displayed by the marginal means, participants who studied instruction sheets emphasizing drug names demonstrated better performance on the factual drug questions than participants who studied instruction sheets emphasizing time of day information. Thus, consistent with the second hypothesis, performance was facilitated when the type of information emphasized by the instruction sheet matched the types of questions participants attempted to answer. However, the presence of a ceiling effect on this measure indicates that this result should be viewed with caution.

The univariate analyses indicated that there was no main effect or interaction for the factual time of day questions (see Table 5 for means).

The univariate analyses indicated that there was no main effect or interaction for the inferential questions (see Table 6 for means).
### Table 1

Mean Number of Correct Responses and Mean Percentage of Correct Responses for Memory Factual Drug Questions as a Function of Representational Format and Information Emphasis

<table>
<thead>
<tr>
<th>Information Emphasis</th>
<th>Representational Format</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>List</td>
<td>4.16 (70%)</td>
<td>1.61</td>
</tr>
<tr>
<td></td>
<td>Matrix</td>
<td>5.13 (85%)</td>
<td>1.09</td>
</tr>
<tr>
<td>Time of Day</td>
<td></td>
<td>4.60 (77%)</td>
<td></td>
</tr>
<tr>
<td>Drug Names</td>
<td></td>
<td>5.29 (88%)</td>
<td>1.16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.79 (80%)</td>
<td>1.08</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.03 (84%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.69 (78%)</td>
<td>1.10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4.94 (82%)</td>
<td></td>
</tr>
</tbody>
</table>

**Note.** Higher scores indicate better memory performance with six representing the maximum possible score.
### Table 2

<table>
<thead>
<tr>
<th>Information Emphasis</th>
<th>Representational Format</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>List</td>
<td>3.56</td>
<td>1.17</td>
</tr>
<tr>
<td></td>
<td>Matrix</td>
<td>2.97</td>
<td>1.33</td>
</tr>
</tbody>
</table>

**Time of Day**

<table>
<thead>
<tr>
<th></th>
<th>M (71%)</th>
<th>3.31 (66%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>3.53</td>
<td>3.06</td>
</tr>
<tr>
<td></td>
<td>1.17</td>
<td>1.29</td>
</tr>
</tbody>
</table>

**Drug Names**

<table>
<thead>
<tr>
<th></th>
<th>M (72%)</th>
<th>3.22 (64%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>3.59</td>
<td>2.90</td>
</tr>
<tr>
<td></td>
<td>1.12</td>
<td>1.33</td>
</tr>
</tbody>
</table>

Note. Higher scores indicate better memory performance with five representing the maximum possible score.
<table>
<thead>
<tr>
<th>Information Emphasis</th>
<th>List</th>
<th>Matrix</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time of Day</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>3.58 (60%)</td>
<td>4.50 (75%)</td>
<td>4.00 (67%)</td>
</tr>
<tr>
<td>SD</td>
<td>2.01</td>
<td>1.10</td>
<td></td>
</tr>
<tr>
<td><strong>Drug Names</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>4.47 (75%)</td>
<td>4.58 (76%)</td>
<td>4.53 (76%)</td>
</tr>
<tr>
<td>SD</td>
<td>1.77</td>
<td>1.31</td>
<td></td>
</tr>
<tr>
<td><strong>M</strong></td>
<td>4.00 (67%)</td>
<td>4.54 (76%)</td>
<td></td>
</tr>
</tbody>
</table>

*Note.* Higher scores indicate better memory performance with six representing the maximum possible score.

Table 3

Mean Number of Correct Responses and Mean Percentage of Correct Responses for Memory Inferential Questions as a Function of Representational Format and Information Emphasis
<table>
<thead>
<tr>
<th>Information Emphasis</th>
<th>List M</th>
<th>Matrix M</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time of Day</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>5.79 (97%)</td>
<td>5.88 (98%)</td>
<td>5.83 (97%)</td>
</tr>
<tr>
<td>SD</td>
<td>0.42</td>
<td>0.34</td>
<td>0.34</td>
</tr>
<tr>
<td><strong>Drug Names</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>6.00 (100%)</td>
<td>6.00 (100%)</td>
<td>6.00 (100%)</td>
</tr>
<tr>
<td>SD</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Note. Higher scores indicate better comprehension performance with six representing the maximum possible score.

Table 4

Mean Number of Correct Responses and Mean Percentage of Correct Responses for Comprehension Factual Drug Questions as a Function of Representational Format and Information Emphasis
<table>
<thead>
<tr>
<th>Information Emphasis</th>
<th>Representational Format</th>
<th>Time of Day</th>
<th>M</th>
<th>4.47 (89%)</th>
<th>4.25 (85%)</th>
<th>4.37 (87%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td></td>
<td>0.70</td>
<td>0.78</td>
<td></td>
</tr>
<tr>
<td>Drug Names</td>
<td></td>
<td>M</td>
<td></td>
<td>4.65 (93%)</td>
<td>4.37 (87%)</td>
<td>4.50 (90%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD</td>
<td></td>
<td>0.79</td>
<td>0.68</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td></td>
<td>4.56 (91%)</td>
<td>4.31 (86%)</td>
<td></td>
</tr>
</tbody>
</table>

Note. Higher scores indicate better Comprehension performance with five representing the maximum possible score.

Table 5

Mean Number of Correct Responses and Mean Percentage of Correct Responses for Comprehension Time of Day Questions as a Function of Representational Format and Information Emphasis
<table>
<thead>
<tr>
<th>Information Emphasis</th>
<th>List</th>
<th>Matrix</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time of Day</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>5.47 (91%)</td>
<td>5.25 (88%)</td>
<td>5.37 (90%)</td>
</tr>
<tr>
<td>SD</td>
<td>0.96</td>
<td>0.93</td>
<td></td>
</tr>
<tr>
<td>Drug Names</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>5.41 (90%)</td>
<td>5.37 (90%)</td>
<td>5.39 (90%)</td>
</tr>
<tr>
<td>SD</td>
<td>0.62</td>
<td>1.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.44 (91%)</td>
<td>5.31 (89%)</td>
<td></td>
</tr>
</tbody>
</table>

Note. Higher scores indicate better comprehension performance with six representing the maximum possible score.

Table 6

Mean Number of Correct Responses and Mean Percentage of Correct Responses for Comprehension Inferential Questions as a Function of Representational Format and Information Emphasis
General Discussion

The first hypothesis of this study was that participants who studied the list instructions, and participants who studied the matrix instructions, would demonstrate different levels of memory and comprehension for time and dose information. Because list instructions are probably more familiar than matrix instructions to most people, it was predicted that participants who studied the list format would demonstrate better memory and comprehension than participants who studied the matrix format. This prediction of superiority for the list format received some support. Participants who studied the list format showed a tendency to demonstrate better memory performance for the time of day questions than participants who studied the matrix format, although this difference was not significant.

Perhaps of greater interest, results from the memory task suggest that whether a list format or matrix format is superior, may depend on whether factual questions or inferential questions are examined. Although the overall difference between the two formats was small, the list format on average produced better performance for the factual time of day questions, while the matrix format on average produced better performance for the inferential questions. This difference in performance between the list and matrix formats is somewhat puzzling. What is it about the matrix format that caused it to produce better performance for the more difficult inferential questions? One possibility is that the matrix format is more efficient than the list format in emphasizing the union of drug name and time of day information (Day, 1988). This
may make the matrix format more conducive to answering questions that require rapid coordination of drug name and time of day information. For example, when asked an inferential question such as, “If you leave home after dinner, and will not be back home until bedtime the next day, how many quinaglute should you take along?”, an individual with a matrix schedule can find the row or column for quinaglute, and quickly count pills while scanning across or down the columns or rows of the schedule in order to determine how many pills should be taken along. By contrast, an individual with a list schedule can follow the same scanning procedure, but the more rigid top down structure of the list format generally requires an individual to read through more schedule entries, which makes the process of counting pills slower and more difficult. This difference between the matrix format and the list format is certainly small, but it could explain why the matrix format produced slightly better performance for the inferential questions. One possible application of this finding, is that matrix formats may be better than list formats for everyday planning tasks, such as filling a pillbox to ensure that a sufficient amount of medication is taken when one is away from home.

Another interesting question to ask would be whether the effectiveness of the list and matrix formats depends not only on the types of questions participants try to answer, but on the aptitudes and preferences of individual participants. One difference between the list and matrix formats is that the list format is verbal-sequential in nature, while the matrix format is primarily visual-spatial. Perhaps the matrix format might only aid performance on the inferential questions to the extent that participants possess
sufficient visual-spatial aptitude and a preexisting preference for visual formats. Individuals with high verbal aptitude and a preference for verbal-sequential formats might not benefit from matrix formats, and might actually demonstrate better performance with list formats. Although this is somewhat speculative, the relationship between individual aptitudes and representational format is an interesting topic for future research.

The second hypothesis of this study was that the effect of the two types of instructions (drug name emphasis, time of day emphasis) would differ depending on the types of questions participants were asked to answer. It was predicted that participants who studied instruction sheets emphasizing drug names would demonstrate better memory and comprehension for questions that focused on drug names, whereas participants who studied instruction sheets emphasizing time of day information would demonstrate better memory and comprehension for questions that focused on time of day information. The first prediction was supported by the finding that participants who studied the list format emphasizing drug names, demonstrated better memory and comprehension for factual drug questions, than participants who studied the list format emphasizing time of day information. Thus, performance was facilitated when the type of question participants attempted to answer matched the type of information emphasized by the instruction sheets. This indicates that in addition to explicitness and familiarity, information emphasis may also be a factor capable of influencing memory and comprehension for medication instructions. However, due to a ceiling effect on the
comprehension factual drug questions, any conclusion regarding the effect of information emphasis on comprehension for medication instructions should be viewed with caution. Further work, using a more difficult measure of comprehension, is needed before any firm conclusion about this issue can be made.

It is interesting that an effect of information emphasis was found only for the list format, and not for the matrix format. As discussed previously, it is possible that the matrix format gave participants greater freedom than the list format, to apply a preexisting learning strategy when studying the instructions. Reports from several experimental participants indicate that they preferred to approach the task of studying the instructions in terms of drug names (i.e., linking drug names with the time(s) of day that each drug needed to be taken). As discussed previously, if the matrix format gave participants greater freedom than the list format to follow this strategy, this could explain the interaction between information emphasis and representational format found in this study. Thus, a clear direction for future research would be to conduct a survey of experimental participants for their use of learning strategy. At this point, it is unclear whether most participants preferred to approach the learning task in terms of drug names (i.e., linking individual drug names with the time(s) of day each drug needed to be taken), or in terms of time of day information (i.e., linking each of the four time periods in the day, with the drug(s) that needed to be taken at that time). Greater knowledge of how individuals prefer to approach the learning task, could lead
to the design of medication instructions that optimize memory and comprehension, through organization according to this preference.

Greater knowledge of participant's preferred learning strategies would also allow investigation into possible age-differences in learning strategies for multiple medication schedules. As discussed previously, Morrow et al. (1996, 1991) found that older and younger adults appeared to view the task of taking medication in the same way. That is, they found that older and younger adults agreed on the order and grouping of information necessary to take medication correctly, and found that medication instructions were better remembered and comprehended when information appeared in the preferred order and grouping. However, these studies only examined memory and comprehension for instructions pertaining to single medications. As discussed previously, the task of learning time and dose information for multiple medications is more complex (Park et al., 1994). Individuals taking multiple medications must not only comprehend and remember time and dose schedules for individual medications, but must also form a plan for taking medication that coordinates time and dose schedules across multiple medications (Morrell et al, 1989, 1990). In order to form this plan properly, individuals must follow a strategy when studying medication instructions, that allows them to link together time and dose information for multiple medications in an efficient manner. Compared to younger adults, older adults are more likely to have experience taking multiple medications, and this greater experience with the task may lead older adults to follow different (and
perhaps more efficient) strategies for learning multiple medication schedules, than those followed by younger adults.

One difficulty in interpreting the results of this study, is the presence of ceiling effects on a number of the dependent measures, especially for the comprehension task. These were due in part to the relative simplicity of the medication regimens. Although the experimental stimuli were based on a six drug regimen actually prescribed to an older adult (see Day, 1988), real-world medication regimens are frequently not so simple. The medication regimens used in this study were relatively simple, because although time information (the time(s) each drug needed to be taken) varied across medications, dose information (always 1 tablet for each drug) remained constant. Thus, participants could essentially ignore one dimension of the information while studying the instructions. In addition, the recognition measures used to assess memory and comprehension for the medication regimens were also relatively simple (see Appendix). However, the relative simplicity of the medication regimens and recognition tasks, also makes the discovery of significant effects for information emphasis and representational format quite striking. It is possible that stronger effects of information emphasis and representational format could be found with more complex medication schedules, and with the use of cued or free recall measures of memory and comprehension. Of particular interest, these two changes might allow greater insight into the effects of information emphasis and representational format on comprehension for medication schedules.
Past research has identified explicitness and familiarity as two factors associated with improved memory and comprehension for medication instructions (e.g., Heiby & Carlson, 1986; Morrow et al., 1996, 1995, 1988; Morrell et al., 1989). The results of this study supplement these findings, and indicate that information emphasis and representational format may also be associated with improved memory and comprehension for medication instructions. It appears that information emphasis may aid memory and comprehension for medication instructions when the information emphasized by the instructions matches the type of information individuals are required to remember and comprehend. It also appears that representational format may aid memory and comprehension for medication instructions when the format of medication instructions is tailored to the type of task individuals are required to perform.

These results hold potential implications for the design of multiple medication schedules by health care providers. As with instructions for single medications, multiple medication schedules should be explicit and familiar. In fact, explicitness and familiarity are particularly important for multiple medication schedules, due to the increased amount of information individuals are required to remember and comprehend. However, aside from ensuring that information is explicit and familiar, there are special concerns associated with multiple drug regimens, such as the need to arrange time and dose schedules for individual medications in such a way that drug interactions are avoided. For example, if a patient were prescribed two medications that were each to be taken 12 hours apart, it might be reasonable to take both of them at
breakfast, and both of them at dinner. However, if one of these medications interferes with absorption of the other, then the medications need to be taken at different times, and information in the medication schedule should be designed to emphasize this fact. In addition to information emphasis, different types of medication taking tasks should also be considered. For example, if a patient frequently takes trips away from home, then perhaps the patient should be given a matrix schedule that facilitates the task of planning how many pills need to be taken on trips away from home. Examples like these indicate that in addition to ensuring that information is explicit and familiar, designers of medication instructions should consider the type of information that needs to be emphasized, as well as the types of medication taking tasks that will be undertaken by individual patients.
References


Sample Test Sheet

For each question below circle the best answer or answers. (Note: for some questions you may be circling more than one answer choice.

1. How many Lanoxin do you take per day? 0 1 2 3 4
2. How many pills do you take at breakfast time? 0 1 2 3 4
3. How many Quinaglute do you take per day? 0 1 2 3 4
4. How many pills do you take at dinner time? 0 1 2 3 4
5. How many Zantac do you take per day? 0 1 2 3 4
6. When do you take Inderal? Breakfast Lunch Dinner Bedtime
7. When do you take Carafate? Breakfast Lunch Dinner Bedtime
8. When do you take Coumadin? Breakfast Lunch Dinner Bedtime
9. Which pill(s) do you take only at breakfast?
   Lanoxin Inderal Quinaglute Carafate Zantac Coumadin
10. Which pill(s) do you take at lunch time?
    Lanoxin Inderal Quinaglute Carafate Zantac Coumadin
11. Which pill(s) do you take at bedtime?
    Lanoxin Inderal Quinaglute Carafate Zantac Coumadin
12. If you leave home after breakfast, and will not be back home until lunch time the next day, how many Lanoxin should you take along? 0 1 2 3 4
13. If you leave home after dinner, and will not be back home until bed time the next day, how many Quinaglute should you take along? 0 1 2 3 4

14. If you leave home after breakfast, and will not be back home until dinner time the next day, how many Zantac should you take along? 0 1 2 3 4

15. If you leave home after lunch, and will not be back home until bed time, how many Quinaglute should you bring along? 0 1 2 3 4

16. If you leave home after breakfast, and will not be back home until dinner time, how many Lanoxin should you bring along? 0 1 2 3 4

17. If you leave home after lunch, and will not be back home until bedtime, how many Coumadin should you bring along? 0 1 2 3 4
Vita

I was born on April 6, 1970 in Pasadena California to Chris and Nancy Lipinski. Our family moved to Connecticut where I have lived most of my life. Later on, I attended Fairfield University and graduated with a B.A. in Political Science in 1993. I entered the graduate program in Psychology at Lehigh in 1996.
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