

## Effects of label format on knowledge acquisition and perceived readability by younger and older adults

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This research examines consumers' information acquisition and preference for labels of a simulated over-the-counter (OTC) medication. Twelve otherwise identical OTC drug bottles were compared with different back labels varying in (a) print size, (b) amount of white space between text, and (c) label design (standard vs extended/pull-out). A no back label condition served as a control. Older (mean age = 77.7 years) and younger (mean age = 21 years) adults were given one of the 12 bottles and asked to perform one of two information acquisition tasks: (a) they examined the bottle for 3 minutes and then completed a questionnaire with the bottle absent, or (b) they answered the same questionnaire while the bottle was present. Afterwards, participants were given all of the bottles and asked to rank them according to perceived readability. The younger adults' information acquisition performance was significantly better than the older adults' for all label conditions except the control condition where both groups' low performance did not differ. Specifically, the older adults' performance was significantly better in the medium and large print conditions than in the small print conditions – with the latter conditions not differing from the control condition. Younger adults showed no performance differences among the different print-size conditions. No substantial effects on knowledge acquisition performance from the white space manipulations were found. However, the perceived readability ranks showed that both groups preferred larger print size and white space. The white space effect was smaller than for print size, particularly for older adults. The extended/pull-out label design was facilitative for older adults in that it allowed the use of larger print. The results suggest that older consumers may be unable to acquire information in the 'fine' print frequently found in various kinds of product literature.

### 1. Introduction

In recent years, consumers have assumed more responsibility for their health and medical care. Accordingly, there has been increased interest in enabling consumers to acquire information from over-the-counter (OTC) non-prescription pharmaceutical labels (US Food and Drug Administration 1995). Consumer-targeted OTC drug information is provided in various ways such as on the exterior packaging, in inserts, and most commonly, on labels attached to the drug container itself (e.g. Wogalter *et al.* 1999). The US Food and Drug Administration (FDA) requires that OTC drug labels state: what the drug is used for; how to use the drug safely and effectively;

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warnings and drug interaction precautions; information on the drug's active and inactive ingredients; and what to do in case of emergencies (Nonprescription Drug Manufacturers Association 1996). The placement of this relatively large amount of information on the label can be a problem when the surface area of the product container is relatively small, as is usually the case for most OTC drugs.

Several approaches can be taken to remedy the problem. One is to decrease the print size so that all of the information fits on the container label. However, the resulting print size may be too small to be read by people with poor vision, such as older adults (seniors) who tend to consume more pharmaceuticals than other age groups (Vanderplas and Vanderplas 1980, Morrow *et al.* 1986, Watanabe 1994). A second way to deal with the limited label space issue is to omit certain (presumably, less important) information from the container label, and to place the remaining information elsewhere such as on the original packaging or in an insert. The problem with this approach is that the packaging and insert are frequently discarded or misplaced; thereby reducing their availability when the drug is used at later times (Wogalter *et al.* 1993).

A third way is to present the information via an alternative type of on-container label such as a tag or fold-out that extends the available surface area available to print information. Alternative label designs that expand the available surface area to print information are preferred by older adults and in some cases also by younger adults (Barlow and Wogalter 1991, Wogalter *et al.* 1993, 1996, 1999, Kalsher *et al.* 1996, Vigilante and Wogalter 1999). Also, younger adults complied more frequently to a glue-product warning that directed users to wear protective gloves when the warning was placed in an extended label design (a tag) compared with placement on a conventional container label (Wogalter and Young 1994). Furthermore, older adults' knowledge acquisition was benefited when the most critical information was printed onto a previously-unused surface area of an existing OTC bottle container (Wogalter *et al.* 1999). Thus, extended label designs would seem to be beneficial for presenting OTC drug information.

Recently, the FDA has recommended the use of labels that increase the space (e.g. extended labels or tags) on OTC drug containers that are too small to hold all of the necessary drug information (Federal Register 1999). Specifically, the FDA suggests extending a single panel on small OTC drug containers to increase the amount of label space for the necessary printed information (Federal Register 1999). One purpose of the present research is to determine empirically whether an extended panel label design for an OTC bottle label benefits consumers' knowledge acquisition and is preferred over a standard design.

Although characteristics of the textual print would seem to be an important factor in label design, there has been sparse research on the topic until recently. In the past decade, research activity has mainly focused on the effects of various print characteristics on people's ability and willingness to read warnings and other consumer information. Young *et al.* (1992) found that the width of the alphanumeric characters in printed warnings affects the perceived legibility and reading speed. The legibility of print with normal type widths (100% of the font size) was judged to be better than print with smaller type widths (60% and 35% of the font size). Reading speed also differed depending on type width, with thinner type (35% size) producing significantly longer reading times than the wider type (100% and 60% sizes). Anderton and Cole (1982) found that legibility is reduced as the spacing between

letters is reduced. Watanabe (1994) also found that legibility is negatively affected when characters are horizontally compressed.

Smither and Braun (1994) investigated the effects of medication label font type (Century Schoolbook, Courier, and Helvetica), font size (9, 12, and 14 point), and font weight (Roman and bold) on reading speed and various other dimensions. Participants were timed as they read the manipulated medication labels attached either to a medication bottle or to a flat piece of cardboard. They found that younger and older adults took longer to read the labels printed in 9 point font than in 12 or 14 point font. Also, the labels printed in 14 point font were judged easier to read than those in 9 and 12 point fonts. Similarly, Silver and Braun (1993) found that product labels printed in 10 point font were perceived as more readable compared to product labels printed in 8 point font. Young and Wogalter (1990) demonstrated that warnings printed more conspicuously with larger, wider-stroke print with orange highlighting were better recalled than warnings printed less conspicuously with smaller, thinner, non-highlighted print.

Together these results suggest that people generally do not prefer, nor perform well, with smaller print compared to larger print on consumer product labels. The most likely reason for these results is that smaller print is less legible and more difficult to read under certain conditions. For example, less legible print is more likely to produce perceptual difficulties under degraded environmental conditions (e.g. dim lighting) and by readers with reduced visual capabilities (e.g. older adults). Also, legibility may play a role in higher-level cognitive processes. Research (e.g. Chandler and Sweller 1996) indicates that people are less likely to engage in behaviour that produces a higher level of mental workload, such as reading densely-worded consumer information. In other words, people are less willing to expend the mental effort to read information that requires greater time and energy. With this as a consideration, the FDA has recently mandated that all information on OTC drug labels be printed in a font no less than 6 points (Federal Register 1999).

The present research examines whether there are differences in knowledge acquisition and preferences for OTC drug labels that are printed in several sizes (4, 7, and 10 points). The smallest size print is less than the FDA recommended size but is comparable to the font size found on many currently available product labels (Wogalter *et al.* 1999).

Recent FDA regulations also include the use of white spacing in OTC drug labels (Federal Register 1999). The purpose is to help separate and distinguish different sections of text in which each section is a conceptual grouping of information. Such formatting is in contrast to the conventional method of presenting text in continuous prose, or in other words, a single grouping of information. Much of the prior research related to white spacing is indirect, as in comparing textual layouts of a single group (or a few groups) of text versus more numerous groupings of related information. Wogalter and Post (1989) found that instructions in a list-type format produced better computer-task performance by experienced users than instructions that presented the same content in a prose-paragraph format. Morrow *et al.* (1998) found that prescription labels arranged in a list format produce better comprehension and recall performance by older and younger adults compared to labels arranged in a paragraph format. While younger adults generally performed better than the older adults, the difference in performance between the two age groups was smaller with the list format. Additionally, Hartley (1978, 1999) has shown that

increasing the vertical spacing between text facilitates reading comprehension. Research involving computer displays indicates that grouping text into separate conceptually-related sections can facilitate the search and acquisition of information (Tullis 1983). Together, the previous research indicates that labelling in list-type formats, which have greater amounts of white space, has benefits over paragraph-type formats, which have lesser amounts of white space. One potential reason is that separation of textual groups allows information to be shown in separate conceptual units within a context of some larger functional relationship. Conceptual grouping (or chunking) of information may aid in encoding processes because its structure makes it easier to assimilate the information into an existing memorial framework, and as such aiding knowledge acquisition (Frase and Schwartz 1979).

Thus, the grouping or chunking of related information by separating sections or lines with white spacing may be beneficial compared to a denser single grouping of information. The white space formats compared in the present study consisted of no spacing, section spacing, and line spacing. The specifics regarding these formats are described later.

The present research also employs two participant groups, younger and older adults. In general, older adults tend to use more medications than other age groups. Research has shown that sensory and cognitive impairments increase with age (see e.g. Park *et al.* 1999). The impairments include presbyopia, decreased transfer of short-term (working) memory to long-term memory, and reduced processing speed. Because of these age-related declines, older adults were not expected to perform as well as younger adults in the information acquisition tasks.

In summary, the present research examined the effects of available surface area, print size, and white spacing on knowledge acquisition of, and preference for, OTC drug labels. Twelve labels for an OTC medication with a fictitious name were constructed and attached to bottle containers. The labels varied in (a) label design (standard versus extended/pull-out), (b) print size (4 point, 7 point and 10 point) and (c) amount of white spacing between lines/sections of text (no spacing; section spacing that included a single line space between each major sections of information; and line spacing that consisted of each sentence starting on a new line using double spacing). A bottle with no back label served as a control.

Two groups of participants, older and younger adults, performed one of two knowledge acquisition tasks. One task required the participants to search a container label to answer a series of drug-related questions. This task was included to determine the effect of label design on information search. The other task required the participants to examine the container's labels for 3 minutes and then complete the same questionnaire from memory. This task was included to determine the effect of label design on participants' memory of the label information. Thus in one task the bottle was present (available) and in the other it was absent (unavailable) while taking the knowledge acquisition test. Later, after all of the knowledge acquisition testing was completed, participants were shown all 12 container-label variations and asked to arrange them in rank order according to perceived readability.

Most previous research on formatting has examined only a single kind of labelling characteristic in a given experiment. The present research examines multiple levels of three label characteristics (label design, print size, and white spacing) that enable the examination of the interactions among the factors. Also examined was whether the effect of these factors interacts with participant age group.

## 2. Method

### 2.1. Participants

Two different groups of participants were recruited totalling 210. One group comprised 101 older adults (23 males and 78 females) over the age of 65 from various community organizations and retirement communities in the Raleigh-Durham, North Carolina area (mean age = 77.7 years,  $SD = 7.4$ ). The other group comprised 109 younger adults (61 males and 48 females) who were undergraduate students from introductory psychology courses at North Carolina State University who participated as part of a course requirement (mean age = 21 years,  $SD = 4.2$ ).

Based on self-reports, 96% of the older adults reported that they needed glasses to read, whereas only 40% of the younger adults reported that they needed glasses to read. Of those participants who reported wearing glasses, 95% of the older adults and 86% of the younger adults wore their glasses during the experimental session. The highest educational level attained by the older adults was as follows: 16% completed high school, 27% had taken some college or trade school courses, 16% had a bachelor degree, 11% had some form of postgraduate study but no postgraduate degree, and 28% had a graduate degree. Eighty-five percent of the older adults reported having one or more medical ailments. These included: 50% arthritis, 12% cataract, 6% heart condition, 4% asthma, 3% high blood pressure and 10% other. Nineteen percent of the younger adults reported having one or more of the following ailments: 8% asthma, 5% arthritis, and 6% other.

### 2.2. Design

The 12 experimental label conditions were developed using a 3 (print size: 4 point, 7 point and 10 point)  $\times$  3 (white spacing: no spacing, section spacing, line spacing)  $\times$  2 (label design: standard/flat, extended/pull-out) design. The actual experiment was not a complete factorial design. The reason for this is that some of the possible label format combinations on OTC drug containers would not (or could not) be realistically implemented. The excluded conditions were the large print, line spaced extended label, and all of the large and medium print standard label designs. One reason for excluding these conditions was that there was no way to place all of the information content on the standard label using the larger print sizes. Moreover, while it is possible to put the large print, line spaced condition on an extended label, it would require a different or larger extended label design than the extended label design used in the present experiment.

The knowledge-acquisition dependent variable was analysed using a between-subjects (groups) model. The rank order data were analysed using a within-subjects (repeated measures) model. The data were also examined with respect to participant group (older versus younger adults).

### 2.3. Materials

2.3.1. *Bottles*: Twelve identical bluish-green plastic OTC medication bottles (commonly used to contain liquid antacid) with approximate dimensions of 19 cm high  $\times$  9.5 cm wide  $\times$  5.5 cm deep were used. The original labels were stripped from the bottles and replaced by labels designed for the present research. The front and side labels were identical on all 12 bottles. The label information and design were adapted from an actual OTC motion sickness medication; however a fictitious name, Marvine, was used. The front and side labels are shown in figure 1.



Figure 1. Front (a) and side views (b) of the OTC medication bottle.

Table 1. Descriptions of 12 label conditions as a function of print size, white space and label design.

Condition number	Print size	White space	Label design
1	Large (10 point font)	Section (paragraph format)	Extended/pull-out
2	Large (10 point font)	No spacing	Extended/pull-out
3	Medium (7 point font)	Line (sentence format)	Extended/pull-out
4	Medium (7 point font)	Section (paragraph format)	Extended/pull-out
5	Medium (7 point font)	No spacing	Extended/pull-out
6	Small (4 point font)	Line (sentence format)	Extended/pull-out
7	Small (4 point font)	Section (paragraph format)	Extended/pull-out
8	Small (4 point font)	No spacing	Extended/pull-out
9	Small (4 point font)	Line (sentence format)	Standard flat
10	Small (4 point font)	Section (paragraph format)	Standard flat
11	Small (4 point font)	No spacing	Standard flat
12	No label (control)		

The back labels were constructed to correspond to the 12 label conditions listed and described in table 1.

All of the back labels contained exactly the same printed material (except the control, which had no back label). Only the way the information was presented (i.e. via format and label type) varied. Figure 2 shows example back labels. The control condition was included to determine the level of background knowledge that participants had without having seen a back label in the experimental situation. The no-label control provides a baseline to compare to the other conditions in which some form of back label was given. The extent to which performance is higher for the back label present conditions is an indication that some information is being acquired from the back labels.



Figure 2. Example back labels. (a) Small print, no spacing, standard flat label. (b) Medium print, line spacing, extended label. (c) Large print, section spacing, extended label.

In the no spacing conditions, text was continuous prose. In the section spacing conditions, major sections of information (e.g. directions, warnings) were separated by a line space. In the line spacing conditions, each sentence started on a new line using double spacing.

There were two label designs that provided different amounts of labelling surface area. The standard label design was similar to conventional container labels, with all of the information printed on a single side (in this case, a relatively flat surface) of the back of the bottle. For the extended/pull-out label design the back label information was printed on three sides of a label that was folded in half. The front (or first) side of the label folded out like a book cover revealing the second and third page of the label. No information was printed on the back (fourth) side of the extended label as it was attached to the back surface of a bottle.

For all conditions, the back label information was printed in a Helvetica-Narrow (sans serif) font similar to that used on many OTC drug labels. Labels were constructed using a word processing program on an Apple Macintosh computer and printed using a black and white Postscript-enabled 800 dpi laser printer on white bond paper. When attached to the bottles, the paper labels were covered in a high-gloss clear plastic adhesive.

**2.3.2. Forms:** The forms included a consent form, a questionnaire assessing knowledge of an OTC motion sickness medication, and a demographics form. The demographics form asked questions about age, gender, educational background, and use of corrective lenses.

The knowledge questionnaire asked questions about the medication. Example questions include: (a) 'How many tablets does the bottle contain?' (b) 'Within what temperature range should the medication be stored?' (c) 'Who should not take this medication?' and (d) 'What is the proper dosage for children 12 and under?' Each correct answer was given 1 point totalling 37 points. Blank spaces were provided after each question for the participants' written responses.

## 2.4. Procedure

2.4.1. *Knowledge acquisition task*: Participants were assigned randomly to bottle-label and knowledge-acquisition task conditions according to a predetermined random assignment according to order of participation.

All participants were first given the consent form to read and sign. Next, they completed a demographics form. After completing this form, the experimenter read the following scenario to each participant:

Assume for the moment that you and a group are going on a one-day bus trip to the mountains. The group includes children as well as older adults. It will be a bumpy ride, with hills and winding roads. You have taken with you a bottle of medicine called Marvine to help you and others overcome any motion sickness that might occur. Knowing that others on the bus might have medical conditions that mean they should not use the drug, you will need to be careful to whom you give the Marvine.

This scenario is similar to that used in previous OTC knowledge acquisition research reported in Wogalter *et al.* (1999). After the scenario, participants were given additional instructions depending on the specific knowledge acquisition task to which they were assigned. The two knowledge acquisition tasks are described below: bottle available or unavailable.

2.4.1.1. *Bottle available task*: After reading this scenario, the experimenter instructed the participants assigned to the bottle available condition that they would be given a medication container to examine and a questionnaire to complete. These participants were instructed to take as much time as they needed to complete as many of the questions as they could based on their background knowledge about the drug and from the information found on the container. The experimenter then handed the participant the bottle and questionnaire and asked them to begin working on the items.

2.4.1.2. *Bottle unavailable task*: After reading this scenario, the experimenter instructed the participants assigned to the bottle unavailable condition that they would be given a medication container to examine for 3 minutes. They were told to carefully examine the information on the bottle and that after the 3-minute period, the bottle would be taken away and they would be asked to complete a questionnaire based on their background knowledge of the drug and from the information found on the container. The experimenter then handed the participant a bottle, asked them to begin, and began the timer. After 3 minutes the bottle was removed and the participants were given the questionnaire and asked to begin working on the items. All participants were timed from the time they started answering the questionnaire to the time they stated they were finished answering the questions.

The intended purpose of imposing a time limit was to simulate situations where users may allocate a relatively short period of time to examine a product label. Also, it was intended to represent situations where the user is somewhat rushed in examining a label before use (e.g. in a medical emergency). The time limit of 3 minutes was chosen because it represented the average time needed to read through the entire back label at a hurried reading speed by several undergraduate and graduate student pilot participants. The time limit also provided a control of the



maximum amount of time participants were exposed to the label information across all conditions. If a particular label condition was easier to read and acquire information than another label condition, it was expected that a relatively short, but constant time of exposure would be more apt to reveal a difference in a subsequent knowledge acquisition test.

*2.4.2. Bottle label ranking:* After all aspects of the knowledge acquisition test described above were completed, participants were then given all 12 OTC motion sickness medication bottles and told that all of the bottles were identical except for their back labels. The experimenter then orally described the format differences between the label conditions. The participants were instructed to provide a single rank order of the bottles according to a combination of several perceived readability criteria, specifically which label formats were easiest, fastest, and most comfortable to read. Participants were instructed to choose the bottle with the best label and place it to their left (assigned a rank score of one), then decide which label was next best (assigned a rank score of two) and so forth, down to the worst label condition (assigned a rank order of 12). Participants were allowed to change their rank orders until they were satisfied. Ties were also allowed.

Following the completion of these tasks, participants were debriefed and interviewed about their thoughts concerning the materials they had seen. Lastly they were thanked for participating.

### 3. Results

Analyses examined the knowledge acquisition and perceived readability rank scores separately.

#### 3.1. Knowledge acquisition

*3.1.1. Scoring reliability:* The responses from the knowledge acquisition questionnaire were scored by two judges who were blind to experimental conditions and who used both strict and lenient criteria in their evaluations. The former required the exact wording found on the labels, whereas the latter allowed wording that was synonymous in meaning to the wording found on the labels. The judges were highly reliable in their scoring. The correlations were 0.97 and 0.98 between the judges for the lenient and strict criteria, respectively. In addition, the strict and lenient scores themselves were highly correlated, with  $r > 0.96$ . Because of these high correlations, the mean of the two judges' lenient scores are used in the analyses described below. Lenient scores were used instead of the strict scores because the former are more reflective of conceptual understanding as opposed to latter, which are more reflective of verbatim memory (cf. Young and Wogalter 1990). We were more interested in participants' understanding of the material than their recall of the exact words.

*3.1.2. Factorial analysis:* Because of the large number of factors investigated, several analyses were used to fully explore the data. Initially, the knowledge acquisition scores were submitted to a 2 (participant group: older adults, younger adults)  $\times$  2 (task type: label available vs unavailable)  $\times$  12 (bottle label conditions) between-subjects analysis of variance (ANOVA). Significant effects according to the ANOVAs were followed (when applicable) by simple effects analysis and subsequent comparisons among conditions based on the 0.05 probability level. The ANOVA showed that the participant group factor produced a significant main effect,  $F(1,$

162) = 132.47,  $MSe = 31.10$ ,  $p < 0.0001$ . Older adults ( $M = 18.78$ ) acquired less information from the labels than the younger adults ( $M = 27.73$ ). Task type also produced a significant main effect,  $F(1, 162) = 188.27$ ,  $p < 0.0001$ . Knowledge acquisition scores were higher when the label was available for inspection while answering the questionnaire ( $M = 28.59$ ) than when it was unavailable ( $M = 19.92$ ). There was also a main effect of label condition,  $F(11, 162) = 5.96$ ,  $p < 0.0001$ . Paired comparisons among the means showed that all of the medium and large print size conditions produced higher knowledge acquisition performance levels than two of the small print size conditions (the extended label with line spacing and the standard flat label with no white space). Also, the extended label with large print and no white space produced significantly higher scores than the standard flat label with small print and line white space. All 11 experimental (label-present) conditions produced significantly higher scores than the control condition.

The ANOVA also showed an interaction of label condition with participant group,  $F(11, 162) = 2.62$ ,  $p < 0.01$ . Table 2 shows the knowledge acquisition means as a function of bottle label condition and participant group. Also shown are the significant differences between conditions as indicated by different superscript letters. (The table also shows data from the preference rank analysis in the two right-most columns. These data will be discussed later.) The table shows that older adults produced higher knowledge acquisition performance in the large and the medium

Table 2. Mean knowledge acquisition and perceived readability rank order scores as a function of bottle label and participant group.

Bottle label condition				Dependent measures			
				Knowledge acquisition		Perceived readability rank	
Condition number	Print size	White space	Label design	Older	Younger	Older	Younger
1	Large	Section	Extended	22.13 <sup>a</sup>	29.21 <sup>a</sup>	1.62 <sup>a</sup>	2.09 <sup>a</sup>
2	Large	No	Extended	24.56 <sup>a</sup>	28.51 <sup>a</sup>	1.98 <sup>a</sup>	3.33 <sup>bc</sup>
3	Medium	Line	Extended	23.90 <sup>a</sup>	27.86 <sup>a</sup>	3.56 <sup>b</sup>	2.72 <sup>ab</sup>
4	Medium	Section	Extended	21.10 <sup>a</sup>	30.64 <sup>a</sup>	4.03 <sup>bc</sup>	3.70 <sup>c</sup>
5	Medium	No	Extended	22.16 <sup>a</sup>	28.94 <sup>a</sup>	4.56 <sup>c</sup>	4.91 <sup>d</sup>
6	Small	Line	Extended	14.38 <sup>b</sup>	28.55 <sup>a</sup>	7.77 <sup>d</sup>	6.80 <sup>e</sup>
7	Small	Section	Extended	17.25 <sup>b</sup>	29.40 <sup>a</sup>	9.21 <sup>de</sup>	8.42 <sup>f</sup>
8	Small	No	Extended	18.00 <sup>b</sup>	28.36 <sup>a</sup>	9.50 <sup>e</sup>	9.87 <sup>g</sup>
9	Small	Line	Standard flat	16.81 <sup>b</sup>	28.58 <sup>a</sup>	7.27 <sup>d</sup>	6.28 <sup>e</sup>
10	Small	Section	Standard flat	16.40 <sup>b</sup>	29.21 <sup>a</sup>	8.27 <sup>de</sup>	8.07 <sup>f</sup>
11	Small	No	Standard flat	14.71 <sup>b</sup>	28.59 <sup>a</sup>	9.75 <sup>e</sup>	9.88 <sup>g</sup>
12	No label (control)			14.00 <sup>b</sup>	14.96 <sup>b</sup>	11.87 <sup>f</sup>	12.00 <sup>h</sup>

Print size: large (10 point), medium (7 point), small (4 point).

White spacing: no (no spacing), section (spacing between main sections), line spacing (between listed statements).

Label design: standard flat or extended (book cover).

Higher knowledge acquisition scores indicate better performance. Lower rank scores indicate greater perceived readability.

Mean scores with different superscript letters are significantly different from each other ( $p < 0.05$ ).

print size conditions than the small print and control conditions. Performance in the small print conditions did not significantly differ from the control condition. The younger adults performed similarly across all 11 experimental label conditions, and all of which were higher than the control condition.

The ANOVA also showed a significant interaction of task type and bottle label condition,  $F(1, 162) = 2.91, p < 0.01$ . These means are displayed in table 3. When the label was available during the time the questionnaire was completed, knowledge acquisition performance in the large and medium print conditions was generally greater than in the small print conditions. When the label was unavailable during the time the questionnaire was being completed (i.e. from memory), there were no significant differences among the label-present conditions.

The participant group  $\times$  task type interaction was not significant, but the ANOVA showed a significant three-factor interaction of participant group  $\times$  label condition  $\times$  task type,  $F(1, 162) = 1.84, p = 0.05$ . These means are shown in table 4. When the bottle labels were available for inspection, the older adults produced better performance in the large and medium print conditions compared to the small print and control conditions, but no differences among conditions were apparent when the label was unavailable. The younger adults performed better than the older adults and better with the label available than unavailable.

3.1.3. *Subset factorial analyses:* In the preceding analysis, the entire set of 12 bottle label conditions was treated as a single factor. Because of the structure of the label manipulations it was not possible to examine all of the label factors simultaneously in a single factorial ANOVA. Therefore, three subsets of labels were analysed to determine main effects and interactions in smaller analyses with fewer conditions. These ANOVAs examined label type  $\times$  white spacing (using the small print conditions only) and print size  $\times$  white spacing (using two subsets of the extended label conditions).

Using only the six small print conditions (label conditions 6 through 11), a 2 (participant group: older adults, younger adults)  $\times$  2 (label type: standard flat,

Table 3. Mean knowledge acquisition as a function of bottle label and task type.

Condition number	Bottle label condition			Task type	
	Print size	White space	Label design	Label available	Label unavailable
1	Large	Section	Extended	31.38	19.96
2	Large	No	Extended	34.39	18.69
3	Medium	Line	Extended	33.45	18.31
4	Medium	Section	Extended	32.70	19.04
5	Medium	No	Extended	33.63	17.47
6	Small	Line	Extended	25.13	17.80
7	Small	Section	Extended	26.63	20.03
8	Small	No	Extended	27.68	18.69
9	Small	Line	Standard flat	30.06	15.32
10	Small	Section	Standard flat	28.35	17.26
11	Small	No	Standard flat	23.25	20.05
12	No label (control)			16.50	12.46

Table 4. Mean knowledge acquisition as a function of bottle label, participant group, and task type.

Condition number	Bottle label condition			Task type			
				Label available		Label unavailable	
	Print size	White space	Label design	Older	Younger	Older	Younger
1	Large	Section	Extended	26.50	36.25	17.75	22.17
2	Large	No	Extended	32.38	36.40	16.75	20.62
3	Medium	Line	Extended	30.80	36.10	17.00	19.62
4	Medium	Section	Extended	30.50	34.90	11.70	26.38
5	Medium	No	Extended	32.38	34.88	11.94	23.00
6	Small	Line	Extended	16.25	34.00	12.5	23.10
7	Small	Section	Extended	17.25	36.00	17.25	22.80
8	Small	No	Extended	20.25	35.10	15.75	21.62
9	Small	Line	Standard flat	23.88	36.25	9.75	20.90
10	Small	Section	Standard flat	21.70	35.00	11.10	23.42
11	Small	No	Standard flat	13.12	33.38	16.30	23.80
12	No label (control)			15.88	17.12	12.12	12.80

extended)  $\times$  3 (white space: no, section, line) between-subjects ANOVA showed only one significant effect. Younger adults ( $M=28.6$ ) performed better than the older adults ( $M = 16.26$ ),  $F(1, 94)=63.5$ ,  $MSe = 59.48$ ,  $p < 0.0001$ .

Using a subset of conditions of the extended label condition, two additional factorial ANOVAs were conducted. One was composed of a 2 (participant group)  $\times$  2 (print size: small, medium)  $\times$  3 (white spacing: no, section, line) design (using label conditions 1, 2, 4, 5, 7 and 8). The ANOVA not only showed a participant group main effect (with means similar to that noted above), but also a print size main effect,  $F(1, 91)=4.24$ ,  $MSe=71.74$ ,  $p < 0.01$ . Performance was better for medium print ( $M=26.1$ ) than for small print ( $M=22.9$ ). (There were no large print conditions in this analysis.) The other analysis involving the extended label conditions was similar to the one just mentioned but used a somewhat different set of conditions (label conditions 3 to 8). The design was a 2 (participant group)  $\times$  3 (print size: small, medium, large)  $\times$  3 (white spacing: no, section) factorial. In this analysis, only the participant group main effect was significant.

### 3.2. Questionnaire completion time

The time taken by participants to complete the questionnaire from start to finish was examined. An ANOVA model identical to the first-described knowledge acquisition analysis showed only two effects. One was for participant group,  $F(1, 161)=5.41$ ,  $MSe=135.85$ ,  $p < 0.05$ . The younger adults ( $M=20.95$  s) completed the questionnaire faster than the older adults ( $M=24.88$  s). The other was for task type,  $F(1, 161)=108.41$ ,  $MSe=135.85$ ,  $p < 0.0001$ . Participants completed the questionnaire faster when the label was unavailable ( $M=14.37$  s) than when it was available ( $M=31.37$  s).

### 3.3. Perceived readability rank order

The perceived readability data consisted of rank order scores with lower numbers indicating greater perceived readability.

3.3.1. *Analysis across all label conditions:* Rank order as a function of condition was first tested using the non-parametric multi-condition within-subjects Friedman test, which was significant,  $p < 0.0001$ . The Wilcoxon Matched-Pair Signed-Rank test together with a Bonferroni correction (to maintain experiment-wise error at 0.05) was used to make paired comparisons. The mean ranks and significant differences are shown in the two right-most columns of table 2. The older adults' and younger adults' ranks were analysed separately. Only the significant comparisons are described below.

For the older adults, the large print conditions were preferred over medium print conditions, which in turn were preferred over the small print conditions. Within the medium and small print conditions, line spacing was preferred over no spacing. For the small print conditions, there were no significant differences between the standard flat and extended labels. The control label was the least preferred compared to all other conditions.

For the younger adults, a similar pattern of rank order means was shown. However, there were more differences that were significant between label conditions relative to those seen in the older adults' data. Large print with section spacing was preferred over all other conditions except for the medium print line spacing condition, which in turn was preferred over all other conditions except for large print no spacing. Large print no spacing was preferred over the medium print no spacing and all six small print conditions. Medium print section spacing was preferred over the medium print no spacing, which was in turn preferred over all six small print conditions. Within the six small print conditions, line spacing was preferred over section spacing, which in turn was preferred over no spacing. There were no significant differences between the standard flat and extended labels for the comparable small print conditions. The control label was the least preferred.

3.3.2. *Subset factorial analyses:* Like the analyses conducted on the knowledge acquisition data, three separate factorial analyses were conducted to examine main effects and interactions among different subsets of the bottle label conditions.

A 2 (participant group: older adults, younger adults)  $\times$  2 (label type: standard flat, extended)  $\times$  3 (white-spacing: no, section, line) mixed-model ANOVA (with the latter two factors repeated measures) comprised of only the six small print conditions was conducted (label conditions 6–11). The ANOVA showed significant main effects for all three factors. Younger adults ( $M = 8.22$ ) gave lower ranks than the older adults ( $M = 8.63$ ),  $F(1, 201) = 12.64$ ,  $MSe = 4.05$ ,  $p < 0.001$ . For these conditions, the standard flat label ( $M = 8.25$ ) was preferred over the extended label ( $M = 8.59$ ),  $F(1, 201) = 6.19$ ,  $MSe = 5.72$ ,  $p < 0.05$ . Comparisons for the white spacing main effect means indicated that line spacing ( $M = 7.03$ ) was preferred over the section spacing ( $M = 8.49$ ), which in turn was preferred over no spacing ( $M = 9.75$ ),  $F(2, 402) = 282.20$ ,  $MSe = 2.66$ ,  $p < 0.0001$ . There were two significant interactions. One was for participant group and white spacing,  $F(1, 402) = 14.67$ ,  $MSe = 2.66$ ,  $p < 0.0001$ . While both groups preferred line spacing to section spacing and section spacing over no spacing, the older adults preferred the section and line spacing to a greater extent than the younger adults. The other significant interaction involved label type and white spacing,  $F(2, 402) = 8.69$ ,  $MSe = 2.09$ ,  $p < 0.001$ . The standard flat labels received lower ranks than the extended labels in both the section and line spacing, but there was no difference between the label designs with no spacing.

The second subset analysis of the ranks (using label conditions 1, 2, 4, 5, 7 and 8) was a 2 (participant group: older adults, younger adults)  $\times$  3 (print size: small, medium, large)  $\times$  2 (white-spacing: no, section) mixed-model ANOVA (with the latter two factors repeated measures). The ANOVA showed significant main effects for all three factors. The older adults ( $M=5.15$ ) gave lower ranks than the younger adults ( $M=5.39$ ),  $F(1, 201)=7.12$ ,  $MSe=2.42$ ,  $p<0.01$ . Print size comparisons showed that large print ( $M=2.25$ ) was ranked significantly lower than medium print ( $M=4.30$ ), which in turn was preferred over the small print ( $M=9.25$ ),  $F(2, 402)=2018.1$ ,  $MSe=2.60$ ,  $p<0.0001$ . Section spacing ( $M=4.85$ ) was preferred over no spacing ( $M=5.69$ ),  $F(1, 201)=147.49$ ,  $MSe=1.47$ ,  $p<0.0001$ . There were two significant interactions. One involved participant group and print size,  $F(2, 402)=14.67$ ,  $MSe=2.66$ ,  $p<0.0001$ . Older adults gave significantly lower ranks for large print than the younger adults, but the two groups did not differ for small and medium print. The other interaction was between participant group and white spacing,  $F(1, 201)=42.60$ ,  $MSe=1.47$ ,  $p<0.0001$ . While section spacing was preferred over no spacing by both participant groups, the difference was larger for the younger adults compared to the older adults.

The third factorial analysis was a 2 (participant group: older adults, younger adults)  $\times$  2 (print size: small, medium)  $\times$  3 (white-spacing: no, section, line) mixed-model ANOVA (with the latter two factors repeated measures) using a subset of the extended label conditions (conditions 3–8). The ANOVA showed significant effects for all three factors. Younger adults ( $M=6.07$ ) gave lower ranks than older adults ( $M=6.44$ ),  $F(1, 201)=16.49$ ,  $MSe=2.47$ ,  $p<0.0001$ . Medium print ( $M=3.91$ ) was preferred over small print ( $M=8.59$ ),  $F(1, 201)=2337.60$ ,  $MSe=2.85$ ,  $p<0.0001$ . Line spacing ( $M=5.21$ ) was preferred over section spacing ( $M=6.34$ ), which in turn was preferred over no spacing ( $M=7.21$ ),  $F(2, 402)=186.17$ ,  $MSe=2.19$ ,  $p<0.0001$ . The ANOVA also showed a significant participant group  $\times$  white spacing interaction,  $F(2, 402)=19.91$ ,  $MSe=2.19$ ,  $p<0.0001$ . While both groups preferred line spacing and least preferred no spacing, the difference was larger for the younger adults than the older adults. There was also a significant print size  $\times$  white spacing interaction,  $F(2, 402)=14.73$ ,  $MSe=1.48$ ,  $p<0.0001$ . Preference for medium print over the small print was smaller with line spacing than with the other two spacing conditions.

#### 4. Discussion

This research examined the effects of label type, print size and white spacing given on the back labels of a fictitious OTC medication. Younger and older adults answered questions while one of the 12 manipulated labels was present or was absent (i.e. from memory). Later participants rank ordered all of the labels on perceived readability.

Both the knowledge acquisition and rank order scores showed that print size was a very important label factor for older adults but to a somewhat lesser extent for younger adults. In the knowledge acquisition task, older adults were only able to show higher knowledge acquisition than the no label control (a) when medium (7 point) or large (11 point) print was used but not when small (4 point) print was used, and (b) when the label was available to them when answering the knowledge test. For the younger adults, the print size manipulation had no effect. They performed equally well with all three sizes of print, producing knowledge acquisition scores higher than the control, not only when the label was present but also from memory.

However, the results from the rank order data suggest that both age groups preferred the larger print, followed by the medium print, over the small print. Larger print size was more strongly preferred by the older adults than the younger adults. For the younger adults, some of the medium print conditions were perceived as readable as the large print conditions.

Older adults also performed more slowly in answering the knowledge acquisition questionnaire. The latter result concurs with research showing that as age increases, performance on short-term/working memory and speed of cognition decreases (see e.g. Park *et al.* 1999). However, these cognitive processes cannot account for the decreased knowledge acquisition performance by the small print conditions. The most probable explanation for the decreased performance by older adults in the small print conditions is due to reduced visual capabilities relative to the younger adults. Presbyopia, a collection of vision problems in adults as they age, results in reduced acuity and a reduced ability to read small print (Watanabe 1994). Many products contain labels that are printed as small as or smaller than the small print condition in this study (e.g. Wogalter *et al.* 1999). This suggests that older adults may not be able to acquire information from many kinds of product documentation such as proper-use instructions, maintenance requirements, and safety information. Given that many older adults take one or more medications on a regular basis and also have reduced visual capabilities, it would seem essential to ensure that the size of the print is large enough to enable information transmission from the label to the receiver.

While the knowledge acquisition test failed to show any white spacing effects, the ranking task, however, showed that both participant groups preferred more white space. Line spacing (with the most white space) was preferred over section spacing, followed by no spacing. During the debriefing period, several of the participants commented that the line spacing made the labels easier to read and that the paragraph-type separation between sections of label text helped to differentiate the different parts of the label material.

Interestingly, the older adults showed a less pronounced white spacing effect compared to the younger adults. This indicates a lower degree of importance relative to print size. For younger adults, print size was less of an issue because they could extract information in the small print conditions, whereas older adults could not. An inability to read the material probably produced a strong negative bias on preference judgments. Thus, the older adults made their readability preference judgments on the basis of print size and less strongly with regard to white spacing. Probably for any given reader, if the print size is large enough to be read, increasing the size further is not likely to make much difference for that individual in the same circumstances except in noticeability. But if the print size is not large enough for that individual to read it, then there is a strong reduction in readability preference. This was found for the older adults more so than the younger adults.

The discrepancy between the knowledge acquisition scores and perceived readability scores is not unexpected. The research literature in psychology and human factors/ergonomics commonly shows that performance and subjective judgments do not always match, particularly when they are measuring different concepts (e.g. Wogalter *et al.* 1997, Wogalter and Dingus 1999). A generic finding is a small or no difference in performance with a larger difference in subjective judgments. Subjective judgments are often somewhat more sensitive in detecting differences among conditions than measures of memory and behaviour. With more

participants and more sensitive procedures, significant differences between the white spacing conditions in the knowledge acquisition scores might have been noted.

A ceiling effect (i.e. scores near maximum) was apparent in the younger adults' data when the label was available for inspection during the knowledge test. This concurs with the notion that when the print size is large enough to read, further increases of size will not further facilitate performance. However, this particular result is dependent on the task and the individuals participating. A ceiling effect was less obvious in the younger adults' performance in the label unavailable task, and was absent in the older adults' data.

The study also failed to show a direct effect of the extended label design compared to the standard flat design. Somewhat oddly, one analysis showed the standard flat design was better than the extended label. On the surface, this would appear to be a surprising finding. It is surprising since previous research (Kalsher *et al.* 1996, Wogalter *et al.* 1996) shows greater preference for and compliance to extended labels and tags compared to traditional container labels (Wogalter and Young 1994). This apparent conflict in the results is reduced when it is noted that a direct comparison between the two label-design types in the present research could only be made in the small print conditions. The extended labels with no spacing and section spacing produced considerable white space at the bottom of the panels. During the debriefing period, several participants commented negatively about the wasted label space in these two conditions, a perception that might have reduced their preference judgments.

Actually, an opposite conclusion, that the extended label is beneficial, can be drawn from other findings. The extended label design provides additional label space that could be used to increase print size on small containers. Larger print sizes could not otherwise be used on standard flat labels because the material would not fit. At debriefing, many participants agreed with the idea that an extended label design was a good way to include larger print and allow for white spacing. Thus, the extended label did, by proxy, yield positive effects in that it served as a vehicle to carry the larger and medium print labels, which were the conditions that showed significant knowledge acquisition benefits for older adults.

Many of the current findings support past research on print characteristics of consumer product labels. For example, there was support, in the form of user preference, for Morrow *et al.*'s (1998) finding that a list format (comparable to the line-spacing) aids reading comprehension, and for Hartley's (1984) recommendations for using white spacing between sections of text (comparable to section-spacing) on medication labels. The present research also confirms Smither and Braun's (1994) finding that people prefer and are able to read through more information in medication labels that use larger print fonts compared to labels that use smaller fonts.

The present results also correspond to the FDA regulations that concern the standardization of the formatting for OTC drug labelling (Federal Register 1999). The FDA has set the minimum print size for OTC medication labels to a 6 point font, although they encourage the use of larger font sizes. In the present study, a 4 point font was not legible to older adults, whereas the 7 and 11 point fonts were. The FDA also requires the use of a horizontal line to separate the information under each major OTC drug label heading and to use a bullet format to list chunks of information. The present study showed that greater separation between text is preferred as long as the print size is adequate. Finally, the FDA encourages the use



of an extended label design when surface area is limited on an OTC medication bottle. It was noted in the present study that the standard flat label was unable to accommodate the larger print that older adults could see. The FDA has also recently mandated that labels contain a certain ordering of sections (indications, warnings, directions for use) that are similar to those found by Vigilante and Wogalter (1997) in a consumer preference study. Although OTC drug labels served as the vehicle to examine label characteristics, the findings from this study are probably applicable to other kinds of product label, particularly for products that are complex and/or hazardous and which have limited surface space. Extended label designs, whether it is a pull-out or a tag, or simply making better use of existing surface space, can enable larger print and increased white space. Sufficiently large print is a necessary characteristic for older adults to read the material. While larger print is not as important to younger adults as it is to older adults, the data suggest that print size and white spacing can affect preferences and performance of both age groups.

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### References

- ANDERTON, P. J. and COLE, B. L. 1982, Contour separation and sign legibility, *Australian Road Research*, **12**, 103–109.
- BARLOW, T. and WOGALTER, M. S. 1991, Increasing the surface area on small product containers to facilitate communication of label information and warnings, *Proceedings of Interface 91* (Santa Monica, CA: Human Factors and Ergonomics Society), 88–93.
- CHANDLER, P. and SWELLER, J. 1996, Cognitive load while learning to use a computer program, *Applied Cognitive Psychology*, **10**, 151–170.
- FEDERAL REGISTER 1999, Over-the-counter human drugs: labeling requirements, US Food and Drug Administration, volume 64, no. 51, 17 March.
- FRASE, L. T. and SCHWARTZ, B. J. 1979, Typographical cues that facilitate comprehension, *Journal of Educational Psychology*, **71**, 197–206.
- HARTLEY, J. 1999, What do these instructions mean? Text design, medical information and older readers, In D. Park, R. Morrell and K. Shifren (eds), *Processing of Medical Information in Aging Patients* (Mahwah, NJ: Lawrence Erlbaum), 233–248.
- HARTLEY, J. 1984, Spacing and structure in instructional text, In R. Easterby and H. Zwaga (eds), *Information Design* (New York: John Wiley), 497–516.
- HARTLEY, J. 1978, *Designing Instructional Text* (New York: Nichols).
- KALSHER, M. J., WOGALTER, M. S. and RACICOT, B. M. 1996, Pharmaceutical container labels: enhancing preference perceptions with alternative designs and pictorials, *International Journal of Industrial Ergonomics*, **18**, 83–90.
- MORROW, D. G., LEIRER, V. O., ANDRASSY, J. M., HIER, C. M. and MENARD, W. E. 1998, The influence of list format and category headers on age differences in understanding medication instructions, *Experimental Aging Research*, **24**, 231–256.
- MORROW, D. G., LEIRER, V. O., ANDRASSY, J. M., TANKE, E. D. and STINE-MORROW, E. A. L. 1996, Medication instruction design: younger and older adult schemas for taking medications, *Human Factors*, **38**, 556–573.

- MORROW, D. G., LEIRER, V. O. and SHEIKH, J. 1988, Adherence and medication instructions: review and recommendations, *Journal of the American Geriatric Society*, **36**, 1147–1160.
- NONPRESCRIPTION DRUG MANUFACTURERS ASSOCIATION 1996, Label readability guidelines: over-the-counter drug labeling, 1–16.
- PARK, D. C., MORRELL, R. C. and SHIFREN, K. 1999, *Processing of Medical Information in Aging Patients: Cognitive and human factors perspectives* (Mahway, NJ: Lawrence Erlbaum).
- SILVER, N. C. and BRAUN, C. C. 1993, Perceived readability of warning labels with varied font sizes and styles, *Safety Science*, **16**, 615–625.
- SMITHER, J. A. and BRAUN, C. C. 1994, Readability of prescription drug labels by older and younger adults, *Journal of Clinical Psychology in Medical Settings*, **1**, 149–159.
- TULLIS, T. A. 1983, The formatting of alphanumeric displays: a review and analysis, *Human Factors*, **25**, 657–682.
- US FOOD AND DRUG ADMINISTRATION 1995, Public hearing on over-the-counter drug labeling, Washington, DC, 29 September.
- VANDERPLAS, J. M. and VANDERPLAS, J. H. 1980, Some factors affecting legibility of printed materials for older adults, *Perceptual and Motor Skills*, **50**, 923–932.
- VIGILANTE, JR, W. J. and WOGALTER, M. S. 1997, The preferred order of over-the-counter (OTC) pharmaceutical label components, *Drug Information Journal*, **31**, 973–988.
- VIGILANTE, JR, W. J. and WOGALTER, M. S. 1998, Older adults' perceptions of OTC drug labels: print size, white space and design type, In S. Kumar (ed.), *Advances in Occupational Ergonomics and Safety* (Louisville, KY: IOS Press and OHMSHA), 599–602.
- VIGILANTE, JR, W. J. and WOGALTER, M. S. 1999, Over-the-counter (OTC) drug labeling: format preferences, *Proceedings of the Human Factors and Ergonomics Society 43rd Annual Meeting* (Santa Monica, CA: Human Factors and Ergonomics Society), 103–107.
- WATANABE, R. K. 1994, The ability of the geriatric population to read labels on over-the-counter medication bottles, *Journal of the American Optometric Association*, **65**, 32–37.
- WOGALTER, M. S. and DINGUS, T. A. 1999, Methodological techniques for evaluating behavioral intentions and compliance, In M. S. Wogalter, D. M. DeJoy, and K. R. Laughery (eds) *Warnings and Risk Communication* (London: Taylor and Francis), 53–82.
- WOGALTER, M. S. and POST, M. 1989, Printed tutorial instructions: effects of text format and screen pictographs on human-computer task performance, *Proceedings of Interface 89* (Santa Monica, CA: Human Factors and Ergonomics Society), 133–138.
- WOGALTER, M. S. and YOUNG, S. L. 1994, Enhancing warning compliance through alternative product label designs, *Applied Ergonomics*, **25**, 53–57.
- WOGALTER, M. S., BEGLEY, P. B., SCANCORELLI, L. F. and BRELSFORD, J. W. 1997, Effectiveness of elevator service signs: measurement of perceived understandability, willingness to comply, and behaviour, *Applied Ergonomics*, **28**, 181–187.
- WOGALTER, M. S., FORBES, R. M. and BARLOW, T. 1993, Alternative product label designs: increasing the surface area and print size, *Proceedings of Interface 93* (Santa Monica, CA: Human Factors and Ergonomics Society), 181–186.
- WOGALTER, M. S., KALSHER, M. J. and LITYNSKI, D. M. 1996, Influence of food label quantifier terms on connoted amount and purchase intention, *Proceedings of the Human Factors and Ergonomics Society 40th Annual Meeting* (Santa Monica, CA: Human Factors and Ergonomics Society), 385–389.
- WOGALTER, M. S., MAGURNO, A. B., DIETRICH, D. A. and SCOTT, K. L. 1999, Enhancing information acquisition for over-the-counter medications by making better use of container surface space, *Experimental Aging Research*, **25**, 27–48.
- YOUNG, S. L. and WOGALTER, M. S. 1990, Comprehension and memory of instruction manual warnings: conspicuous print and pictorial icons, *Human Factors*, **32**, 637–649.
- YOUNG, S. L., LAUGHERY, K. R. and BELL, M. 1992, Effects of two type density characteristics on the legibility of print, *Proceedings of the Human Factors and Ergonomics Society 36th Annual Meeting* (Santa Monica, CA: Human Factors and Ergonomics Society), 504–508.