Reading Pages of a Consumer Product Manual Text and Warnings: Effects of Format Salience and Visual Cues on Eye Movements

Jennifer A. Cowley and Michael S. Wogalter

Psychology Department, Human Factors and Ergonomics Program, North Carolina State University
Raleigh, NC 27695-7650 USA

This study evaluated whether high or low salience product manual warning formats resulted in different frequencies of both reading and warning recall accuracy. Both experimental conditions constituted an amalgamation of warning and product manual format features. The low salience condition was comprised of a capitalized signal word, paragraph prose-style warning text, warnings integrated with page content with low salience visual cues whereas the high salience condition included an icon, signal word panel, bulleted warning text, warnings placed separately at the page bottom with high salience visual cues. Eye movements were recorded while participants read pages from product manuals followed by a warning recall test. No significant difference in the number of warnings read was found but visual cues in the high salience condition shifted foveal vision to the warnings significantly more often than the cues in the low salience condition. Warning recall was higher in the low salience condition than in the high salience condition, probably because of the particular task and formatting used. Caveats and study implications are discussed.

INTRODUCTION

Many kinds of products have potential hazards. One way to mitigate the effects of hazards is to educate consumers about what exactly the hazards are, how to avoid them and the consequences of hazard exposure. Warnings, specifically visual warnings, are often the only source of consumer education and protection against hazard exposure if the hazard cannot be designed out or guarded against in a system (Wogalter, DeJoy & Laughery, 1999). However, warnings are usually the least effective means in preventing hazard exposure compared to the more primary methods of designing the hazard out of the product or guarding against the hazard (Laughery & Wogalter, 2006). Nevertheless, warnings serve the purpose of consumer protection and hazard exposure prevention when attempts to design out or guard against are not dependable. The current research seeks to understand what warning features and formats effectively attract visual attention and readership and how this is related to warning content recall.

Visual warnings can be found on products as labels, as signage, in product manuals, and now more frequently on websites. Most warning research involves on-product labels and signage. Much less warning research has been done with product manuals (Huntley-Fenner, Harley, Trachtman, & Young, 2007; Laughery & Young, 1991; Wogalter, Barlow, and Murphy, 1995; Young, 1991; Young & Wogalter, 1990). Since products frequently have insufficient space to attach all necessary warnings, usually the lesser important warnings are relegated only to the product manual. The product manual is usually considered the complete reference source for a product's operation, maintenance, and safety. However, product manuals apparently are often not read or incompletely read by consumers (Cowley, Kim & Wogalter, 2006; Leonard, 2001; Mehlenbacher, Wogalter & Laughery, 2002). In addition, warnings in product manuals are sometimes physically and temporally separated from the product such that users must recall warnings previously read. Because product manuals are different from on-product labels and signage, some research findings might not generalize across media. Research specifically on product manual use, is important in its own right.

One traditional method of assessing the relationship between visual attention, readership and memory formation is through memory assessments of warning content. Correct recall of warning content, together with a control condition not exposed to the warning content, can indicate what warnings were attended to and/or read (Rodriguez, 1991; Young & Wogalter, 1990). In recent years eye tracking technology has emerged as a promising new method to compliment traditional methods by measuring and analyzing participant's eye movements; a potentially more direct evaluative method of visual attention and readership.

Few studies heretofore have used eye tracking technology to evaluate warning effectiveness; much of the work is in relation to on-product warning labels or in advertising rather than product manuals. Most of the findings somewhat consistently indicated that warnings with salient features were noticed more readily. For example, Laughery and Young (1991) (also Laughery, Young, Vaubel & Brelsford, 1993) manipulated alcoholic beverage warning label formats (e.g., icons, colors and borders) and found that the addition of an icon, color and a pictorial significantly reduced the total time needed to find the warning. Krugman, Fox, Fletcher, Fischer and Rojas (1994) compared a standard U.S. Surgeon General warning from cigarette packaging to other warnings in which the font and wording were both manipulated. These manipulated warnings were noticed more readily and more frequently than standard U.S. Surgeon General warnings. Recently, Peterson, Thomsen, Lindsay, and John (2010) evaluated the frequency of warning readership in full-paged product magazine ads that contained or lacked graphics. The results indicated that consumers spent 2.5 times more time viewing warnings with graphics than without graphics and had more accurate recall of the warning content. However, relatively few studies have evaluated warnings in product manuals and none assessed the effects of product manual warning formats on visual attention and readership using eye tracking methodology.

In addition to warning formatting, product manual features may also impact visual attention. One feature is a visual text-based cue that is intended to send visual attention from a position in the product manual text to an affiliate warning. For example, "See Warning 1" is an exemplar *sending* cue in the manual's text that potentially points visual attention to the *receiving* cue; i.e., "Warning 1." After Warning 1 is read, visual attention can return to the original text location by scanning the page for the sending cue. Little research exists that assessed the impact of cues on visual attention. Tabbers, Martens and van Merrienboer (2004) found that text-embedded cues that directed visual attention from a physical text location to graphical content presented in another location led to higher retention rates than auditory cues. However, eye tracking has not been used to examine or confirm whether foveal vision moved to the graphical content. These results suggest that cuing potentially can direct visual attention; thus, eye tracking technology may elucidate how cuing to and from warnings impacts attention and readership.

This research examines, through the use of eye tracking technology, the effect of product manual warning formats and visual cuing on eye movements and warning recall.

METHOD

Participants

Thirty-two university student participants, 21 males (65.6%) and 11 females (34.4%), with a mean age of 19.3 years (*SD*=1.7) had a self-reported ethnicity classifications of 78.2% Caucasian, 12.5% African American, 3.1% Asian, 3.1% East Indian, and 3.1% mixed race. Percentages of self-reported number of school years completed were: 53.1% of participants completed 12 years of education, 21.9% completed 13 years, 12.5% completed 14 years, 6.3% completed 15 years, and 6.2% completed 16 years or more. Of the 32 participants, 30 were full-time students (93.8%) and 2 were part-time students (6.2%).

Stimuli and Apparatus

Each participant viewed a Microsoft PowerPoint (PP) presentation representing one of two conditions. The PP was configured to present each product calibration slide (a slide with a red "X" at the midpoint) for 5 s and each product manual slide for 60 s. Sixty seconds was determined in pilot testing to be 9 s less than the average reading time for a single product manual (PM) slide. A slight time constraint was employed to discourage off-task thinking. Each PM slide presented text and warnings on one of three topics: (a) washing machine installation, (b) garage door installation, and (c) vehicle seat adjustment. All participants viewed the exact same product manual content for all three topics; only the warning and manual formatting differed across conditions. A 3 X 3 Latin square was used to counterbalance the PM slide ordering across conditions. Thus, participants were randomly assigned to one of six PP presentations (3 PP slide orderings in each of the two conditions).

Each PM slide displayed blocks of 14-point font text with 2.125-inch (5.40 cm) left and right horizontal margins allowing approximately 12-14 words per line. The low salience condition (See Figure 1) was comprised of an indented warning paragraph with paragraph prose style text, a capitalized signal word and mixed-case, 14-point visual cues. In contrast, the high salience condition (See Figure 2) consisted of an indented, black bordered box containing bulleted warning text, a light grey signal word panel with an icon next to a capitalized, large and bolded signal word. The visual cues (both sending and receiving) were bolded and capitalized using 15-point font. The warnings in the low salience condition were embedded within the product manual text while the high salience condition displayed warnings separated from the related text and placed at the bottom of the PM page. Warnings in the high salience condition were located at the page bottom to maximize warning salience (Wogalter, Smith-Jackson, Mills, & Paine, 2002).

Participants viewed PM slides on a 17-inch (43.2 cm) 1024 X 768 resolution HP monitor and desktop computer on a Windows XP platform. Eye movements were recorded using a pupil-center corneal reflection method on a Model 501 tracking system manufactured by Applied Science Laboratory. Gaze Tracker analysis software generated *x* and *y* coordinates to compile eye movement data.

Two paper-based tests were administered to participants; a cued recall test and a standardized test called the Nelson-Denny Reading Comprehension test. The paper-based 46-item, open-ended cued recall test evaluated participant's memory recall of all information covered in these PM slides. An example question was, "Do not recline the seatback while…" and the participant filled in the missing information in the blank provided. One of two orders (one is the reverse order of the other) was given to half the participants in each condition. The second standardized test, the Nelson Denny Reading Comprehension test, evaluated the reading and comprehension abilities of each participant.

Procedure

Initially, informed consent was obtained. All participants were assigned to one of two between-subjects conditions. Before the eye tracking head gear was fitted, specific oral and written instructions about the PP presentation and eye tracking sessions were provided. It was explained that after the calibration of the eye tracking equipment, he/she would see a PP presentation consisting of 6 slides: 3 slides of PM pages (1 page per slide) interleaved with 3 calibration slides (slides with a red "X"). These PP slides would automatically selfadvance providing 5 s of calibration followed by 60 s of reading time per PM slide. Participants were asked to focus on the center of a red "X" during the calibration time.

Participants were also told in the initial instructions that after completing the 6-slide PP presentation, he/she would be taking part in a recall test on the information they read about in the PM slides. Upon completing the PP presentation, participants immediately began the cued recall test which was placed face-down on the table next to the participant before the PP presentation began. Head gear was not removed until after completing the recall test. Then, participants took the Nelson Denny Reading Comprehension test, were debriefed and finally, released. Participants were not financially compensated but instead received course credit.

RESULTS

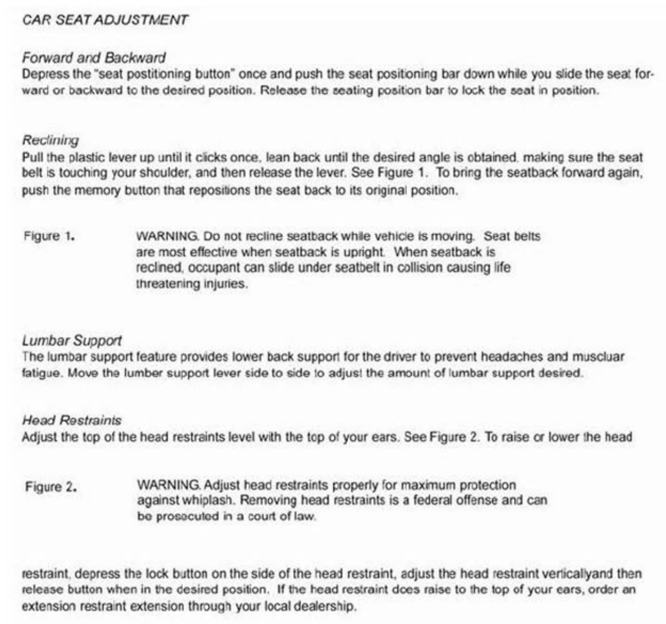
Operational definitions

The main dependent variables from the eye movement data required operational definitions. The Gaze Tracker analysis software overlays each participant's eye movement data onto each PM slides. Look zones, or research-defined areas of interest, can then be manually drawn overtop to subset or compartmentalized pertinent eye movement data for further analyses. In the current study, look zones were manually drawn around every component of the PM slide (e.g., headings, paragraphs, visual cues, warning icons, warning signal word panels, warning text, etc.). However, only look zones pertaining to visual cues and warnings were used in the analyses described below.

The three dependent measures were defined as follows. First, the *proportion of opportunities read*, a measure of how many warnings were read by each participant, was based on fixations and reading. A *fixation* was operationally defined as a collection of 3 or more nystagmus movements within a 1 degree radius lasting 100 milliseconds or longer (Rayner, 1998). *Reading* was defined as having three or more fixations in a look zone that housed at least one sentence. Each participant had six different opportunities to read the warning text because there were six different warnings presented; two per product manual slide. The *proportion of opportunities read* was the total number of opportunities read (i.e., three or more fixations in the portion of the warning that had at least one sentence of text) by a single participant divided by six total opportunities.

The second dependent measure, *cue effectiveness proportion*, was calculated by viewing each participant's eye movement video to assess whether visual cues redirected visual attention from the PM text to the warning. A *cued attentional shift* occurred when the participant first read the warning cue and then shifted their foveal vision to the cued warning resulting in at least one fixation on the cued warning. For each participant, the total number of times out of six opportunities a cued attentional shift occurred was tallied; this number divided by six total opportunities was the *cue effectiveness proportion*.

Figure 1.
The low salience condition with low salience warnings and low salience cues


CAR SEAT ADJUSTMENT

Forward and Backward
Depress the "seat postitioning button" once and push the seat positioning bar down while you slide the seat forward or backward to the desired position. Release the seating position bar to lock the seat in position.

Reclining
Pull the plastic lever up until it clicks once, lean back until the desired angle is obtained. making sure the seat belt is touching your shoulder, and then release the lever. See Figure 1. To bring the seatback forward again, push the memory button that repositions the seat back to its original position.

Figure 1. WARNING. Do not recline seatback while vehicle is moving. Seat belts are most effective when seatback is upright. When seatback is reclined, occupant can slide under seatbelt in collision causing life threatening injuries.

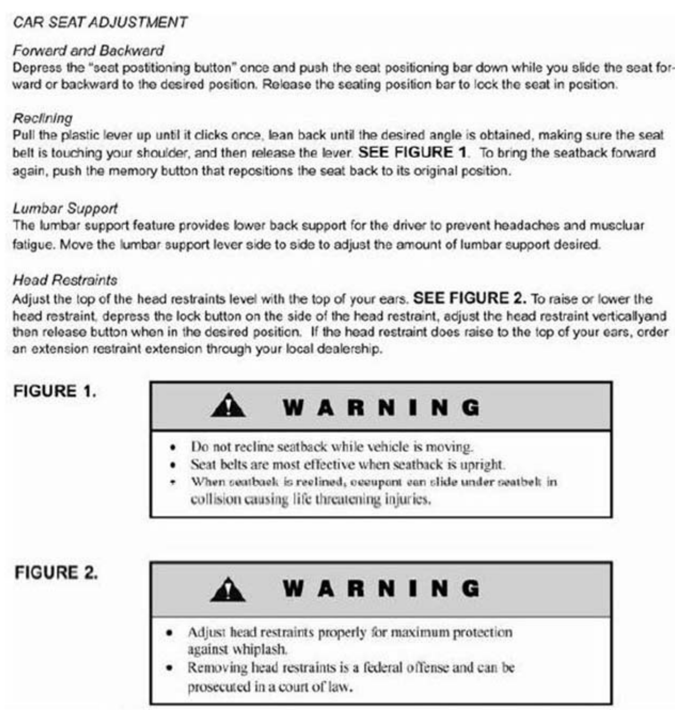
Lumbar Support
The lumbar support feature provides lower back support for the driver to prevent headaches and muscluar fatigue. Move the lumber support lever side to side to adjust the amount of lumbar support desired.

Head Restraints
Adjust the top of the head restraints level with the top of your ears. See Figure 2. To raise or lower the head

Figure 2. WARNING. Adjust head restraints properly for maximum protection against whiplash. Removing head restraints is a federal offense and can be prosecuted in a court of law.

restraint, depress the lock button on the side of the head restraint, adjust the head restraint verticallyand then release button when in the desired position. If the head restraint does raise to the top of your ears, order an extension restraint extension through your local dealership.

Figure 2.
The high salience condition with high salience warnings and high salience cues


CAR SEAT ADJUSTMENT

Forward and Backward
Depress the "seat postitioning button" once and push the seat positioning bar down while you slide the seat forward or backward to the desired position. Release the seating position bar to lock the seat in position.

Reclining
Pull the plastic lever up until it clicks once, lean back until the desired angle is obtained, making sure the seat belt is touching your shoulder, and then release the lever. SEE FIGURE 1. To bring the seatback forward again, push the memory button that repositions the seat back to its original position.

Lumbar Support
The lumbar support feature provides lower back support for the driver to prevent headaches and muscluar fatigue. Move the lumbar support lever side to side to adjust the amount of lumbar support desired.

Head Restraints
Adjust the top of the head restraints level with the top of your ears. SEE FIGURE 2. To raise or lower the head restraint, depress the lock button on the side of the head restraint, adjust the head restraint verticallyand then release button when in the desired position. If the head restraint does raise to the top of your ears, order an extension restraint extension through your local dealership.

FIGURE 1.
WARNING
- Do not recline seatback while vehicle is moving.
- Seat belts are most effective when seatback is upright.
- When seatback is reclined, occupant can slide under seatbelt in collision causing life threatening injuries.

FIGURE 2.
WARNING
- Adjust head restraints properly for maximum protection against whiplash.
- Removing head restraints is a federal offense and can be prosecuted in a court of law.

Percent correct was computed from the open-ended response cued recall test. All open-ended responses were coded by two judges into the following categories: “no response,” “a completely incorrect response,” “a more incorrect than correct response,” “a more correct than incorrect response” and “a completely correct response.” Discrepancies were resolved by two judges and inter-rater reliability was assessed using the Kappa Correlation Coefficient (Viera & Garrett, 2005). The resultant Kappa was 0.89 with a 95% confidence interval ranging between 0.87 and 0.90. Fourteen out of 46 questions were about warning content. Thus, the total number of responses that were judged as either “completely correct” or “more correct than incorrect,” was summed, divided by 14 total responses and multiplied by 100 to obtain the *percent correct* for each participant.

Analyses

Three analyses examined: (1) the warning readership frequency differences, (2) the effect of visual cues on eye movements, and (3) the warning content recall differences between experimental conditions.

First, a one-way, between-subjects ANOVA (n=27; 7 records were discarded due to low quality data) was conducted using the mean *proportion of opportunities read* as the dependent measure. The ANOVA results indicated participants in the low salience condition (M=.69; SD=.27) read slightly more warnings than the high salience condition (M= .56, SD=.34) but the difference was not statistically significant [F(1,25)=1.14, p=.30].

The second analysis assessed how visual cues influenced visual attention by (n=32; 2 records discarded due to poor calibration) evaluating the mean differences between high and low salience conditions in the *cue effectiveness proportions*. A significant ANOVA [F(1,30)=4.48, p=.04, η^2=.13] showed that the high salience cue condition (M=0.20, SD=0.2, n=15) produced significantly more shifts in visual attention to the warnings compared to the low salience cue condition (M=0.06, SD=0.1, n=17).

The third analysis evaluated whether the experimental condition affected warning content recall. A one-way, between-subjects ANOVA on the recall data was conducted (n=32; 2 records discarded due to poor calibration). The ANOVA showed a significant effect of salience condition on amount of warning content recalled [F(1,30)=6.31, p=.02, η^2=.17]. The low salience condition (M=30.4%, SD=14.4%) had a significantly higher mean *percent correct* compared to the high salience condition (M=18.3%, SD=12.8%).

To determine if there was a significant difference in reading and comprehension abilities across conditions, a one-way between subjects ANOVA using the Nelson Denny scores, was conducted. No significant difference was found.

DISCUSSION

The results indicated that high salience visual cues directed visual attention significantly more often than low salience cues. However, the increased number of attentional shifts from the cues to the warnings in the high salience condition did not appear to result in more readership of the warnings. Participants in the low salience conditions read slightly, but not significantly, more warnings than those in the high salience condition. Albeit non-significant, this difference may have contributed to the significant warning content recall differences. However, the cued attentional shift and the reading of the warning seem to be two temporally different events. Effective visual cues were those that resulted in at least one fixation inside the look zone surrounding the entire warning; however, most of the participants did not fixate more than twice in that zone indicating that reading did not occur at that time. Additional review of the eye tracking data suggests that many participants returned to the original location in the text to continue reading the PM.

The finding that low salience warnings resulted in better recall of the warning content was unexpected given previous research indicating that high salience formats generally increased memory for warnings and instructions. One likely reason for this somewhat surprising result is the nature of the task that participants performed and the particular formatting of the PM page across conditions. The present study was a highly controlled experiment under a somewhat contrived setting. The participants were undergraduates who never purchased the products involved, but who were asked to read these PMs with perhaps little personal impetus to do so. In addition, product consumers in naturalistic settings generally do not read manuals presented as PP slides while wearing eye tracking headgear. Also, the participants were not physically interacting with these products while reading.

Reading time constraints may have also contributed to these findings. The PP slides were presented at a more rapid rate than perhaps some people would comfortably read the material with. Consequently, two caveats are noteworthy. First, reading strategy (i.e., normal reading behavior vs. visual search) could have been influenced by the time constraints imposed (60 s per PM page). This may or may not correspond to reading strategies used by consumers in ecological settings. Typical reading behavior for native English speakers involves top-to-bottom, left-to-right eye movements when reading blocks of text, whereas searching for information in a page involves eye movements that sweep across the page in search of features that match expectations (Rayner, 1998; Shrestha, Owens, & Chaparro, 2008). At the outset, participants were told that the study’s purpose was to record eye movements while “reading” and were not given any impetus to search for specific information. However, the time constraint could have encouraged participants to switch from normal reading to a visual search strategy to find text headings, topic sentences and other summary information in lieu of reading the entire page content.

The second caveat is that time constraints may affect the readership of the high salience warnings given at the bottom of the page. If participants were reading top-to-bottom, left-to-right, then warnings in the low salience conditions (with warnings in the body of the page) may have a greater likelihood of being read than the high salience condition (with warnings at the bottom of the page). In straight-through reading, the bottom of the page is typically read last. Thus, material that the bottom of the page might be missed if participants could not read the entire PM page during the criterion limit of 60 s. Further research is needed to evaluate whether the present findings were due to warning formats, to warning positioning in the PM page, to time constraints, and/or or to the participants' reading strategy.

Future research could also determine what individual warning and cuing format features effectively guide visual attention to important warning information. The current research used a composite of several warning and PM features in each condition; thus, the research effects were attributed to this composite and not necessarily to any one individual feature. A more systematic manipulation of individual features and combinations of features may be useful to evaluate which significantly impacts warning readership and recall. In addition, there is a need to understand why other studies such as Young and Wogalter (1990) found better recall and comprehension for warnings with salient print and icons in a PM compared to low salient print and no icons. The results may be attributed to the use of a particular set of features comprising the salience conditions as well as the reading strategies participants employed. Another important consideration is the evaluation of the array of purposes that product manuals serve (e.g., finding some information in a time crunch, looking for safety information as a result of an accident, reading about the PM to get acquainted with the product's features, etc.) and how that affects reading strategies given different PM and warning formats.

Acknowledgements

The authors would like to thank Douglas J. Gillan and Eric N Wiebe for their assistance in this research.

REFERENCES

Cowley, J. A., Kim, S., & Wogalter, M. S. (2006). People do not identify tire aging as a safety hazard. *Proceedings of the Human Factors and Ergonomics Society, 50*.

Huntley-Fenner, G., Harley, E., Trachtman, D., & Young, D. (2007). ANSI Z535.6 and conspicuity: A test of the new state of the art format for instructions. *Proceedings of the Human Factors and Ergonomics Society, 51,* 1029-1034.

Krugman, D. M., Fox, R. J., Fletcher, J. E., & Rojas, T. H. (1994). Do adolescents attend to warnings in cigarette advertising? An eye-tracking approach. *Journal of Advertising Research, 34,* 39-52.

Laughery, K. R., & Young, S. L. (1991). An eye scan analysis of accessing product warning information. *Proceedings of the Human Factors and Ergonomics Society, 35,* 585-589.

Laughery, K. R., Young, S. L., Vaubel, K. P., & Brelsford, J. W. Jr. (1993). The noticeability of warnings on alcoholic beverage containers. *Journal of Public Policy & Marketing, 12,* 38-56.

Leonard, S.D. (2001). Relation of Owner's Manual to Safety. *Proceedings of the First International Driving Symposium on Human Factors in Driver Assessment, Training and Vehicle Design.* Iowa City, IA: University of Iowa Public Policy Center, 125-130.

Mehlenbacher, B., Wogalter, M. S., & Laughery, K. R.(2002). On the reading of product owner's manuals: Perceptions and product complexity. *Proceedings of the Human Factors and Ergonomics Society, 46,* 730-735.

Peterson, E. B., Thomsen, S., Lindsay, G., & John, K. (2010). Adolescents' attention to traditional and graphic tobacco warning labels: An eye-tracking approach. *Journal of Drug Education, 40,* 227-244.

Rayner, K. (1998). Eye movements in reading and information processing: 20 Years of research. *Psychological Bulletin, 124*(3), 372-422.

Shrestha, S., Owens, J., & Chaparro, B. S. (2008). Eye movements on a single-column and double-column text web page. *Proceedings of the Human Factors and Ergonomics Society,52,* 1599-1604.

Tabbers, H. K., Martens, R. L., & Merrienboer, J. J. G. v. (2004). Multimedia instructions and cognitive load theory: Effects of modality and cueing. *British Journal of Educational Psychology, 74,* 71–81.

Viera, A. J., & Garrett, J. M. (2005). Understanding interobserver agreement: The Kappa statistic. *Family Medicine*, *37*, 360-363.

Wogalter, M. S., Barlow, T., & Murphy, S. A. (1995). Compliance to owner's manual warnings: Influence of familiarity and the placement of a supplemental directive. *Ergonomics, 38,* 1081-1091.

Wogalter, M. S., DeJoy, D. M., & Laughery, K. R. (1999). *Warnings and risk communication.* Philadelphia, PA: Taylor and Francis.

Wogalter, M. S. & Laughery, K. R. (2006). Risk perception and warnings. In G. Salvendy (ed.), *Handbook of Human Factors and Ergonomics*, 3rd edition (pp. 241-270) New York: Wiley-Interscience.

Wogalter, M.S., Smith-Jackson, T. L., Mills, B., & Paine, C. (2002). Effects of print format in direct-to-consumer prescription drug advertisements on risk knowledge and preference. *Drug Information Journal, 36,* 693-705.

Young, S. L., & Wogalter, M. S. (1990). Comprehension and memory of instruction manual warnings: Conspicuous print and pictorial icons. *Human Factors*, *32*, 637-649.