The Value of Including a Picture of the Medicine on Pharmaceutical Labels

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There are a number of adverse drug events that occur per year due to ingesting the wrong medication. The present study examined whether including a picture of the medicine on pharmaceutical labels increased the participants' ability to identify the medicine that they should be taking. Participants were shown fake pharmaceutical labels that included either a picture or text description of the medicine's appearance, and were asked to identify the medicine being depicted or answer questions about the information found on the label. Participants performed better on questions relating to the content on the label than on questions asking them to identify the medicine. However, if the depiction was a color picture of the medication, participants performed better on pill identification questions than if the depiction was a black-and-white picture or text description. Thus, a color picture may help patients identify their medicine and reduce the number of cases involving the ingestion of the wrong medication.

INTRODUCTION

Kenagy and Stein (2001) estimated that as many as 10,000 patients die each year due to confusing labeling and packaging of medicine. Kenagy and Stein reported that these deaths are due in part to the fact that drug "names, labels, and packages are not selected and designed utilizing Human Factors principles, such as simplicity, standardization, differentiation, lack of duplication and unambiguous communication … the FDA standards do not require application of these principles" (p. 2033-2041). It is not surprising then that the labels provided by the drug companies for use are error prone. They often contain bad names, poor labels, and improper packaging. This leaves much opportunity for the development of guidelines to improve the usability of the labels. For example, adding pictorial cues would make use of some of the basic human factors principles known to help users identify objects, which in this case would be the medicine being consumed. Furthermore, if the label that is adhered to the bottle displayed a picture of the pill it contained, it would bring forth the multi-dimensional coding that is already set in place by the design of the pill that can help users in identifying their medicine (e.g., National Library of Medicine, 2012). Knowing that the dimensions of color, shape, size, and imprint vary between medicines allows both distributors and consumers to identify the major characteristics of the medication's appearance, and reduce potential complications associated with ingesting the wrong medicine.

Dennis Quaid's Twins--An Example Case

In the last decade there have been significant developments to advance the usability and accessibility of medical systems (Carayon & Xie, 2012). Unfortunately, we are still in the process. In November 2007, Dennis Quaid's twins were given a lethal dose of Heparin (a blood thinner) 10 days after they were born. The Quaids sued the pharmaceutical company drug maker, Baxter Healthcare Corporation, not the hospital (Cedars-Sinai) over their babies' overdose. While the Quaids agreed to a $750,000 settlement with the hospital, they sued Baxter, requesting a change in the drug label, so that the 10 unit dose is packaged completely different than the 10,000 unit dose. At the time of the accidental overdose, both doses were contained in vials that were a similar shade of blue which resulted in the dose confusion in conjunction with the poor labeling. The 10-unit pediatric dose and the 10,000-unit adult dose came in vials of identical size and shape. Although the vials were in different shades of blue, this distinction was not salient, unless the vials were seen in reference to each other.

One month prior to the accident with the Quaids' twins, another incident occurred that was similar in nature in Indianapolis, Indiana. Baxter was aware of this incident, which meant that the error with the Quaids' twins could have been prevented. Although Baxter issued a nationwide safety alert and redesigned the label for the drug, they did not recall the old stock of Heparin after the incident. Baxter could have prevented the incident by recalling the old heparin vials (CBSNews, 2009). Although this example references vials of a liquid medication, the main point is that it was the poor package labeling and color coding that contributed to the error. Incidents such as the Quaids' point to the need for a reform of the medication label. Thus, restructuring the information on the label could ultimately increase patient safety.

Ways to Identify Medicine

To the everyday users, many pills look very similar. However, close observation of any medicine reveals that there are distinguishing features of the pill. These features include shape, size, color, and imprints. The different variations in medicine are applied intentionally to help medical professionals identify the different types of medicine. Hence, there is reason to pay close attention to the deviations that are present among the pills. The two pictures shown in *Figure 1* are both of capsules that are pink, yet they contain completely different dosages of the same medicine. Prevacid has intentionally used different colors in regards to the coding of their capsules to denote a difference in the dosage. The 15 mg capsule is denoted by a pink and turquoise capsule (see F*igure 1* left pair of pills) while the 30 mg capsule is denoted by a pink and black capsule (see *Figure 1* right pair of pills). This distinction is very helpful for the pharmacies to help decipher the two dosages.

Figure 1. Illustration of the medicine, Prevacid, with color coding used to distinguish dosage.

Figure 2. Illustration of the medicine, Prozac and Triatimene, with similar color names used.

Although the Prevacid example is of the same medicine with different dosages, similar color combinations when used for different types of medication can lead to confusion. For example, Prozac (see *Figure 2* left) is contained in a yellow/beige and green capsule, while Triatimene (see *Figure 2* right) is contained in a very similar colored capsule (yellow and green). Thus, having pictorial representations of these mediations may be important in helping not only the pharmacists, but the end user identify their medication. Printing the picture of the medicine in full color may highlight the fine distinctions between medicines. Currently, the industry only provides verbal and numeric representations to describe medication, but given the subtle cues provided by the pills, it may be better to use a picture to convey the information.

Some pharmacies are trying to incorporate the medication identifiers on the label. Therefore a description of the medication is printed directly on the label such as white, oval, tablet, a logo, and imprint (e.g., 4331/500). This information allows both the pharmacist and the consumer to verify the medication they are taking, provided that they read the description of the medication. However, the descriptions may not be adequate because some of the wording is not commonly used among the general public. Shapes such as hexagon, are not commonly recognized by users. A patient may read this shape correctly. However, they may not have the knowledge or understanding of what a hexagon looks like or may not have sufficient information to make the distinction between a hexagon (6 corners), a heptagon (7 corners) or a trapezoid (4 corners). However, having a picture would help convey salient information such as how many angles are in a heptagon.

Websites such as Healthline (n.d.) are providing visual representations of the descriptive information (e.g., color, shape) about the pill. They are listing the various possible colors and shapes of medication in formats that are easy to reference when entering descriptive information about the pill. The formats obtain both visual and descriptive cues which can enhance user performance. *Figure 3* illustrates examples from their website. If information as rich in detail as this were located on the prescription label itself, then it would greatly enhance consumer safety by allowing pharmacists and end users to quickly and accurately identify the medication.

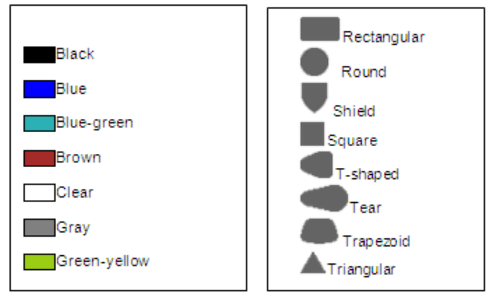

Figure 3. Illustration of various colors and shapes that are possible to help consumers identify medication highlighted by the Healthline website.

Present Study

The present study was designed to determine whether users can better identify their medicine through usage of pictures of the medication on the label. However, adding a picture may not necessarily be helpful in circumstances where a black and white printer is used because the color coding feature is lost. Therefore, in the present study we will examine whether the picture needs to be in full color or if it can be printed in black and white. In addition, the present study examines whether the location of the medication description influences participants' ability to process the information in the label.

METHOD

Participants

Forty eight participants (*M* = 20.4 years of age, *sd* = 4.05) were included in this experiment. All participants reported being fluent in English and having 20/20 vision (normal vision) or corrected-to-normal vision. Because most of the participants were recruited from the university's introductory psychology course, many were in their freshman or sophomore year. Only a quarter (N = 12, 25%) of the participants reported that either they or a family member worked in the medical industry.

Design

The study used a 3 (medication depiction: text, color picture, or black and white picture) x 4 (depiction location: Top-right, top-left, bottom-right or bottom-left) x 2 (trial type: experimental vs. experimental distractor) within-subjects factorial design. The medication depiction variable contained three levels: text, color picture, and black and white picture. The text condition consisted of a pharmaceutical label with a verbal description of the pill displayed in black text. The color picture label contained a picture of the medication displayed in color. The black and white picture category consisted of a label with a picture of the medication displayed in black and white. The second independent variable was depiction location, which consisted of information being presented in one of four quadrants of the label: Top-right, top-left, bottom–right or bottom-left. The depiction location denoted the placement of the medication description on the label. The final variable was trial type: experimental versus experimental distractors. In the experimental trials, participants were asked to identify the medicine being described on the label. The experimental distractor labels were identical to the ones used on the experimental trials; with the only difference being participants were instructed to identify three other pieces of information from the label.

The dependent variables were response time and accuracy. Response time was measured from the time that the stimulus was presented until a selection was made by pressing a response on the touch screen. Accuracy was measured as the participants' correct response to the question.

Apparatus and Stimuli

Participants were presented with images of fake pharmaceutical labels generated by the experimenter and presented on a touch-screen computer monitor. Participants were seated 11 inches from the touch screen. The size of the individual pharmaceutical label measured 1 ¾ inch wide (9.04° visual angle) x 2 ¾ inches long (14.04° visual angle). The description or depiction of the medicine occupied one corner of the label, measuring 7/8 of an inch wide (4.55° visual angle) x 1 inch long (5.19° visual angle). For the text condition, the font size used was 12 pt Arial style, and for the picture conditions, the picture did not to exceed the 7/8 of an inch x 1 inch in size (4.55° x 5.19° visual angle). While the literature review showed that using 14 pt font would be optimal for reading (Skelly et al., 2003), the 12 pt font size was used because font sizes between 10 and 14 points are most commonly used on pharmaceutical labels (see e.g., Shrank et al., 2007). For the color picture condition, the image was taken from a pill database. For the black and white picture condition, the color picture was transformed to black and white using MS PowerPoint (see *Figure 4*, top label). A custom Visual Basic program was written and used to present the stimuli as well as record the participants' response and response time on each trial.

Procedure

At the beginning of the experiment, participants read and signed an informed consent form and filled out a demographics questionnaire. Before beginning the actual experiment, the participants were administered a training block, which lasted approximately 5 minutes. The training block began with four Ishihara plates that asked the participants to identify the number they saw in the stimuli. This test screened for color blindness. Then, participants were given 12 practice trials that mirrored the sequence of events used in the experimental session. The sequence of each trial was as follows: the label was presented for 15 seconds and then removed. At that time a question appeared with 5 response alternatives. The participant then registered his/her response by touching the correct answer on the computer screen. After completing the training trials, participants were then given an opportunity to ask questions or opt out of the experiment.

Figure 4: Example illustration of the labels for each of the three conditions (Black & White Picture, Color Picture, and Text)

In the experimental session, the participants were presented with 96 trials that included 24 experimental trials (2 replications of the three depiction conditions at the four possible locations), 24 experimental distractor trials, and 48 pure distractors. The orders of the trial types were randomized. The sequence of events for each trial was as follows (see *Figure 5*): The participant was shown a screen which asked them to "press when you are ready to begin". After they pressed the button, a second screen appeared which displayed a picture of the fake pharmaceutical label. The participant had 15 seconds to read the label. After 15 seconds, the screen timed out and a third screen appeared. On screen 3 the experimental (pill identification) or distracter question was presented and the appropriate responses were displayed (see *Figure 6*).

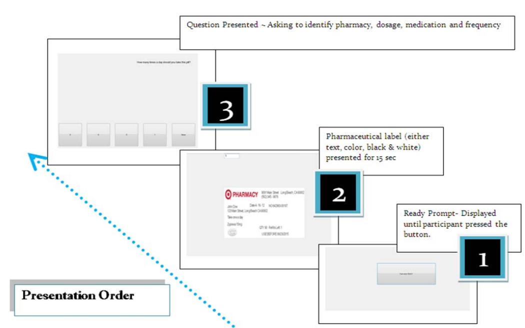

Figure 5. Picture displaying the presentation order.

If the participant was presented with an experimental question, s/he was shown 4 pictures of medication and asked to select the medication that was depicted in the previous label. For a distractor question, participants were asked about other information located on the label (which pharmacy filled the medication, the frequency the medication should be taken, or the dosage of the medication in milligrams). In all conditions, the correct response was placed among 3 distractors, and the participants were given a fifth "none" option.

Figure 6. Picture displaying the experimental (medication) and the 3 distractor condition responses.

At the end of the experiment, participants were given a debriefing form.

Analysis of Data

Mean response times for correctly answered trials and the proportion of correctly answered questions were computed separately for each participant in each condition resulting from the 2 (trial type: experimental or experimental distracter) x 3 (description condition: color, text, or black and white) x 4 (location: upper right, upper left, lower right, or lower left) factorial design. The mean response times and proportion correct was then submitted to separate repeated measures analyses of variances (ANOVAs).

RESULTS

Accuracy

For proportion correctly answered trials, there was a significant main effect of trial type, $F(1,47) = 125.00$, $p < .001$. Accuracy was higher on the experimental distracter trials ($M = .82$, $SD = .01$) than on the experimental trials ($M = .61$, $SD = .01$). There was also a significant main effect for description condition, $F(2,94) = 10.45$, $p < .001$. Bonferonni post-hoc pairwise comparisons showed that accuracy was higher for the color picture condition ($M = .77$, $SD = .02$) compared to both the text ($M = .71$, $SD = .02$), $p = .041$, and black and white picture ($M = .66$, $SD = .02$), $p = .001$. The accuracy rates for the text and black and white picture conditions did not differ from each other, $ps > .24$.

These main effects were qualified by a significant interaction between trial type and description condition, $F(2,94) = 4.65$, $p = .012$, see *Figure 7*. To determine the nature of this interaction, test of simple effects of description were performed separately for each trial type. The effect of description condition was significant for the experimental trials, $F(2,94) = 7.83$, $p = <.001$, but not for the experimental distracters trials, $F < 1.0$.

It is important to note there was the lack of an effect of the location of the description on performance, Fs < 1.0.

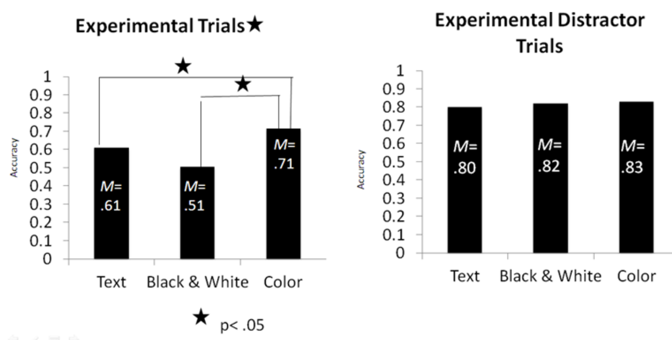

Figure 7. Illustration of the trial type and description condition interaction for accuracy.

Response Time (RT)

For RT, there was a significant main effect of trial type, $F(1,14) = 12.55$, $p = .003$. Participants had significantly shorter RT on the experimental distractor trials ($M = 2,624$ msec, $SD = 143.67$ msec) than on the experimental trials ($M = 3,098$ msec, $SD = 193.78$ msec). However, this main effect was qualified by a significant interaction between trial type and description condition, $F(2, 28) = 3.39$, $p = .048$, see *Figure 8*. To determine the nature of this interaction, test of simple effects of description condition were performed for each trial type. The effect of description condition was significant for the experimental trials, $F(2,40) = 7.12$, $p = .002$, but not for the experimental distracters trials, $p > .90$.

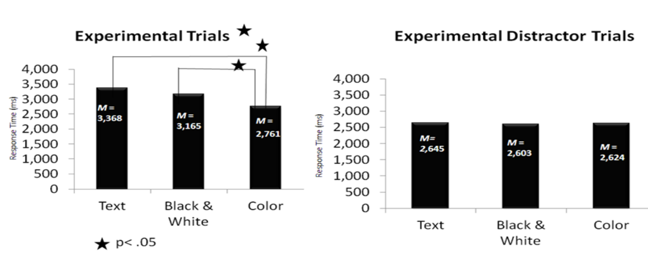

Figure 8. Illustration of the trial type and description condition interaction for response time.

Similar to the accuracy analysis, there was no significant effect of the location of the description on performance $Fs > 1.0$.

DISCUSSION

The primary goal of the current research study was to determine whether altering the prescription label by adding a black and white picture, color picture, or text description of the medication would impact a person's ability to identify their medication. As was expected, for the pill identification trials, the color picture condition yielded faster response times and higher accuracy than the text or black and white picture conditions. The response time and accuracy data converged, showing no speed accuracy tradeoff. Therefore, the present data clearly showed that by adding a color picture of the medication to the prescription label, one could significantly increase a person's ability to accurately and quickly identify their medication. Having a black and white picture of the pill on the prescription label, though, did not really improve participant's ability to identify their medication over text descriptions of the medication. The added color dimension then was the critical feature in helping the participants to identify their medicine. The markings on the pills, however, did not seem to be used because the markings should have been salient cues in both the black and white picture and text conditions. Thus, it seems that the color aspect of the picture attracted the participants' attention to the pill depiction, which then led to their better performance for identifying it.

The specific finding that the color depiction reduced identification errors suggests that the Baxter vial labeling incident experienced by Dennis Quaid's twins, described in the Introduction, was due not to the use of slightly different shades of blue on the label per se, but to the lack of a perceptual comparison to match the correct target vial with the intended one. Therefore the use of semantic cues from the text, and black and white depictions, may be more beneficial under conditions of low visibility because the quality of the colored picture would be reduced.

The participants were shown the same labels in the experimental trials and the experimental distractor trials. The main difference was that the experimental trials asked participants to identify the pill described on the label, whereas the experimental distractor trials asked participants about other information on the label (which pharmacy filled the medication?, how often one should take the medication?, and what was the dosage of the medication in milligrams?). Participants were about 1 second faster and 20% more accurate on the experimenter distractor trials than on the experimental trials. Thus, it was easier for the participants to extract content from the label than the perceptual information needed in the selection of the correct pill. One possible reason why the participants' performance was better on the experimental distractor trials was that they were more familiar with the information being queried. For example, the pharmacies used were local well known chains making the information easier to encode for the participants. In one sense, this finding is encouraging because it implies that the content of the label (i.e., pill name, number of times the pill should be taken, and dosage) could be processed quickly and accurately. However, if participants are taking the wrong pill, then the content associated with the correct pill has no benefit to the participant.

Users who take multiple medications may transfer their pills to another pill holder tool, such as those designed for each day of the week and for the different time period of the day (e.g., morning, afternoon, and evening). Even in this case, the ability for end users to be able to quickly identify their medication is important because the user can verify that the pill is the correct medicine prior to transferring it to the pill holder.

The lack of an effect of the location of the description was evident in both the response time and accuracy data analyses. This result is somewhat surprising because reading habits in the U.S. would lead to the prediction that information in the upper-left corner should be read first, and users should have better encoding of information presented in that location. However, it may be the case that the label is small enough that all of the information could be accessed easily within a single glance and participants use other cues such as pictures or text to guide their attention. The information location may be more important in applied contexts because the pill bottle is round, which means that certain parts of the label may be more/less visible from a given point of view.

In summary, participants were able to use and reference the color dimension of the pill in the color picture condition. Having a color picture of the medication led to participants being able to identify the medication depicted on the label faster and more accurately. The performance benefit from the color picture is likely a result of participants not having to make any transformations in processing the information. The text description required the user to transform the verbal description into an image or mental representation, thus requiring more cognitive demands. In contrast, the color picture condition allowed the users to use the perceptual cues in the pictures to identify the medicine.

LIMITATIONS

Since this was an initial investigation of the value of adding a depiction of medication on prescription labels, the study employed a convenience sample of college students. Use of college students, per se, does not invalidate the research findings, but care must be taken not to make generalization to other groups. Future studies should examine a more diverse set of individuals, especially elderly users or user that take multiple medications a day.

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