NBSIR 75-797

An Evaluation of a Range-Top Warning Light System

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U.S. DEPARTMENT OF COMMERCE, Rogers C.B. Morton, *Secretary*
James A. Baker, III, *Under Secretary*
Dr. Betsy Ancker-Johnson, *Assistant Secretary for Science and Technology*

NATIONAL BUREAU OF STANDARDS, Ernest Ambler, *Acting Director*

1.0 INTRODUCTION

During fiscal 1974, 401 In-Depth Investigation Reports (IDIR's) involving range-related accidents were obtained from the Consumer Product Safety Commission (CPSC) for the CPSC-funded "Appliances" project. The Human Factors Laboratory staff of the National Bureau of Standards (NBS) reviewed these reports in order to identify any systematic relationship(s) between injuries, hazards, and user activity sequences.[1] CPSC also asked NBS to suggest countermeasures designed to reduce the number and severity of appliance-related accidents and to investigate the feasibility of such countermeasures.

One accident sequence to emerge from the IDIR analysis concerned injuries to range users who were unaware that one or more of the surface units was activated. This problem occurred mainly with electric ranges, and proposed solutions to it have focused on increasing the user's awareness of surface unit activation. The use of warning lights has been recommended by both Underwriter's Laboratory (UL) and NBS. Specifically, UL has proposed that a signal lamp indicating burner activation be clearly visible to a person standing directly in front of and 10 feet from the range. A viewing elevation of five feet with a standard-size pan positioned on the burner surface was specified.[2] The positioning of the signal light or lights in relation to the surface unit controls, however, was not specified so that a single warning light, regardless of its position, can fulfill the requirements of the proposed standard.

In contrast, the former NBS Office of Flammable Fabrics recommended that indicators be provided which unequivocally denote for the user which surface element is energized.[3] This may be done by providing a separate signal light for each element and by positioning each light adjacent to the control for that element.

The proposed UL standard does not consider the activities of the range user. Kitchen tasks vary with respect to cognitive content, i.e., different kitchen tasks require varying degrees of concentration (Steidl, 1972). This point is important because the ability to distract someone from a task is related in a complex way to the "demandingness", or cognitive content, of the task (Fitts and Posner, 1967). Two possible outcomes may occur when individuals perform a highly cognitive task.

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[1] Detailed results of the accident analysis effort will be presented in the Final Report for the project.

[2] Proposed Amendments to UL Standard No. 858, "Household Electric Appliances," February 1, 1974.

[3] Letter from Sidney Greenfield, NBS, to Walter Kirk, American Gas Association Labs, Inc., January 2, 1973.

They may become so engrossed in that task that their susceptability to a distraction, such as a warning signal, is inhibited. Or, the performance of that demanding task may instead serve to attune their perceptual capabilities and actually enhance their responsiveness to a warning stimulus. How the effectiveness of any given alerting system relates to task content cannot be accurately predicted without empirical test.

The present study evaluated a user alerting system in terms of the cognitive content of the range user's activity as well as certain attributes of the display which could influence the response of the visual system. These physical variables were to include signal light intensity, surround color, and signal light position on the range top. For reasons to be discussed later, signal light intensity could not be varied independently.

An alerting system of warning lights was studied since this was the system recommended by both UL and NBS, as well as the one most often employed by range manufacturers at the present time. In accordance with the NBS recommendation, a system was studied which provided a separate warning light for each of the usual four range burners.

The present study was limited in scope. It was not an attempt to design an "optimal" alerting system. To have done so would have involved the evaluation of other types of systems, many of which would be of limited acceptability to users and/or manufacturers. Other potentially important factors, including kitchen configuration and the position of the user in relationship to the range, were also excluded from the present investigation.

2.0 METHODOLOGY

2.1 Design

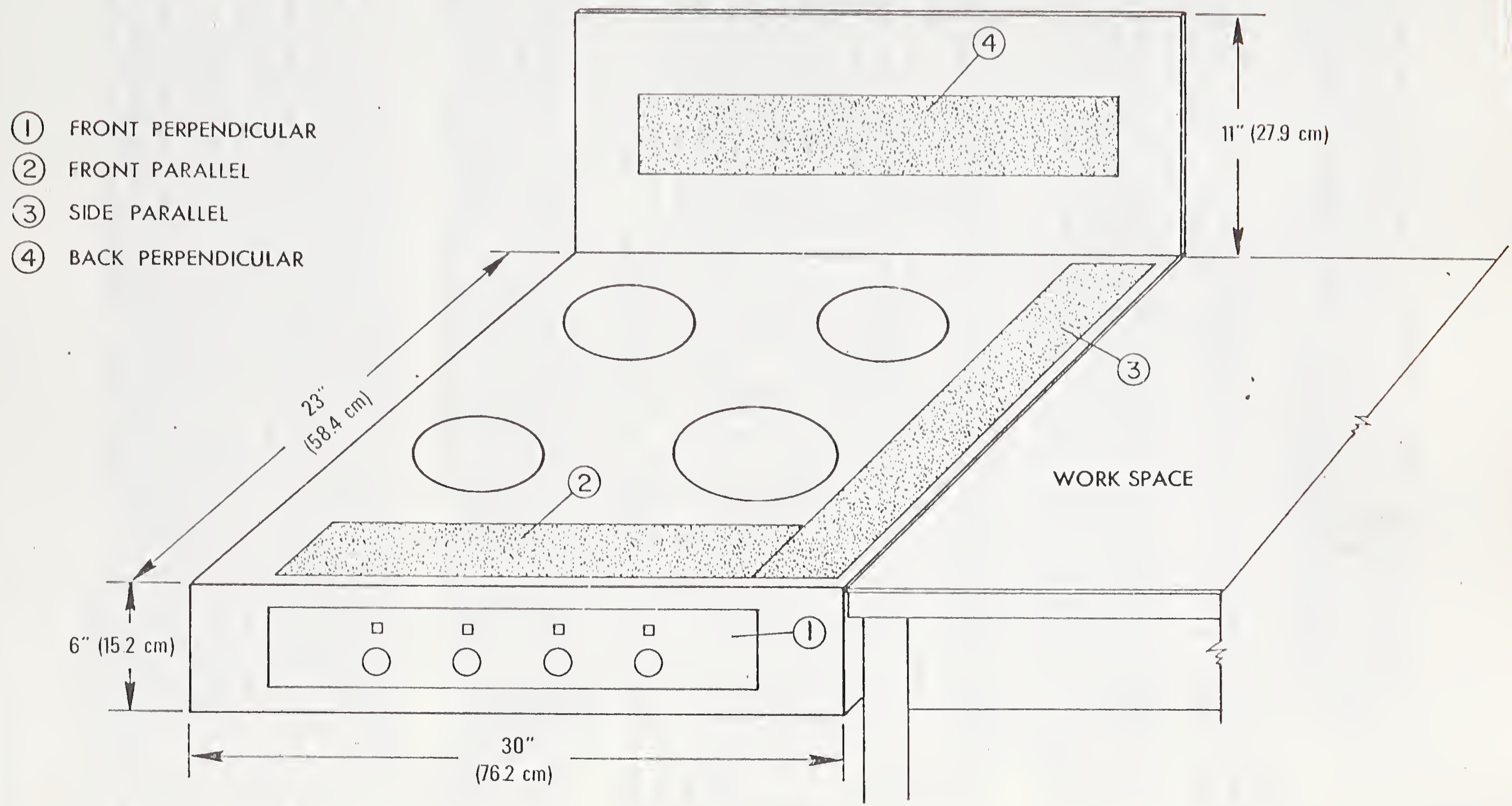
In the present study, both warning light color and ambient lighting were held constant. Red was selected as the most appropriate color since, according to current military and industrial standards, it signifies alert or warning (Woodson & Conover, 1964). Ambient lighting was set at 50 footcandles as this is the level generally recommended for kitchens (Kaufman, 1966; Woodson & Conover, 1964).

Warning light position was varied. The warning lights were positioned next to each of four control knobs on a moveable control panel. This panel could be fitted into any one of four positions on the range stimulator as Figure 1 illustrates. The panel positions employed were based on a review of currently available range designs and included warning lights adjacent to controls located on:

1. the front of the range, perpendicular to the cooking surface (Front Perpendicular);

2. the front of the range, parallel to the cooking surface (Front Parallel);

Figure 1. DIAGRAM OF MOCK KITCHEN RANGE SHOWING FOUR CONTROL PANEL POSITIONS



3. the side of the range, parallel to the cooking surface (Side Parallel); and

4. the back (back-splash) of the range, perpendicular to the cooking surface (Back Perpendicular).

Other warning light systems were considered (e.g., lights adjacent to the surface element) but were not included in the study as their implementation would involve practical problems or major changes in range design.

The background against which the signal lights were fitted was also varied. Informal surveys conducted in (a) local homes and apartments and (b) local retail outlets revealed that control knobs and warning lights are generally fitted against either a dark, flat surface (brown or black) or a chromed, reflective surface.

Research on visual perception (e.g., Geldard, 1972) indicates that the contrast ratio between the brightness of the stimulus (warning light) and its surround (background panel) is more relevant than background color in terms of the psychophysical response characteristics of the human eye. However, controlling contrast ratio would involve controlling the ambient light conditions at each of the four experimental range-top warning light positions; such precision was not feasible in the present experimental situation. Furthermore, controlled light conditions do not exist in real kitchens where contrast ratios vary as a function of the time of day, the type of day (sunny or cloudy), the position of the observer, and so on. In the present study the background color against which the lights were fitted was varied systematically recognizing that the actual contrast ratios were thus undefined and represent a possible confounding variable. Two backgrounds were employed: a flat, black surface and a chromed, reflective surface.

Finally, two levels of task demand were employed. Working a jigsaw puzzle was chosen as a high cognitive task, analogous to kitchen tasks like cooking or meal planning. Sorting beans into four different receptacles was chosen as a low cognitive task, analogous to washing dishes or chopping vegetables. That the cognitive content of the analogous kitchen tasks varies has been validated by subjects' ratings in a study by Steidl (1972).

Practical considerations interfered with an original intention to treat warning light intensity as an independent variable. Actual range-top warning lights had been provided by a range manufacturer for use in the study. When measured in the NBS laboratory, however, the intensity ranges of these lights were found to differ widely. The experimental apparatus had been fitted with a single rheostat; because of this limitation, a single rheostat setting produced a different stimulus intensity in each of the four lights. Rather than employ a generically different type of light whose intensities could be more closely matched, the actual warning lights were used for their face validity and authenticity. In the present study, then, warning light intensity was varied, but not in a uniform manner.

The two surround colors, four warning light positions, and two types of tasks combined factorially to produce a total of 16 unique stimulus conditions. A repeated measures design was employed, that is, each subject participated in all of the stimulus conditions.

2.2 Apparatus

A mock range top was constructed for use in the study. In accordance with averages observed in local retail outlets, it measured 30 inches (76.20 cm) across and 23 inches (58.42 cm) deep, and contained three 6-inch (15.24 cm) diameter heating units and a fourth 8-inch (20.32 cm) heating unit in the right front position (see Figure 1). It was finished with a white surface since white, according to range salesmen, is the most popular range color. Non-functional heating units were obtained from old ranges and mounted on the range top. Each element was equipped with a switch which, when depressed, deactivated the corresponding pilot light.

A separately constructed control panel could be mounted in each of the four specified positions: Front Paralled, Front Perpendicular, Side Parallel, and Back Perpendicular, as indicated in Figure 1. The four warning lights were back-mounted to the panel so that a 3/8-inch (0.95 cm) square was visible to the observer. Non-functional control knobs were mounted beneath each light. The panel was constructed of a chromed, reflective surface, but a flat, black surface could be affixed without obscuring either the warning lights or control knobs.

Pilot light intensity was measured in a darkened room by a Spectra Pritchard spot photometer. As noted above, the high variability of individual lights coupled with a limited experimental apparatus did not permit the uniform variation of warning light intensity. However, high, medium, and low intensity "ranges" were set; the average individual intensity readings, in nits (candelas per square meter), are presented for each light at each intensity range in Table 1. Each point represents the average of four intensity readings. In all cases, a readily perceivable difference existed between each intensity range for each light.

Each of the pilot lights was connected to the experimenter's console. This console contained a digital timer and controls which activated the lights and set light intensity. Activation of any of the four lights started the timer; the subject's closing of the switch on the range-top element deactivated it. Finally a clock timer was used to measure the interstimulus interval (ISI).

While the experiment itself was conducted in a physical science laboratory module at NBS, attempts were made to simulate a "typical" kitchen. One of the problems of the proposed UL standard was that it had not considered adequately typical kitchen design or use patterns. It had specified that the proposed warning light be visible from a

TABLE 1

Intensity of Individual Warning Lights (in Nits) as a Function of Intensity Range Setting

	Intensity Range		
Light	Low*	Medium*	High*
1	12.37	38.60	45.17
2	25.50	77.90	95.60
3	43.27	128.75	160.92
4	20.50	64.50	77.87

viewing distance of 10 feet, but typical kitchen design does not usually permit such viewing conditions. A small informal survey conducted by NBS personnel in local home and apartment kitchens revealed that, in 10 out of 12 cases, work spaces were located adjacent to, not in front of, the range.

During the survey, measurements of work spaces, distance from work spaces to the range, counter heights, and so forth, as well as simple "layout" diagrams were made for each kitchen. Based on these data, the laboratory subjects were provided with a work space and range height of 36 inches (91.44 cm). For convenience, the range simulator was situated to the left of the work space since the survey data had shown no preference for side. The distance from the center of the work space to the edge of the range measured 20 inches (50.80 cm). Subjects stood while working.

Movable partitions separated the subjects' area from the control area. A closed circuit TV camera was mounted in the far corner of the room and focused on the subject. All the subjects' activities were observed on a monitor in the control area. The experimenter was also within easy voice range of the subject.

A portable AM radio was operated whenever data were being collected. This not only masked background and equipment noise which might serve as potential cues to the subject, but also provided diversion and helped reduce boredom.

2.3 Subjects

Eight women, ranging in age from 21 to 58 and naive to the purposes of the study, served as subjects and were paid for their participation. All had 20/40 vision or better as measured by a standard Snellen acuity chart. Subjects who normally wore glasses were requested to do so both during the acuity test and the experiment itself.

2.4 Procedure

Once in the laboratory, subjects were tested for binocular visual acuity. They were then read a standard set of instructions; these instructions are included as an Appendix to this report.

Subjects were informed that the purpose of the research was to study cooking behavior. They were asked to perform two different types of tasks, a "thinking" task and a "manual" task (high and low cognitive task content, respectively). The "thinking" task involved working a jigsaw puzzle in the work space next to the range. This task was described as analogous to following a recipe while cooking. The "manual" task, described as analogous to chopping vegetables, involved sorting four different types of beans into four different containers. Subjects were informed that they would be told which task to perform at any given time.

They were further instructed that they would be distracted during their performance, that is, from time to time, one of the four red signal lights would come on. Whenever they noticed that one of the lights was activated, they were to quickly pick up one of the four bean containers and place it on the corresponding range top element. This action would deactivate the light, and the subject could then remove the container and resume her task.

The problems involved with controlling warning light intensity were noted above. Because lamp intensity was not uniform at a particular range setting, it could not be considered an independent variable in the data analysis. For procedural purposes only, however, the three stimulus ranges were combined factorially with the four warning light positions and two background colors to produce 24 different experimental conditions. These conditions were administered in a different random order to each subject. Randomization helped control transfer and/or learning effects. Within each condition, half of the session was devoted to the puzzle task and the other half to the bean sorting task. Subjects switched tasks on verbal command from the experimenter.

Each session lasted 48 minutes and consisted of 16 experimental trials or signal light activations. Exactly half of the activations occurred during each task. During a given session, each of the four signal lights was activated four times, but the order of activation was random. Interstimulus interval (ISI) was also varied randomly. Four different ISI values were employed, ranging from one to five minutes, with a mean of three minutes.

In order to familiarize subjects with the experimental set-up, four practice trials were administered on the first day. Thereafter, each subject participated in a total of four 48-minute experimental sessions on each of six days. Following each session, subjects were given a short break during which time they could walk around or leave the experimental room. The experimenter used this time to change the control panel position or background color when appropriate. Thus, each day's session lasted approximately four hours.

A typical experimental trial is described as follows. The experimenter, seated out of the subject's view, activated one of the four warning lights according to a predetermined random time interval and light position schedule. At the same time, a digital timer was activated and the experimenter reset the clock timer to the ISI appropriate for the next trial. Once the subject noted the light's activation, she picked up one of the bean containers and placed it on the burner corresponding to the activated light. This action turned off the light and stopped the digital timer. The experimenter then recorded the subject's reaction time to the light and reset the digital timer. Concurrently, the subject removed the container from the burner and resumed her task. Thus, a modified type of vigilance task was created, with reaction time measures as the dependent variable.

3.0 RESULTS

A high degree of variability was observed in the data. The overall mean reaction time was 7.9 sec. with a standard deviation of 5.2 seconds. In addition, some 135 scores, or more than four percent of the total, fell three standard deviation units or more above the individual subject means, indicating a definite positive skew. Since most statistical tests assume a normal distribution of scores, a logarithmic transformation was used to normalize the data. Each score, X, was converted to X' by means of the formula:

$$X' = \log_{10} X.$$

According to Kirk (1968), log transformation of data is often appropriate when the dependent variable is reaction time and the data are positively skewed.

Mean transformed scores were then computed for each subject in each of the 16 experimental conditions formed by the factorial combination of four warning light positions, two background colors, and two task types. Since means were computed across the three intensity ranges, each mean represented 24 converted reaction time scores. These means were then submitted to a three-way analysis of variance for repeated measures designs.

The results of this analysis are presented in Table 2. A significant effect ($F = 21.50$, $df = 1,7$, $p < 0.005$) was found for task type indicating that tasks high in cognitive content produced reliably longer reaction times than tasks of low cognitive content. The median reaction time scores for each subject are presented in Table 3 as a function of task type. Median scores are used since they provide the best index of central tendency when the original distribution of scores is skewed.

In addition, a significant effect was found for warning light position ($F = 3.16$, $df = 3, 21$, $p < 0.05$). The group sums of the transformed reaction time scores associated with each of the four range-top positions are presented below:

Front Parallel	26.2
Front Perpendicular	25.7
Back Perpendicular	25.2
Side Parallel	23.1

Since a significant F ratio only indicates that a difference exists between groups, Duncan's New Multiple Range Test was employed to determine where the difference or differences lie. The results of this test

TABLE 2

Summary Table

Analysis of Variance

Transformed Scores

Source	SS	df	MS	F
Subjects	2.34	7	---	---
A (Position)	.18	3	.060	3.16*
AxS	.39	21	.019	
B (Background)	.00	1	.000	0
BxS	.05	7	.007	
C (Task)	.43	1	.430	21.50**
CxS	.14	7	.020	
AxB	.00	3	.000	0
AxBxC	.18	21	.009	
AxC	.01	3	.003	<1
AxCxS	.16	21	.008	
BxC	.00	1	.000	0
BxCxS	.01	7	.001	
AxBxC	.01	3	.003	<1
AxBxCxS	.09	21	.004	
TOTAL	3.99	127		

* $p < .05$
** $p < .005$

TABLE 3

Median Reaction Times (seconds) for
Each Subject as a Function of Task Type

Subject	Task Type: Low Cognitive (Bean Sorting)	High Cognitive (Puzzle)
1	4.0	5.0
2	4.4	5.2
3	3.7	5.6
4	4.5	4.8
5	4.8	5.8
6	4.8	6.3
7	9.7	20.1
8	5.6	6.0
All Subjects Combined	4.8	5.9

are shown in Table 4. They indicate that the scores associated with both the Front Parallel and Front Perpendicular positions were significantly longer than those associated with the Side Parallel position. No other significant differences were observed.

Background color was not found to influence reaction time. The mean transformed scores associated with the chrome and dark backgrounds were, in fact, identical. None of the interaction terms approached statistical significance.

As discussed earlier, warning light intensity was not varied uniformly in the present study. Instead, intensity ranges were set that encompassed the 16 different intensity values presented in Table 1. Note that they cover a wide range - from a low value of 12.37 nits on Light 1 to a high of 160.92 nits for Light 3. Subjects' mean transformed responses to these designated intensity values were compared by a simple t-test for dependent groups. They were not shown to differ significantly ($t = 1.67$, $df = 7$).

4.0 DISCUSSION

The present study demonstrates that the activity of the range user can appreciably affect his or her response to an alerting system. Subjects performing the task high in cognitive content produced generally higher reaction times, i.e., they were less easily distracted from their task by a warning light signal. Conversely, subjects performing tasks low in cognitive content were more responsive to the distraction of the warning light.

From a theoretical standpoint, these results support the notion presented earlier that high task involvement tends to filter out or obscure low levels of external stimulation which are extraneous to the task at hand. Housewives have indicated preferences for those kitchen tasks which they also rate high in cognitive content (Steidl, 1972). The current results suggest that high cognitive tasks also produce slower response times to distracting stimuli. Thus, these preferred tasks are potentially more hazardous, as the performer of a high cognitive task may be less responsive to the visual cues signalling a potential accident.

An interpretation of the significant Position effect is not so straightforward. Subjects' response times were briefest to warning lights in the Side position. These responses were significantly briefer than those associated with both the Front Perpendicular and Parallel positions but no other significant differences were found.

Part of the superiority of the Side Position must be attributed to proximity; as shown in Figure 1, this is the range-top position nearest to the subject's work space. Field of view must also be considered. To perform the required tasks, subjects stood facing the counter adjacent

TABLE 4

Duncan's New Multiple Range Test

Comparing Differences Between Group Sums

For the Position Variable

(Transformed Scores)

	Side Parallel ΣX_3	Back Perp. ΣX_4	Front Perp. ΣX_1	Front Parallel ΣX_2
$\Sigma X_3 = 23.1$	---	2.1	2.6*	3.1*
$\Sigma X_4 = 25.2$			.5	1.0
$\Sigma X_1 = 25.7$				.5
$\Sigma X_2 = 26.2$				

* $p < .05$

to the mock range. Assuming the "normal" eye and head movements associated with performing the tasks, the chances were small that either Front position would be within the subjects' central visual field. On the other hand, the two positions to which the subjects responded most rapidly, the Side and Back, would more likely fall within the central field of view.

The importance of viewing angle with respect to the psychophysical response characteristics of the human eye is well documented (e.g., Geldard, 1972). The image of a warning light viewed directly will fall on the central (foveal) area of the eye's retina; in this region visual acuity and color sensitivity is maximal. On the other hand, the image of a warning light viewed at an angle may fall on the peripheral region of the retina. This region contains far fewer color receptors but is maximally sensitive to low levels of illumination.

The intent here is not to dismiss the obtained results as experimental artifact, for the laboratory set-up was patterned after observed kitchen design. The real implication may be that warning lights should be positioned as close to the work space, and hence to the observer, as possible, which might require "custom fitting" a range's control panel to individual kitchens.

The other systems variables under study, warning light surround and intensity, were not shown to significantly influence subjects' reaction times. Nor were any significant interactions among variables observed. The failure to obtain significant differences should not, however, be equated with negative results. Instead, the failure of these variables to influence performance may indicate that, within limits, they need not be considered as differentially affecting safety in the design of future warning light systems. (This statement requires further qualification regarding warning light intensity and contrast ratio which were not systematically varied in the present study.)

Significant differences were found in the present study; thus, some interpretation of these differences beyond the experimental laboratory must be attempted. Consider, for example, the task variable. The observed median reaction times for the high and low cognitive tasks were 5.9 and 4.8 seconds, respectively. This is a relatively small, although statistically significant, difference. In most cases, a surface element which is unknowingly activated this additional 1.1 seconds has little impact. In certain circumstances, however, so short a time frame could precipitate an accident. The flammability of certain fabrics is within these limits and sufficient time is available for a child[4] to make contact with an exposed and energized burner.

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[4]The accident sequence of concern in the present study involved adult range users injured while unaware that a surface element was activated; children, therefore, were not included as subjects. Young children frequently incur contact burns when crawling on a range top, but it is doubtful that a system of warning lights is the appropriate deterrent for such behaviors.

Another significant aspect of the present study is its support of a human factors approach to safety programs. The results clearly point to the significance of the human using the system; not only were the tasks performed by the user found to influence reaction times, but the physical location of the observer in relationship to the alerting system was relevant as well. The writers of future performance standards should not ignore this interaction between a system and its user. To consider the psychophysical capabilities and limitations of that user is not enough. The user's behavior must be assessed as he or she actively interfaces with the system in question and performs the usual tasks related to it.

Finally, certain inadequacies of the present study should be examined. For example, despite efforts to simulate an average kitchen, post-experimental interviews with subjects indicated that the laboratory atmosphere was not completely dispelled. Instead of preparing food, subjects were performing seemingly nonsensical tasks and occasionally placing a pan of beans on a mock range top. Instead of being in a real kitchen with freedom to move from counter to sink to range, they stood for 48-minute sessions at a mock-up counter in front of walls which, though decorated with posters, were metal. In a few instances, subjects seemed genuinely engrossed in their tasks (several reaction times of one minute or more were found), but it is likely that most of their attention was directed towards monitoring the warning lights. The influence of factors such as these on subjects' behavior should not be ignored.

5.0 METHODOLOGICAL NOTE

The exploratory nature of this study should be noted. The application of human factors psychology to product safety has typically taken one of two forms. Precise, objective, and quantifiable dependent measures have been collected from subjects in a rigorously controlled laboratory setting where tasks are contrived to simulate real-world activities. Or, observations have been made of subjects performing real tasks in natural situations and surroundings. In this latter case, data collection has often been limited to rather global descriptions of activity sequences or discrete check lists where the presence or absence of certain pre-established behaviors is noted.

Compromise is inherent in choosing one of these methodologies over the other. One method provides easily-analyzable data; the other insures greater face validity or correspondence with the "real world."

The present study may be viewed as a first step towards merging these two extremes to apply a methodology which uses objective, quantifiable measures to study natural behavior. Specifically, the present study attempted to increase the face validity of a study in a laboratory setting by simulating real surroundings and tasks.

Given that the present attempt to simulate real-world surrounding in the laboratory was moderately successful, the validity of such an approach is not universally accepted. Chapanis (1967), for instance, contends that the subjects' awareness that they are participating in an experiment can never be removed. Furthermore, this awareness constitutes only a small portion of the multitude of environmental, psychological, and physiological variables that influence behavior at any point in time. The laboratory study generally manipulates three or four of these variables, attempts to hold constant several others, but must ignore the vast and largely unspecified remainder that continue to influence performance in unidentified ways.

The obvious solution, of course, is to collect data only in real surroundings. For the present study, volunteer households might have been found where range-top warning lights could have been instrumented to occasionally activate during kitchen use. However, time, money and a multitude of logistical problems make this type of naturalistic solution untenable.

A compromise solution could involve interfacing a study of warning lights with another of the observational studies to be conducted in the new human factors research facility kitchen. That is, concurrent with a study of cooking behavior, a range-top warning light or system of lights could be instrumented to "spontaneously" activate once or twice during any given subject's experimental session. In this manner, subjects would in no way be attuned to the activation of a warning light; their main task, in fact, would be to prepare food. Any desired parameters relating to the physical set-up of the range could be varied between subjects.

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Appendix - Instructions to Subjects

APPENDIX

INSTRUCTIONS TO SUBJECTS

We're trying to find out something about how people behave when they're cooking. We think that using a kitchen involves two main types of activities or tasks - manual tasks and so-called "thinking" tasks. For example, one manual activity would be chopping vegetables. A "thinking" activity would be reading and following a recipe. We realize that preparing a meal involves both "manual" and "thinking" activities, and we'd like to be able to find out some of the differences, if any, between them.

Since we don't have a real kitchen, we're going to ask you to do some other tasks which we feel fit into the categories of "manual" and "thinking." The manual task involves bean sorting - as you can see, the beans are here in this pot (indicate). The thinking task involves putting together one of the jigsaw puzzles sitting on that table (indicate).

First, let's talk about the bean sorting, or manual, task. As you can see, there are four different colors of beans. There are also four pans, each of which is labeled with a different colored bean. Once you're asked to begin, we'd like you to start taking beans from the large pot and dividing them by color into the four smaller pans. In other words, put the white beans in the pot labeled with the white bean, the brown beans in the pot labeled with the brown bean, and so on. Once a small pan becomes filled, simply empty all sorted beans into this larger empty pot (indicate). There is no need to hurry at this task. We just ask you to work at a steady pace, as though you were preparing an unrushed meal at home.

The thinking task involves working a jigsaw puzzle. There are a number of different puzzles on this table - you should pick one that you think you can put together in a couple of hours. Again, we don't want you to hurry - instead, it's important to work at a steady pace as you often would in your own kitchen.

During each session, you'll spend half of your time sorting beans and the other half working on the puzzle. At the beginning of each session, I'll tell you which of the two tasks you are to start with. Sometimes you'll start sorting beans; other times you'll start out working the puzzle. Later on in the session, I'll tell you when to switch tasks.

At the same time you're working with one of these tasks, some distractions will interrupt your work. These distractors will involve the mock range top you see here (indicate). As you can see, the range has the usual four burners, four control knobs, and an indicator light next to each control knob. From time to time, one of these indicator lights will distract you by lighting up, like this (turn one light on). Each time you see one of the lights come on, you are to turn it off by putting one of the pans - it doesn't matter which one - on the appropriate burner, like this (put pan on burner). Once you place a pan on the appropriate burner, the light will go off. As soon as the light is turned off, count to three slowly and then remove the pan and resume whichever of the two tasks you were involved in before you noticed the light coming on. Before you start, you'll have some time to practice so that you can learn which burner goes with which knob and which light.

This can get pretty complicated, so let's go over it all again. You'll be working - at a steady and relaxed rate - on either a puzzle or at sorting beans; that is, at either a manual or a thinking task. You'll be told at the beginning of each session which task you're to start with, and then later in the session when to switch activities. As you're working, you'll be asked to watch for distractions - just as you would at home while preparing a meal. In this case, the distraction will be an indicator light on the range top. It's important that you notice whenever one of the lights comes on, but you should not be watching so intently that you neglect performing one of the tasks. As soon as you do notice a light on, you are to turn it off by placing any one of the small pans on the appropriate burner. Once the light is off, you can resume your main job of sorting beans or working the puzzle.

You'll be participating in this project for six days for about four hours a day. Periodically, we'll take short 10-minute breaks. I'll be sitting here behind the screen if you have any problems. Do you have any questions now before we begin?

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16. ABSTRACT (*A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.*)

A descriptive analysis of In-Depth Injury Investigations of range-related accidents revealed a series of incidents where range-users were unaware that surface elements were energized. One proposed solution to this problem involved a system of four warning lights to indicate individual surface unit activation. A laboratory study using human subjects evaluated the effectiveness of such a system. The backgrounds against which the warning lights were fitted and the intensity of the lights were not shown to influence subjects' responses in a reaction time task; however, the position of the lights and the type of ancilliary task being performed by the subject did. These results are discussed in terms of product design and safety, and implications of the study for methodological development are considered.

17. KEY WORDS (*six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons*) Consumer products; human factors; kitchen; ranges; reaction time; safety; warning lights.

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