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EXECUTIVE SUMMARY

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Introduction

A crucial component of the rehabilitation process for low vision persons is the enhancement of visual function through the optimization of residual vision. Intervention strategies of potential benefit are numerous, and have considerable potential in terms of both practicality and applicability, being perhaps the easiest and least expensive of interventions to effect. However, despite this potential, much is still unknown about the relative benefits of specific environmental modifications to the enhancement of residual vision, and the extent to which facilitative effects are consistent across differing visual conditions and tasks.

Previous research in this area suggests that environmental modifications such as increased illumination can facilitate performance, that low vision persons may benefit more from such strategies than sighted persons, and that there may be considerable variation from one low vision individual to the next as to what environmental and task conditions are optimal.

The purpose of the present study was to investigate the effects of several stimulus characteristics on the performance of visually impaired subjects across various tasks related to many kinds of real world visual functioning. Several research questions were addressed:

1. What is the relative strength of various stimulus effects?

2. Would such a ranking of stimulus effects remain constant across different visual tasks?

3. To what extent do such characteristics interact with one another? Are such interactions consistent across tasks?

4. How do various group performances differs relative to these variables? Are the stimulus effects the same for a low vision group as for a group with simulated visual acuity losses?

Method

Subjects

Two distinct populations were tested in separate phases of the project. The first involved the testing of sighted individuals under conditions of simulated visual impairment. The sighted subjects consisted of 50 students enrolled in a general psychology course (26 females and 24 males). These subjects were tested while wearing specially treated spectacles which simulated acuity losses within a range extending from approximately 20/200 to 20/600, and comprised the Simulated-Loss group. The second phase involved the testing of 44 low vision clients residing in Mississippi (26 females and 18 males), who comprised the Low Vision group. Low Vision subjects ranged in age from 17 to 56 ($\bar{x}$ = 32.3). The percent of visual loss varied greatly from 1 percent to 99 percent, with an average loss of 79 percent. Twelve of the 44 had a secondary disability. The primary optical diagnoses of this group also varied greatly, totaling 19 different conditions. Over half of this group were diagnosed as having more than one visual disorder, making categorization according to diagnosis somewhat questionable.

Tasks and Variables

Three visual performance tasks measuring aspects of visual functioning such as visual search, pattern recognition, and visuomotor control, were developed and administered. Tasks and manipulated variables were as follows:

1. Landolt-C Search Task. The subject's task was to search through an array of Landolt C's printed on a small card, locating C's of a designated orientation, and marking them. Performance was measured in terms of speed and accuracy. The task, which relates to tasks involving visual scanning, (such as reading), was performed under three levels of illumination (50, 200, and 300 footcandles), three levels of contrast (.72, .86, and .92), and three target sizes (12, 18, and 24 pts.).

2. Rotary Pursuit Task. The task involved tracking with a handheld stylus, a lighted target as it moved along a prearranged pattern for 30 second trials. Performance was measured in terms of the amount of time during each trial the stylus made contact with the moving target. The task was performed at two different target speeds, at the above three levels of contrast.

3. Pattern Identification Task. Stimuli consisting of either the letter C or E were presented singly to subjects via a memory drum. The task was to view each stimulus and to (a) identify the letter, and (b) determine its orientation (up, down, right, left). Viewing distance from the drum was individually adjusted so that task difficulty was more comparable for subjects with differing levels of impairment. Two presentation modes were employed: moving-target and stationary-target. Three contrast levels (.72, .86, and .92), two background conditions (black and white), three stimulus sizes (12, 18, and 24 pts.), and three illumination levels (50, 200, and 300 fc's) were manipulated.

Several considerations influenced the choice of variables, the range of values, and other methodology involved in the tasks. The variables themselves were chosen from among those environmental and task variables which are reasonably modifiable in real world work situations, in order that results and conclusions might have practical implications for the workplace. The range of values selected for each manipulated variable was guided by the following criteria: (1) relatedness to real world task variable ranges (e.g., print sizes), (2) the need to avoid ceiling or floor effects within a heterogeneous sample, and (3) maximization of the sensitivity of measurement. Because a different range is optimal for differing levels of impairment, the strategy of relative placement from the task was used. That is, subjects with greater acuity impairment were placed closer to the task than those with less, in order to approximate the same range of difficulty for each subject. Although this technique allows the confounding of distance (and thus, viewing field angle), with stimulus values, interpretation of results can remain straightforward if viewed in the context of relative differences in stimuli, rather than absolute values.

Procedure

An estimate of each subject's distance acuity was obtained using an Illiterate E Acuity Chart to determine placement of subjects in the Pattern Identification Task, adjusting task difficulty relative to acuity. Simulated-Loss subjects wore the adapted spectacles to simulate low vision acuity.

Subjects were first given instruction and practice on the Rotary Pursuit Task to eliminate a possible learning curve on this task. Following this practice, subjects began the testing sequence, which lasted approximately one hour, including a short break midway through the sequence. Tasks were divided where needed into segments of no more than 6 minutes in length and were presented in a counterbalanced order, as were variable levels within tasks.

Discussion

The low vision population is extremely heterogeneous because of the great variability between persons on many dimensions which undoubtedly influence visual performance. These include etiological variables, such as the type and number of visual disabilities, age of onset, prognosis, background and experience characteristics, and a whole range of subject characteristics such as personality, cognitive functioning, and motivation. Such characteristics combine in almost infinite variety to produce almost as many distinct patterns of visual functioning as there are low vision persons. This considerable heterogeneity becomes problematic to the study of low vision performance, because it is difficult to identify consistent variable effects statistically. Although the visual performance of many low vision persons may be affected in similar ways by specific environmental and task variables, these consistencies are often masked by the many differences that are also apparent in their performances. It is because of these difficulties that the use of a sample of subjects with simulated visual acuity losses is useful. The simulation of reduced acuity allows the investigation of variable effects on visual performance without a multitude of other factors creating additional "noise" which might mask such effects. Simulated-Loss subjects are impaired ONLY by the reduced acuity, not by multiple disabilities, not by impaired sensory development, and not by inadequate education. Thus, the effect of a stimulus characteristic on visual performance is more a "pure" reflection of the disability produced by reduced acuity, with the functional disability perhaps most characteristic of low vision persons.

Variable Effects Across Groups

Results of the two subject groups and the legally blind subset do not greatly differ. There are only minor instances where the findings relative to each group are actually in conflict, with most differences in findings being ones of degree rather than of type. In general, performances by the Simulated-Loss group were superior to those of the Low-Vision group and the Legally-Blind group, probably because individuals in this group were on the average higher functioning, had no secondary disabilities, were more accustomed to performance testing situations, and did not have a "vested interest" in evaluation outcome.

The smaller to nonexistant stimulus effects exhibited by the Low-Vision and Legally-Blind groups are apparently due primarily to the much greater performance variability of these groups, both in terms of within subject and between subject variation. It appears that environmental and task characteristics influence the visual performance of most low vision persons in much the same way that they influence those with simulated impairments. However, the variable effects are somewhat less consistent from one subject to the next and, for any given subject, from one time to the next.

Variable Effects Across Tasks

Size proved to be the most potent of the variables, resulting in significant main effects for all groups on each task for which it was included. In addition, Size significantly interacted with virtually all other variables, most consistently for the Simulated-Loss group. The Contrast variable had a somewhat weaker effect on performance, and was considerably more task dependent (i.e., the strength of effect varied from task to task). Across groups, Contrast had the greatest influence on the Landolt-C Search Task. The Illumination variable had a significant influence only on the Simulated-Loss group performances, most particularly on the Pattern Identification Task.

Variable Interactions

Consistency of interactions was greater across tasks than across groups. Size interacted consistently with other variables such that as Size decreased, other variables such as Illumination and Contrast increased in influence, most consistently for the Simulated-Loss group. However, only half of these interactions reached significance for the Low-Vision group; none for the Legally-Blind group. A Contrast X Target Speed interaction occurred on the Rotary Pursuit Task for all groups, but yielded differing patterns for each.

When the Pattern Identification Task was varied, as with different background conditions and presentation modes, the strength of variable effects differed, suggesting that they are somewhat task dependent, at least for the Simulated-Loss group. For example, the Size effect, always large, was further increased for the White Background condition, while Illumination most influenced performance for the Black Background. Contrast most greatly affected performance on Moving Targets, while the Size X Contrast interaction was greatest for the Stationary Target condition.

Summary of Results

1. Subjects with simulated losses in acuity performed better on all tasks than low vision persons, even though average acuity loss was significantly greater for this group. Their performances were also less variable, and were influenced by task variables in more systematic and predictable ways.

2. The subset of low vision subjects who tested as legally blind, exhibited lower performances on average and greater performance variability.

3. Group comparisons (e.g., Simulated-Loss vs. Low-Vision) yielded somewhat different patterns of variable effects, but differed more in terms of degree rather than kind.

4. Of the several stimulus and environmental variables manipulated, stimulus size had the greatest and most systematic effect on performance.

5. Virtually all other variables exhibited some effect on performance, but such effects were task specific. In general, as task difficulty increased (e.g., smaller stimulus size) the likelihood of various sti-

mulus effects also increased. Since all variables impacted on task difficulty, this resulted in numerous interactions, as would be expected.

6. The relative strengths of variable effects are fairly consistent across tasks, while absolute strengths are more task dependent. Thus, while Size always had a greater influence on performance than Contrast, the specific potency of each depended on the task involved.

Implications for Environmental Intervention

The fact that all variables did, in one context or another, significantly affect visual performance, should be considered a fairly convincing argument for the use of such strategies as intervention techniques for maximizing low vision visual performances. While not every variable can be manipulated for a specific real world task, generally one or more could be incorporated into most tasks to enhance their visibility.

Individual performances varied, exhibiting differing amounts of reaction to specific variables, especially among the low vision population. Thus, environmental intervention strategies should be as flexible as possible in order to take into consideration the varying needs of specific clients. Optimally, this would include assessment techniques to provide information as to the specific environmental variables which most influence a client's visual performance. However, such assessment techniques should be as task specific as possible, since stimulus effects tended to be task dependent.

A general strategy in the absence of individual assessment would be to change those characteristics which can be modified for a given task, in the direction which generally enhances visibility (e.g., increases in illumination, contrast, and size, decreases in target speed, and visual complexity) but in ways which maintain maximum flexibility whenever possible. It should be remembered that while the relationship between a variable and stimulus visibility may be fairly straightforward, relationships between variables and visual performance are more task dependent. For many tasks, "more" is not always "better." For most individuals, stimulus effects will follow a curvilinear function relative to most visual tasks, with moderate levels of the variable having a more facilitative effect on performance than levels at either extreme. Because of such task dependence and because of the variability in individual needs across and within low vision persons, flexibility in environmental modifications or enhancements is especially desirable.

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