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TASK PERFORMANCE AS A MEASURE OF VISION

James E. Sheedy, O.D., Ph.D.
Michael G. Harris, O.D., J.D., M.S.
Ian L. Bailey, O.D., M.S.

University of California
School of Optometry
Berkeley, California 94720

INTRODUCTION

An important function of vision is to provide us with sensory information to efficiently perform tasks - especially occupational-type tasks. In the research laboratory and the clinic we often measure and quantify various aspects of the visual sense such as visual acuity, stereoacuity, contrast sensitivity, amplitude of accommodation, etc. These and many other measures of visual performance each has an effect upon the performance of occupational-type tasks.

Many visual/optical conditions result in enhancement of some visual measures and decrease in others. This makes it difficult to assess the net effects. Examples of comparative corrections which result in visual trade-offs include: spectacle compared to contact lens correction, bifocal spectacles to progressive addition lenses, or different forms of presbyopic contact lens corrections. In this paper we present the results of several studies which utilize a set of occupational-type tasks to compare complex optical and visual conditions.

METHODOLOGY

The tasks, fully described elsewhere[1], were selected on the bases that they were related to occupational tasks and that we judged them to be highly dependent upon critical visual input for performance. The tasks and a summary description follow:

Pointers and Straws (PS) - placement with one hand of 28 wooden pointers into 28 drinking straws protruding from a wooden platform in fixed but random angles within 45 degrees of vertical.
Needle Threading (NT) - threading 18 small beads onto a short length of 20 lb test nylon line.

Card Filing (CF) - placement of 26 3x5 cards, each with one letter of the alphabet typed on it, behind the appropriate index card in a small file box.
Grooved Pegboard (GP) - placement of 25 identically grooved pegs into grooved holes which required proper peg orientation for insertion.
Reading Task (RT) - silent reading of seven lines of words on Bailey-Lovie word reading charts[2].
Letter Counting (LC) - visually counting the number of occurrences of an assigned letter in a paragraph of nonsense words on a VDT screen.

A trial of each task required 1-2 minutes to perform, therefore multiple trials under different visual conditions could be performed in one subject seating. Subjects were instructed to perform each task as quickly and accurately as possible, practice trials were scheduled. Each performance trial was timed and the errors recorded. Four to six trials under each condition were measured in order to establish an average performance for a given subject. The ordering of the trials was structured so that training effects were equalized among the test conditions. Our studies show that the speed of performance on these tasks is a more sensitive discriminator than the errors of performance.

BINOCULAR VISION

Task performance with binocular vision was compared to performance with monocular vision. The primary advantage of binocularity in performing these tasks would appear to be enhanced depth perception due to stereopsis. Some of the tasks (e.g. PS, NT) require depth perception for performance.

Thirteen subjects, screened for normal binocular vision, performed selected tasks with both eyes open and also with each eye occluded[1].

The binocular speed advantages for each task relative to the better monocular speed were:

Pointers and Straws	29.5%	$p < 0.001$
Needle Threading	20.4%	$p < 0.001$
Card Filing	8.9%	$p < 0.001$
Grooved Pegboard	4.0%	$p < 0.001$
Reading Task	3.7%	$p < 0.05$
Letter Counting	-0.1%	ns

These results show that denial of binocular vision in individuals with normal binocular vision causes a loss of performance speed in some tasks. The most significant losses were for those tasks which are highly dependent upon depth judgments (PS and NT). Flat tasks such as RT

and LC were only minimally affected by loss of binocularity. These results indicate that individuals with normal binocular vision utilize binocular vision attributes, most likely stereopsis, to enhance performance of tasks which require depth judgments.

Since some of the tasks are strongly affected by the denial of binocular vision and others are not, we can utilize this fact in studying whether performance differences between two visual conditions are due, in part, to binocular vision decrements. This is applied to the following study of monovision correction of presbyopia.

MONOVISION CONTACT LENS CORRECTION OF PRESBYOPIA

Monovision (MV) correction of presbyopia, accomplished by providing the distance correction in one eye and the near correction in the other eye, has been shown to result in some loss of stereopsis and also some loss of contrast sensitivity. We tested task performance on 18 presbyopic subjects under MV conditions and also under BV conditions (distance contact lenses with reading spectacles)[3]. Testing was performed at the dispensing visit and at 2 and 8 weeks post dispensing.

The BV speed advantage was:

Dispensing	2 Weeks	8 Weeks	
Pointers and Straws	4.0% ($p<0.005$)	1.9% (ns)	3.5% ($p<0.0005$)
Card Filing	4.2% ($p<0.05$)	0.7% (ns)	2.8% ($p<0.005$)
Letter Counting	4.2% ($p<0.025$)	5.7% ($p< 0.005$)	2.8% (ns)

These results show a significant speed loss of about 3-4% with MV compared to BV on these tasks. These particular 3 tasks were selected because loss of binocular vision had quite different effects upon their performance as measured previously[1] (PS-29.5%, CF-8.9%, LC-0.1%). The relatively equal decrements of performance on all three tasks with MV suggests that the performance decrement caused by monovision is not substantially related to loss of depth judgment, but, more likely, related to losses of resolution or contrast sensitivity.

SIMULTANEOUS VISION BIFOCAL CONTACT LENS CORRECTION OF PRESBYOPIA

One method of contact lens correction of presbyopia is a simultaneous vision bifocal in which the central zone of the contact lens has the near refractive correction and an annular zone has the distance refractive correction, resulting in some light from both distant and near objects being imaged simultaneously on the retina. Task performance with this contact lens

correction (BCL) was compared to performance with distant contact lenses with reading spectacles (DCL) on a group of 32 presbyopic subjects who were screened and considered to be probable successful BCL wearers[4].

DCL speed advantages at dispensing and after 8 weeks of wear were:

	Dispensing	8 Weeks
Pointers and Straws	9.1% ($p<0.025$)	6.1% ($p<0.025$)
Card Filing	14.5% ($p<0.025$)	7.2% ($p<0.025$)
Letter Counting	9.9% ($p<0.025$)	5.6% ($p<0.025$)

Performance speed is decreased by 6-7% with BCL compared to DCL and, as with monovision correction, tasks with heavy dependence on binocular input are affected to about the same extent as tasks which are not.

SUMMARY

Occupational task performance is an effective method for comparing functional differences between vision corrections. An advantage of this method is that it provides a comparison of the aggregate visual abilities in situations with complex optical and/or visual differences. We have presented studies on presbyopic contact lens corrections as examples.

Monovision correction results in task performance speed decreases of about 3-4% compared to distant contact lenses with reading spectacles, the center surround simultaneous vision bifocal contact lens results in a speed decrease of 6-7% compared to the same control condition. Although the monovision and bifocal contact lens corrections were not directly compared to one another, it appears that monovision results in a smaller performance decrement. In both cases, it appears that the performance losses are not attributable to losses of binocular vision.

REFERENCES

1. Sheedy JE, Bailey IL, Buri M, Bass E. Binocular vs. monocular task performance. Am J Optom Physiol Optics 63(10): 839-846, 1986.
2. Bailey IL, Lovie JE. The design and use of a new near-vision chart. Am J Optom Physiol Optics 57: 378-387, 1977.
3. Sheedy JE, Harris M, Busby L, Chan E, Koga I. Monovision contact lens wear and occupational task performance. Am J Optom Physiol Optics 65(1): 14-18, 1988.
4. Sheedy JE, Harris MG, Bronge MR, Joe SM, Mook M. Task and visual performance with simultaneous vision bifocal contact lenses. Submitted for publication.