Bulletin of the Psychonomic Society
1982, Vol. 19(6), 351-352

Prolongation of a visual afterimage with systematic alternation of room illumination

BENJAMIN WALLACE
Cleveland State University, Cleveland, Ohio 44115

The present study investigated the effect of changing room illumination on perceived afterimage duration. Subjects observed a light pulse and reported upon their perception of a resultant afterimage. This afterimage was first produced and observed in the dark and was continually viewed in this environment until it was reported to have disappeared. The room lights were then turned on, and the subjects reported if the afterimage reappeared and, if it did, on its persistence. Upon the afterimage's disappearance in the lighted environment, the room lights were turned off and, again, subjects reported upon the afterimage. This systematic alternation between dark and light room environment continued until subjects no longer reported perceiving an afterimage. It was found that such alternation prolonged afterimage duration, with four illumination changes appearing to be the maximal number for producing the effect.

Visual afterimages are produced when a pulse of light bleaches retinal photoreceptors (Alpern & Barr, 1961; Brindley, 1959, 1962, 1963). Generally, these afterimages endure for a very brief period of time, ranging from a few seconds (Meudell & Pease, 1968; Wallace, 1979a, 1979b; Wallace & Smith, 1981) to several minutes (Hall & Wilsoncroft, 1964; McGuinness & Lewis, 1976; Misiak & Lozito, 1951; Smith & Wallace, 1982). The variance in afterimage duration is generally attributable to the conditions of the inducing stimulus or to changes in the background illumination against which an afterimage is projected.

Of the aforementioned experiments, many were conducted with the express purpose of attempting to discover methods for prolonging afterimage duration. For example, Misiak and Lozito (1951) reported that viewing an afterimage binocularly, as compared with monocularly, increased its duration. Also, Smith and Wallace (1982) found that if subjects could attach a meaningful name to an afterimage shape (e.g., "triangle" for an enclosed, three-sided figure), it was reported to endure for a longer period of time.

From the many attempts to develop techniques and methods for prolonging afterimage duration, one variable that appears to have attracted considerable attention is the role of room illumination. As early as 1896, Helmholtz (1896/1962) reported success in prolonging afterimage duration by alternating the level of brightness against which an afterimage was projected. This phenomenon was replicated in several subsequent experiments by other researchers (Evans, 1928; Hall & Wilsoncroft, 1964; Williamson, 1945).

Reprint requests should be sent to the author, Department of Psychology, Cleveland State University, Cleveland, Ohio 44115.

Unfortunately, the alternation between viewing an afterimage in differently illuminated environments has not been carried out in a systematic fashion. For example, Evans (1928) slowly flickered a light illuminating his experimental environment, and this prolonged afterimage duration. However, he did not specify how many times he flickered the light to produce afterimage prolongation. The present study was undertaken with the express purpose of systematically varying room illumination phases to determine if such a procedure might assist in prolonging afterimage duration. Also, if this proved successful, the maximal number of room illumination alternations that produced afterimage prolongation would be specified.

METHOD

Subjects

Eight subjects from introductory psychology classes served as participants. Each individual received extra course credit for being in the experiment. Also, each subject had normal, 20/20 uncorrected visual acuity.

Apparatus

The experiment was conducted in a 3.1 x 6.4 m completely lightproofed room. The stimulus to be observed was produced by a pulse (approximately 1 msec in duration) from an electronic 2,000-beam cp/sec Vivitar (Model 273) flash unit. This unit was mounted on an adjustable stand that could be raised or lowered to permit the light source to be projected to the subject's eyes from an eye-level position. The subject's head was stabilized during the experiment by placing it in a Marietta Instruments combination head-and-chin rest. Each subject was presented a single pulse of light (6 min visual angle; approximately 28 fc).

Procedure

Each subject was individually led, blindfolded, to the experimental room and was seated in a chair. The experimenter then

0090-5054/82/060351-02$00.45/0

turned the room lights off and removed the blindfold from the subject. The subject was then instructed to gaze in the straight-ahead direction to observe a stimulus light. This position was localized by fixating toward the voice of the experimenter. A visual fixation point was intentionally avoided so that such a stimulus would not influence afterimage persistence or formation.

When the light source was visible, the subject was requested to indicate when an afterimage was formed and when it disappeared. As soon as disappearance was described, the experimenter turned the lights on in the experimental room. The subject was then requested to indicate what, if anything, was visible. If the afterimage reappeared (as it did for all subjects employed here), the subject was to so indicate. When this reemergent afterimage disappeared, this was also to be reported. The experimenter would then turn the room lights off and again the subject was to report what, if anything, was visible. If the afterimage reappeared, this was to be reported, as well as the subsequent disappearance of such. This alternation between a dark and a lighted environment continued until the subject no longer reported reappearance of the afterimage. Each subject only received one trial (one alternation series). Amount of time spent by each subject in the lighted or dark environment was solely dependent upon the subject's report of afterimage duration within each environment. All subject responses were tape-recorded for subsequent data analyses.

RESULTS AND DISCUSSION

The cumulative afterimage durations (in seconds) over the various illumination phases are presented in Table 1. As this table indicates, alternating between a dark and lighted environment while observing an afterimage appeared to prolong its duration. Employing this procedure, the longest enduring afterimage for any one subject was 115.2 sec.

A possible reason why alternation of room illumination appears to prolong afterimage duration is because of the probable photoreceptor recovery from bleaching by light. That is, afterimage prolongation may be attributable to photoreceptors in different parts of the retina that are at different stages of recovery from prior illumination. Thus, as some photoreceptors recover from prior illumination bleaching by an intense pulse, other photoreceptors become bleached but by a weaker light source (room illumination). This continues until there is complete recovery from bleaching by the intense light pulse (the original inducing stimulus). When this happens, the afterimage is reported to have disappeared.

It should also be noted that the perceived brightness of the afterimage was reported by most subjects to decrease from one room illumination phase to another. It was reported as being brightest in the first room illumination phase (dark) and weakest in the fourth illumination phase (light). Regardless of the perceived brightness of the afterimage, however, it appears that it can only be prolonged for a limited period of time with the deployment of room illumination changes. The time, per se, varies from subject to subject, and the durations reported here do not necessarily represent the maximal afterimage durations possible. For example, a more intense inducing stimulus would probably produce a longer enduring afterimage (Helmholtz, 1896/1962). However, regardless of the initial afterimage duration produced from a single room-illumination condition, changes in that condition do appear to prolong afterimage durations.

Table 1
Cumulative Afterimage Durations (in Seconds) Over Various Room Illumination Phases

	Illumination Phase (in Order)			
Subject	Dark to Light	Light to Dark	Dark to Light	Light to Dark
1	43.1	59.2	87.3	101.5*
2	27.3	40.2	84.8	99.0*
3	32.4	36.9	79.4	104.0*
4	34.8	58.2	73.0	87.0
5	52.6	81.0	110.5	115.2*
6	48.2	62.5	81.3	97.8*
7	25.2	48.6	64.0	78.5*
8	26.2	53.4	73.4	81.5*
Mean	36.2	55.0	81.7	95.6
SD	10.5	13.9	13.8	12.4

**The afterimage disappeared after this phase. Subject 4 reported the afterimage as enduring for one additional phase with a cumulative duration of 95.5 sec.*

REFERENCES

ALPERN, M., & BARR, L. Durations of the afterimage of brief light flashes and the theory of the Broca and Sulzer phenomena. *Journal of the Optical Society of America,* 1961, **52**, 219-221.

BRINDLEY, G. S. The discrimination of afterimages. *Journal of Physiology,* 1959, **147**, 194-203.

BRINDLEY, G. S. Two new properties of foveal afterimages and a photochemical hypothesis to explain them. *Journal of Physiology,* 1962, **164**, 168-179.

BRINDLEY, G. S. Afterimages. *Scientific American,* 1963, **209**, 84-93.

EVANS, J. N. A clinical method to determine the rate of elimination of afterimages (eikonoscopy). *American Journal of Ophthalmology,* 1928, **11**, 194-202.

HALL, R. J., & WILSONCROFT, W. E. Prolonged visual afterimages. *Psychonomic Science,* 1964, **1**, 267-268.

HELMHOLTZ, H. *Physiological optics* (Vol. 2). New York: Dover, 1962. (Translated from the 1896 edition.)

MCGUINNESS, D., & LEWIS, I. Sex differences in visual persistence: Experiments on the Ganzfeld and afterimages. *Perception,* 1976, **5**, 279-294.

MEUDELL, A., & PEASE, K. G. Influence of meaning on fragmentation of visual afterimages. *Perceptual and Motor Skills,* 1968, **27**, 965-966.

MISIAK, H., & LOZITO, C. C. Latency and duration of monocular and binocular afterimages. *Journal of Experimental Psychology,* 1951, **42**, 247-249.

SMITH, L. D., & WALLACE, B. The role of a cognitive factor in the prolongation of an induced visual afterimage. *Bulletin of the Psychonomic Society,* 1982, **19**, 145-147.

WALLACE, B. Hypnotic susceptibility and the perception of afterimages and dot stimuli. *American Journal of Psychology,* 1979, **92**, 681-691. (a)

WALLACE, B. The role of iris pigmentation in the perception of an afterimage. *Perception & Psychophysics,* 1979, **26**, 469-471. (b)

WALLACE, B., & SMITH, L. D. Sclera color and reports of afterimage persistence. *Perception & Psychophysics,* 1981, **29**, 277-279.

WILLIAMSON, W. P. Afterimage perimetry: A rapid method of obtaining visual fields; preliminary report. *Archives of Ophthalmology,* 1945, **33**, 417-422.

(Received for publication March 15, 1982.)