Perceptual and Motor Skills, 1975, 41, 403-406. © Perceptual and Motor Skills 1975

BLINKING AND THINKING¹

MORRIS K. HOLLAND AND GERALD TARLOW

University of California, Los Angeles

Camarillo-(UCLA) Neuropsychiatric Institute Research Program

Summary.-Blinking is related to certain cognitive processes. For example, individuals "punctuate" their speech by blinking between phrases and at the end of sentences. Daydreaming is associated with low rates of blinking. Blinking occurs between fixations and may be timed so as not to interfere with significant visual input. Apparently, blinking occurs at transitions between internal events and is inhibited at other times. In the experiment reported here, blinking was measured while the activity of operational memory was manipulated with mental load kept constant. The rate of blinking was significantly reduced when the cognitive operation of internal counting was being performed. It is inferred that the blink rate is low when information in memory is being operated on. To suspend blinking during certain cognitive activities would be adaptive if blinking disrupts them. Since the blackout period of the blink produces a rapid change in visual level, blinking disrupts those cognitive processes utilizing display areas accessible to visual input. Operational memory and the visual imagination may share components with the visual perceptual system. To protect these vulnerable processes from interference, blinking may be inhibited when they are active.

Blinking occurs at psychologically interesting moments. While serving the tissue need of the eye, blinking is also an external indicator of certain cognitive and affective processes. Telford and Thompson (1933) showed that the rate of blinking was low during tasks requiring concentration and intense mental activity. For example, persons solving arithmetic problems tend not to blink. Other forms of extended cognitive activity such as daydreaming are also accompanied by low rates of blinking. Individuals who do not blink or move their eyes appear to be preoccupied with their own thoughts or fantasies. Blinking is a function of memory load, such that the more the items in memory (and presumably the more the rehearsal activity), the fewer the blinks (Holland & Tarlow, 1972). Apparently, subjects inhibit blinking during focused and extended internal mental activity. However, unfocused or rapidly changing internal states such as disorientation, emotional excitement, frustration, and anxiety seem to be associated with high rates of blinking (Kanfer, 1960; Ponder & Kennedy, 1927).

¹This study was supported in part by a research grant from the University of California, Los Angeles and NIMH Grant MH-R20. The opinions stated are those of the authors and reflect neither the policies of Camarillo State Hospital nor the Board of Regents of the University of California. Requests for reprints should be addressed to Gerald Tarlow, Camarillo-(UCLA) Neuropsychiatric Institute Research Program, Box "A", Camarillo, California 93010.

Blinking seems to occur at the moment of cognitive change. While searching one's memory for a name, one tends not to blink; then, when the name is located, blinking occurs. While trying to solve a mental arithmetic problem, one tends not to blink; then, when the solution is achieved, blinking occurs. Hall (1945) observed that when subjects were reading, most blinks occurred at marks of punctuation and between fixations. A person engaged in conversation or making a speech will also "punctuate" his talk by blinking between phrases and at the end of sentences. In a visual tracking task, Poulton and Gregory (1952) found that subjects tended to blink just before they expected the tracking to start and also immediately after it ended. Perhaps blinking is an indicant of transitions between different gazes, sets, or ideas.

What can account for the relation of blinking to cognitive processes? Broadbent (1958) suggested that subjects suspend blinking while looking at something interesting, and time blinks so as not to interfere with significant visual input. The "blackout" period during a blink is typically 30 to 100 msec. (Lawson, 1948) and, while a significant event could be missed in that time, it is unlikely that this would occur during everyday activities. Furthermore, blinking is inhibited during some activities that are not dependent on visual input; therefore, a more general hypothesis is desirable. This hypothesis is suggested by the fact that blinking is disruptive not only of visual input but also of visual memory. Eidetic children apparently blink to erase their persisting visual images (Leask, Haber, & Haber, 1969). Although blinking prolongs and revives fading after-images (Kinsbourne & Warrington, 1963), it seems to interfere with other images of more central origin. The visualization of a complex geometric figure is made more difficult by blinking. While trying to generate a complex image, individuals typically fixate on an unpatterned surface and suspend blinking. The rapid changes in visual input level resulting from the closing and opening of the lids may cause massive interference in visual processing areas (display areas).

The visual perceptual system, the visual imagination, and some components of short-term memory may share display areas. Such shared areas would be accessible to visual input and therefore vulnerable to visual interference. The concept of a shared display area is supported by evidence from Segal and Fusella (1970), who have shown that visual imaging interferes with sensitivity for visual detection but not for auditory detection. It would be adaptive to inhibit blinking during activities using these shared processing areas. Operational memory is probably one processing component with shared display areas. The term "operational memory" has been used to designate a memory buffer or storage system for items retrieved from long-term memory that are needed to perform a particular operation; for example, operational memory allows counting operations as well as the creative reconstructions of the visual imagination. It BLINKING AND THINKING

would be expected, then, that blinking would be inhibited during certain activities, such as counting or daydreaming, or blinks would be timed so as to occur at transitions between internal events when the shared display areas were clear. From the formulation presented here, it would be expected that the rate of blinking would be low during a continuing task involving processing areas accessible to visual input, and therefore vulnerable to disruption by blinking. If operational memory is a shared component, blinking should be inhibited when it is active. The experiment reported here measures the rate of blinking while varying the performance requirements for operational memory in a task involving no visual input.

Method

Subjects

Eight undergraduate students at the University of California, Los Angeles served as subjects.

Apparatus

Each subject was seated at a standard desk facing a wall with a 4-in. \times 4-in. (.1016 m \times .1016 m) black patch located at eye-level approximately 2 ft (.6096 m) from subjects. The auditory stimuli presented to subjects were prerecorded and delivered via extension speakers placed on the far corners of the desk facing subjects. The experimenter controlled the tape recorder, and a standard event recorder (located in another room) which was activated by a hand switch when subject was observed blinking.

Procedure

Each subject received one practice and 10 experimental trials. Each trial consisted of the following sequence of stimuli: (1) The verbal instruction "Clear" was given, followed by a 20-sec. silent interval. Subjects were instructed that they were at this signal to attempt to "clear their minds" or make their minds "blank." (2) A three-digit number was read, followed by another 20-sec. silent interval. The subjects' task was to remember this number. (3) The instruction "Count" was given, followed by a 20-sec. silent interval. The subjects' task at this signal was to begin counting backwards, silently, from the number previously given. (4) The instruction "Hold" came next, followed by a 20-sec. silent interval. At this signal, subjects were to stop counting and remember the number on which they stopped. (5) The instruction "Report" was last in the cycle and was followed by a 10-sec. pause to allow the subject to respond with the number reached by the backwards counting.

RESULTS AND DISCUSSION

Mean blink rates per minute for the different intervals of the trial cycle were 10.6 for the "Clear" interval, 7.95 for the number interval, 4.95 for the

"Count" interval, and 10.50 for the "Hold" interval.² The rates of blinking during the Intervals 1, 2, and 4 ("Clear," "Number," and "Hold") were not reliably different, but that during the "Count" interval was significantly lower than each of the other three (Wilcoxon signed-ranks test, p < .02). Within each 20-sec. interval, the highest rate of blinking occurred at the very beginning of the period.

In the experiment, operational memory contained a three-digit number during trial Intervals 2, 3, and 4. During Intervals 2 and 4 there was no change in this number. During Interval 3 ("Count"), however, the number changed about once a second on the average as subjects counted backwards. The rate of blinking was higher for intervals with no change in memory content, during which no cognitive operations were performed on the information, except, possibly, rehearsal. This result supports previous research (Holland & Tarlow, 1972; Telford & Thompson, 1933) which shows that the rate of blinking is low when information in memory is being operated on. Cognitive operations such as subtracting numbers may be disrupted by sudden changes in visual input because component processes or display areas in visual perception, imaging, and operational memory are shared. Blinking, by causing a brief blackout period, produces sudden changes in visual input. In order to protect from disruption ongoing cognitive processes using shared display areas, it may be necessary to inhibit blinking.

REFERENCES

BROADBENT, D. E. Perception and communication. London: Pergamon, 1958.

- HALL, A. The origin and purpose of blinking. British Journal of Ophthalmology, 1945, 29, 445-467.
- HOLLAND, M. K., & TARLOW, G. Blinking and mental load. Psychological Reports, 1972, 31, 119-127.
- KANFER, F. H. Verbal rate, eyeblink and content in structured psychiatric interviews. Journal of Abnormal and Social Psychology, 1960, 61, 341-347.
- KINSBOURNE, M., & WARRINGTON, E. K. A study of visual preservation. Journal of Neurological and Neurosurgical Psychiatry, 1963, 26, 468-475.
- LAWSON, R. W. Photographic evaluation of blackout indices. Nature, 1948, 162, 531-532.
- LEASK, J., HABER, R. N., & HABER, R. B. Eidetic imagery in children: longitudinal and experimental results. *Psychonomic Monograph Supplements*, 1969, 3 (Whole No. 35).
- PONDER, E., & KENNEDY, W. P. On the act of blinking. Quarterly Journal of Experimental Physiology, 1927, 18, 89-110.
- POULTON, E. G., & GREGORY, R. L. Blinking during visual tracking. Quarterly Journal of Experimental Psychology, 1952, 4, 57-65.
- SEGAL, S. S., & FUSELLA, V. Influence of imaged pictures and sounds on detection of visual and auditory signals. Journal of Experimental Psychology, 1970, 83, 458-464.

TELFORD, C. W., & THOMPSON, N. Factors influencing eyelid responses. Journal of Experimental Psychology, 1933, 16, 524-539.

Accepted July 2, 1975.

[&]quot;Standard deviations for these conditions were 5.04, 3.69, 2.91, and 3.24, respectively.