Perception & Psychophysics
1991, 50 (6), 603-604

Notes and Comment

Time and duration: A persistent illusion

GERALD S. WASSERMAN
Purdue University, West Lafayette, Indiana

Attention is drawn to a persistent illusory correlation between the words time *and* duration. *This illusory correlation led Ward (1991) to conclude that neural adaptation and informational adaptation are asynchronous. But when the illusion is dispelled so that like is compared to like, it then appears possible that informational adaptation and neural adaptation may be closely linked.*

The comparison of brain with behavior may be adversely affected by an illusory correlation between time and duration (Wasserman & Kong, 1974). This time/duration illusory correlation is extremely potent, and it has a tendency to recur even though it has been authoritatively recognized (see Uttal, 1981, pp. 498-500). It has recently appeared in the pages of this journal in a paper by Ward (1991), whence the present Comment.

After reporting on a serious and extensive attempt to compare neural adaptation with informational adaptation, Ward concluded that he had not found a close relation between the two; other things being held roughly equal, neural adaptation, measured in single nerve cells, appeared to Ward to be considerably more rapid than informational adaptation, measured in human behavior. However, the present Comment will show that this conclusion depended on Ward's being influenced by the time/duration illusory correlation. The present Comment will also suggest that a closer correspondence between brain and behavior appears when the illusion is dispelled.

The time/duration illusory correlation occurs, in part, because the words *time* and *duration* are not only linked intuitively, but also measured in exactly the same units—seconds. And these two words sometimes actually do refer to the identical quantity; specifically, at the exact moment when a particular stimulus ends, its time relative to stimulus onset is then quantitatively identical to its duration.

A deeper source of the difficulty is the existence of two measurement cultures: one for the investigation of the brain and another for the investigation of behavior. It is particularly common in brain measurements to obtain a record of the electrical potential of a nerve cell as a function of time: one connects an electrode to both the cell and an oscilloscope or chart recorder (or their current microcomputer-based equivalents) and out comes a time series. Neuroscience journals are replete with such time series gathered from diverse preparations under a variety of conditions. Within this measurement culture, it takes extra effort to challenge a preparation with stimuli of different durations; this more arduous task has only been attempted in a few cellular investigations (see the review in Wasserman, Wang-Bennett, & Miyamoto, 1990). These rarer cellular studies demonstrate that stimuli of different durations do each generate a distinct response time series.

But the measurement culture that yields behavioral indices of perception and cognition contains nothing remotely resembling these data; there is currently no way of obtaining a time series that patently expresses the waxing and waning of the perceptions and cognitions of an observer, at least not on a millisecond time scale. Hence, indirect methods are employed in mental chronometry. Of particular interest in the present context is that it is not uncommon to challenge a behaving subject with stimuli of different durations in order to probe the temporal aspects of perception and cognition.

But the set of responses evoked by an ensemble of stimuli of different durations is not the same thing as the response evoked by a single stimulus taken as a time series yoked to stimulus onset. We empirically demonstrated, in intracellular recordings from single photoreceptor cells (Wasserman & Kong, 1974), that these two different characterizations of the *exact same responses* yield completely different outcomes: increasing the duration of the stimulus ensemble produces a monotone increase in the amplitude of the set of neural responses, whereas the amplitude of the neural response to a single stimulus first increases and then decreases as time after stimulus onset increases.

Therefore, it is invalid to compare the neural response time series evoked by a single stimulus with the set of behavioral responses evoked by an ensemble of stimuli of different durations. Unfortunately, the potent illusory correlation between time and duration facilitates such comparisons, which led Ward to his conclusion.

Clearly, it would be valid to compare the set of neural responses evoked by an ensemble of stimuli of different durations with the set of behavioral responses evoked by a comparable stimulus ensemble. Such a comparison may be facilitated by examining the quantitative plot published by Wasserman (1978, p. 167), which shows the amplitude of neural responses in a photoreceptor cell evoked by stimuli of different durations. That plot demonstrates that stimulus duration has an effect on neural response

Correspondence should be addressed to Gerald S. Wasserman, Sensory Coding Laboratory, Department of Psychological Sciences, Purdue University, West Lafayette, IN 47907-1364 (e-mail: codelab@psych.purdue.edu).

amplitude that parallels the behavioral effect of stimulus duration on information transmission reported by Ward (1991; see his Table 1). Although this parallel does not, of course, prove that informational adaptation is linked to neural adaptation, it does show that one need not conclude that they are not linked.

Finally, it is worth reiterating that one can best defend against illusory correlations "by exactly replicating the psychophysical procedure with the physiologic material" (Wasserman & Kong, 1974, p. 913).

REFERENCES

Uttal, W. R. (1981). *A taxonomy of visual processes*. Hillsdale, NJ: Erlbaum.

Ward, L. M. (1991). Informational and neural adaptation curves are asynchronous. *Perception & Psychophysics*, **50**, 117-128.

Wasserman, G. S. (1978). *Color vision: An historical introduction*. New York: Wiley.

Wasserman, G. S., & Kong, K.-L. (1974). Illusory correlation of brightness enhancement and transients in the nervous system. *Science*, **184**, 911-913.

Wasserman, G. S., Wang-Bennett, L. T., & Miyamoto, R. T. (1990). Temporal dispersion in natural receptors and pattern discrimination mediated by artificial receptors (cochlear implants). In H.-G. Geissler, M. H., Müller, & W. Prinz (Eds.), *Psychophysical explorations of mental structure* (pp. 211-227). Toronto: Hogrefe & Huber.

(Manuscript received August 2, 1991;
accepted for publication August 5, 1991.)