Comments on Cavanagh and Mather (1989): Coming up short (and long)

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Abstract—Cavanagh and Mather (1989) reviewed literature concerning the possible distinction between short- and long-range processes in motion perception and concluded that the distinction cannot be supported. Instead, they proposed that motion perception be considered on the basis of detectors for first-order (luminance, color) and second-order (first-order motion, texture, stereo) stimulus attributes. They supported their position with studies of motion based on second-order stimuli. The present paper contends that when experiments permitting the investigation of both processes in the same display are included and when criteria are examined in their totality rather than one-by-one, the original short-range/long-range distinction can be retained. Furthermore, it is argued that the first-order/second-order distinction does not represent a theoretical advancement and that studies of second-order motion can be interpreted in terms of the older distinction. It is concluded that the short-range/long-range distinction is useful and should not be abandoned.

1. INTRODUCTION

Cavanagh and Mather (1989) have presented a review of literature concerning the putative existence of short- and long-range processes in motion perception, particularly the perception of apparent movement. They point out that 'the main criteria which were said to discriminate between the two motion processes fail,' and they pursue the argument that 'the observed differences forming the basis of the claims for two motion processes may be more easily attributed to differences in the stimuli used in traditional short-range and long-range experiments than to differences between two motion processes' (p. 105). The stimulus differences to which they refer are represented by an alternative dichotomy: On one hand, there are stimuli that are specified by 'first-order statistics' (i.e. luminance and color); on the other, stimuli are specified by 'second-order statistics' (e.g., stimulus forms defined by relative motion, texture, or binocular disparity). Cavanagh and Mather (1989) argue that motion detection in general is carried out by similar kinds of motion detectors, different collections of which are sensitive to a specific first-order or second-order stimulus attribute. In view of the common design of the motion detectors, they claim, it is meaningless to discuss short-range and long-range apparent motion in terms of separate perceptual processes. In the present paper it is argued (a) that Cavanagh and Mather (1989) overlooked experiments that studied both short-range and long-range motion in the same paradigm, and which addressed many of their criticisms; (b) that it is not productive to examine criteria for discriminating between the short- and long-range process in a one-by-one manner as was done by Cavanagh and Mather (1989); (c) that characterizing motion detectors as being selective for either first-order or second-order statistics is theoretically no more productive than postulating the existence of separate motion processes; and (d) that results of studies of apparent movement involving stimuli...
defined by second-order attributes can be fruitfully interpreted in terms of the short-range/long-range distinction.

Before pursuing their claims in more detail, it is worthwhile to consider the term 'criterion' as used by Cavanagh and Mather (1989). In the initial quotation presented in this paper, the authors refer to criteria used to discriminate between short- and long-range motion processes. Yet their table 1 (p. 105) lists 'properties' of the two processes. Petersik (1989) presented a similar table in which he referred to 'characteristics' of the two processes. At this point it is wise to recall the distinction between characteristics (or properties) and criteria, since any given characteristic is not necessarily also a criterion. For example, the presence of two eyes may be a characteristic of the human organism, but it is neither a criterion for identification of homo sapiens nor a basis for discriminating a human being from most other animals. In terms of perception, some event or stimulus feature might be characteristically associated with a percept (e.g., physical contours associated with a figural percept), although it is not necessarily so (e.g., in subjective figures). Thus, the absence of perceptual processing of contours with subjective figures does not imply that contour processing is never a characteristic of figural perception. It is the present author's opinion that some 'criteria' referred to by Cavanagh and Mather (1989) might be more productively thought of as characteristics, at least until more evidence is available (e.g., as suggested in Section 2.5, it is not clear whether cooperativity ought to be considered a criterion for identifying the short-range process). Nevertheless, to be consistent with the contentions of the original authors, in this paper I treat their criteria as though they were just that. In any event, the arguments presented in Section 3 below are not specific to any particular set of criteria.

To begin, this paper examines certain claims made by Cavanagh and Mather (1989).

2. DIFFERENCES DUE TO PARADIGMS?

Cavanagh and Mather (1989) suggest that alleged differences between the properties of the short-range and long-range processes may be artifacts of the different experimental paradigms used to study them. For example, they state '... the reported differences between short- and long-range motion were the result of the different stimuli used in the two paradigms and not an indication of two qualitatively different motion processes' (p. 124). Also, 'the differences in temporal properties which are supposed to discriminate between the short- and long-range motion processes may be attributable to the different spatial frequency content of the stimuli used in the two paradigms: predominantly high spatial frequencies in short-range experiments with kinematograms (broad-based spectrum) and predominantly low spatial frequencies in long-range experiments using isolated stimuli (high-frequency roll-off in spectrum ...)' (p. 110).

The impression given by the review is that random-dot kinematograms are the only stimuli that have been used to study the short-range process. However, there is another class of stimulus, namely the bistable apparent-motion display, that has been used to study both short-range and long-range processes. Below are indicated some differences that can be found with stimuli that are used in the same experimental paradigm and which have the same spatial-frequency spectra, but which nonetheless reveal differences between short-range and long-range motion processing.