LENGTH ESTIMATION OF EVOLVING LINES: A FURTHER INVESTIGATION

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Abstract

Forty subjects were asked to evaluate the length in evolving horizontal lines. Evolving lines, presented for 750, 1500 and 3000 msec in the centre of a computer monitor, expanded symmetrically from the central point toward the two endpoints from 0 to 84 mm, or shrunk symmetrically from two endpoints toward the central point from 84 to 0 mm. Subjects fixate their gaze in the median point between the stimuli. A variant of the constant method was used. Results show that fixation of the gaze differentiates the evaluations of the expanding lines from the shrinking lines.

In a paper dated 1887 (see Stern 1897, p. 338) Höfler wrote: "It would be quite desirable to look more closely at the changes that representations undergo during the first moments of their transforming from percepts to memory representations. Here there are a series of paradoxes, for instance we can *perceive* only in the immediate present, whereas we make use of the content of the most recent past, as if it were present. We assume we can take advantage of that content with the evidence of certainty, while, strictly speaking, we would be making judgements only on the basis of the evidence due to the likelihood of memory processes. All these facts are common, and they are not experienced as paradoxical: they have therefore to find their ultimate explanation only in the special behaviour of the memory representations in the past just started".
After 109 years, the proposal of Höfler is still erwünscht. On one hand, no one seems attracted by the problem of what happens to our percepts on the way from the light of the present to the darkness of memory, passing through the twilight of what Husserl (1980, p. 380 ff.) called Retention (a sort of primary memory). Nor does anyone seem to realise that current models of the sensory register may be acceptable for the vision of objects presented in a tachistoscopic setting, but can in no way account for the treatment of continuously changing stimuli nor for perception of events in real time. On this latter point see also Neisser 1983, Dennett 1991 chap. VI, or even Vicario 1996. On the other hand, the problem appears intimately related to the methodological question of successive comparison, that is to the terms involved in that comparison: a percepts to another percepts (when the interstimulus interval is sufficiently short), a novel traces to a percepts (when the ISI is a little longer), old traces/novel traces (when the ISI is much longer). The salience of the question raised by Höfler becomes clear when noting that we lack a satisfactory theory of successive comparison, in spite of an effort that goes back to the time of Fechner (1860; for a brief summary of the problem, see Tomat and Vicario, 1992).

Over the last three or four years, a line of research has been carried out in our department by the present authors to address these problems. Two methodological assumptions are critical to the research.

Firstly, we decided to submit non-stationary events (i.e. evolving; Vicario, 1989), to a successive comparison instead of stationary events (i.e. objects). Here the assumption is that during the changes that occur from the perceptual event (considered as a mental presence) to a memory encoding, transformation will be more measurable in the case of precariously balanced contents (i.e. evolving events) than for stabilized contents (such as stationary events, or objects). To investigate this we chose lines varying in length as a simple non-stationary event. Secondly, we decided to measure the effects due to the differences between the subjective lengths of evolving lines as compared with of stationary lines, rather then referring to objective lengths.

SUMMARY OF PREVIOUS RESEARCHES

We started with the successive comparison of stationary and evolving lines of 84 mm in length (Vidotto, Vicario & Tomat, 1996; Vicario & Tomat, 1997, Tomat & Vidotto, 1997). We established that for what stationary lines there is a horizontal anisotropy: the point of subjective equality (PSE) for lines seen in the left visual field is on the average not significantly different from the point of objective equality (POE) (-0.12%), whereas lines seen in the right visual field are substantially underestimated (-2.46%). We found for the duration of the stimulus, that as the presentation is shortened, the underestimation increases: from -0.12% at 3 sec to -2.5% for 0.75 sec.

The variables affecting the stimuli representing the evolving lines found to be were: A) lines in bilateral evolution lengthen from 0 to 84 mm symmetrically from the central point toward the two endpoints; or shorten from 84 to 0 mm symmetrically from the two endpoints toward the central point of the line; B) lines in monolateral evolution lengthen from 0 to 84 mm from the right or left endpoint, or shorten from 84 to 0 mm always from the right or left endpoint; (C) lines in two-phase evolution: first lengthen from 0 to 84 mm from the right or left endpoint, and after shorten from 84 to 0, and vice-versa; (D) lines presenting one phase of evolution and another of stationary: in bilateral evolution: first, lengthen from 0 to 84 mm symmetrically from the central point toward the two endpoints; or shorten from 84 to 0 mm symmetrically from the two endpoints toward the central point of the line during half of the presentation time, and after stay stationary during the other half of the presentation time; in monolateral evolution: first, lengthen from 0 to 84 mm from the right or left endpoint, or shorten from 84 to 0 mm always from the right or left endpoint during half of the presentation time, and after stay stationary during the other half of the presentation time. All lines evolved at regular and constant speed.

In some experiments, the evolving line (the standard stimulus) was always on the left side of the field, while on the right side there was a stationary line (the variable stimulus). In other experiments the standard stimulus appeared on the left or on the right side of the field at chance. Subjects had to say which line, of the two presented in succession, was longer.

The overall results are the following. (1) Only 6% of 280 subjects noticed the problem inherent in the question “Which line is longer?”; it cannot be posed without referring to a specific moment of the evolution like the starting point, the middle or the ending one. (2) Unlike stationary ones, evolving lines do not have the some anisotropy between the left and the right visual fields. (3) There is no significant difference between estimated lengths of bilateral expanding and shrinking lines. (4) The estimated lengths of both bilateral expanding and shrinking lines do not significantly differ from the estimated lengths of stationary lines. (5)

Estimated lengths are correlated with the duration of the stimulus and the related speed of evolution: short durations lead to an underestimation. (6) In two-phase evolution (see case C), estimated lengths of bilateral and monolateral shrinking-expanding lines do not significantly differ from those of bilateral expanding-shrinking ones. (7) Instead lines presenting one phase of evolution and another of stationary (see case D), when expanding and end their evolution with greatest length seems to cause an overestimation of the length, when shrinking and end their evolution by disappearing completely seem to cause an underestimation of the length. In order to find a general interpretation for these different aspects of our experimental studies, we now intend to explore the evaluation of stationary and evolving lines using a fixation point. It may be the case that in peripheral vision, lines are judged in a different way. For example lines that elongate towards the periphery from the centre should be judged in a different way with respect to lines which shorten towards the centre. The aim is not to give a marginal contribution to the study the visual system by orienting attention conditions, but to study the phenomenological analysis of brief events. We intend to verify if the fixation of the gaze in the median point between the two stimuli differentiates expanding lines from shrinking lines.

EXPERIMENT

Subjects. Forty unpaid university students took part in the experiment. Twenty were female, twenty were male. Their ages ranged from 19 to 24 years (m=21.7 yr). They all had normal or corrected-to-normal vision.

Apparatus. The stimuli were presented in random order by a Tektronix computer 4050 (monitor refresh rate: 70-Hz). A horizontal line appeared on the equator and in the central part of the screen. The screen background was dark green, the stimuli were light green. The subjects sat in a chair supporting his or her head on a chin-rest and viewed the stimuli from a distance of 56 cm. The room was weakly but uniformly illuminated.

Stimuli. A little fixation red dot (ø=1.5 mm) appears in the median point of each stimulus. The first line (standard stimulus), that appeared on the left of the screen, could be:

(1) stationary: static lines were maintained for the alltime presentation with length of 84 mm;

(2) expansion: the line expands from 0 to 84 mm growing symmetrically from the central point toward the two endpoints

(3) shrinking: the line shrinks from 84 to 0 mm departing symmetrically from the two endpoints toward the central point. All lines evolved at regular and constant speed. The duration of the presentation of the evolving lines was: 750, 1500 and 3000 msec.

The second line (variable stimulus), that appeared on the right of the screen, was always stationary and varied from trial to trial (78, 80, 82, 84, 86, 88, 90 mm). The duration of the variable stimulus was 1500 msec. Interstimulus interval (ISI) was 2100 msec.

Procedure. Each experimental session had 84 stimuli, presented in random order, different for each subject. The method of constant stimuli was employed. The task of the subjects was to compare, an evolving line (standard stimulus) with a stationary one (variable stimulus), and to say which one was longer without shifting his gaze from the fixation point. The subject effected his choice pressing one of two response keys situated high horizontally, on the left part of the Tektronix keyboard. The subject pressed the key on the left when he retained that the line on the left was longer; and the key on the right when he retained that the line on the right was longer. Judgements of equality of the lines were not allowed. The subjects had three seconds of time from the disappearance of the SV to press one of the two response keys. If the subjects pressed the key after the established time of 3 sec, the answer was not considered and the pair of

stimuli were represented at the end of the trials. After each judgement the writing "Push the bar to go on to the following item" appeared on the screen. The subjects were free to press the spacebar when they wanted after each presentation.

Data analysis. On the raw data the individual thresholds have been calculated using a variation of the solution of the transitions (Masin and Vidotto, 1984; Vidotto, 1990, Vidotto e Zambianchi, 1991). Some ANOVA (within factors, 2x2x2) have been carried out: duration of presentation of the evolving lines, type of evolution, direction of evolution. If necessary standard errors were computed.

Results

In order to verify if the length evaluation of the evolving line is different from the evaluation of the stationary line, we used the difference between the evaluations of line in bilateral evolution and stationary lines (DC%).
Figure 1 shows the average of the PESs and the relative constant errors in percentage (DC%) of lines in bilateral evolution for the two type of evolution (expanding, shrinking). Each of four data point represented on the two solid lines correspond to a different duration of SS: 750, 1500, 3000 msec.
The difference between the length evaluation of bilateral evolution lines and stationary lines is statistically significant for lenghtening lines. (DC%= -2.80, [$F(1,38)=20.39$; $p < .001$]. The evolving lines differs from the stationary lines mainly because the shrinking lines with respect to the expanding lines, are mostly underestimated [$F(1,38) = 14.94$; $p < .001$]. In both cases the underestimation decreases of to the increase of the time of evolution (for stationary lines the time of exposure; [$F(2,76) = 4.45$; $p = .015$]. Also, evolving lines differs from the stationary lines because evolving lines are sensible to spatial anisotropy, while stationary lines are not. Significant interactions there are between type of evolution for duration [$F(3,114 = 4.69$; p .004], Finally there were no significant interactions for position and type of evolution ($F1,76 < 1$], position andduration ($F(3,114) < 1$], type of evolution and duration [$F(2,152) = 1.19$; ns], position and type of evolution and duration [$F= (3.114) = 0.87$; ns].

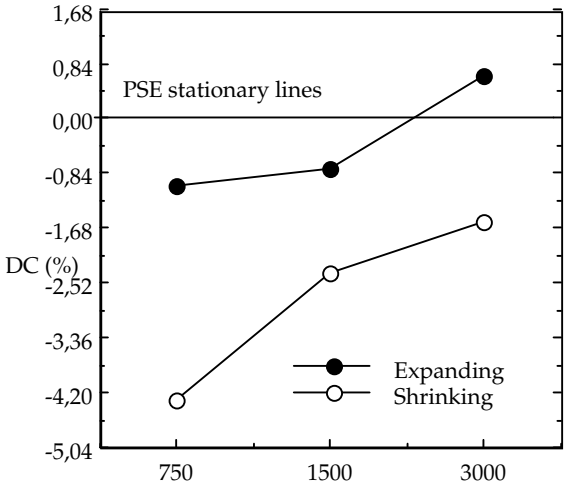

Figure 1. PSE and relative constant errors in percentages (DC%) for evolving lines. Each of three points components the line correspond to a different duration of the SS.
The horizontal dotted line represents the PSE of stationary lines.

Discussion. We begin investigating a curious fact, which had already been observed in other experiments (see: Vidotto, Vicario & Tomat 1996; Vicario &Tomat 1997): it seems that the evaluation of evolving lines is based upon the comparison of traces which can be compared to verbal labels ("longer than", "shorter than"). Observers found it natural to compare an evolving line with a stationary line when the first was at its maximum extension, even though during the instructions no specifications were made about the moment when the observer had to make the comparison (at the beginning, at the end). We can suppose that the traces of evolving events are stationary events, because otherwise we have to suppose that in the memory magazine there is a continuous registration of events we have seen. These traces or labels can have a time marking (the trace concerns a stationary process), but they are not evolutionary (Husserl, 1992, p. 14 and fol.). A categorical strategy for the evaluation of line lengths in evolution would make no effect the fact that the stimulus generating the percept is a stationary or non-stationary event. In fact, both are evaluated in the maximum length. This agrees with the fact that in other experiments the PESs of evolving lines did never significantly differ from the PESs of stationary lines. The same does not happen in this experiment where the evolving lines differ instead from the stationary lines. This complicates even more the whole picture and offer new ideas for further research. We

are sure that attentive mechanisms are involved. It is not the same thing to evaluate a percept presented at the periphery of the visual field or a percept presented in foveal vision, or a percept — as in the present case — which happens to be part presented to the fovea and part to the periphery.

The most important fact that seems to influence the differences among evolving lines and stationary lines is the evolution (lengthening, shortening). If one wants to interpret this fact with a categorical hyphotesis (Vicario, 1993) it must be supposed that such labels have a specific marking to indicate such difference. This is not without sense even from an evolutive point of view: it is rather important for the survival of the species to distinguish in an effective way between an object when is expanding from an object which is shrinking, as for example a predator which is coming close and one which is going away.

REFERENCES

Husserl, E. (1980). Vorlesungen zur Phänomenologie des inneren Zeitbew**uß**tseins. Tübingen, Niemeyer

Husserl, E. (1992) Per la fenomenologia della coscienza interna del tempo. F. Angeli, Milano.

Masin, S.C., & Vidotto, G. (1984). The method of transitions. *Perception* & *Psychophysics*, 36, 593-594.

Neisser, U. (1983). The rise and fall of the sensory register. In: Haber, R. N. (ed.), The impending demise of the icon: a critique of the concept of iconic storage in visual information processing. The behavioral and brain sciences, 6, 1-54.

Stern, L. W. (1897) Psychische Präsenzzeit. Zeitschrift für Psychologie und Physiologie der Sinnesorgane, 13, 325-349.

Tomat, L. & Vicario, G.B. (1992). Il confronto successivo di segmenti. *Contributi degli Istituti e dei Dipartimenti italiani di Psicologia*, 1-2-3-4, 15-27.

Tomat, L.& Vidotto, G. (1997). Perception of stasis and halt in evolving lines. *Fechner Day 97.* Proceedings of the thirteenth Annual Meeting of the International Society for Psychophysics, 299-303.

Vicario, G. B. (1989). Forma ed eventi [Form and events]. In: Longo, O. (ed), Forma, rappresentazione e struttura. Laboratorio Servizio Tecnologia, Napoli, pp.115-129.

Vicario, G. B. (1993). On experimental phenomenology. In: S.C. Masin (ed), *Foundations of perceptual theory*, pp. 197-219.

Vicario, G. B. (1996). Time in physics and psychological time. Report to the international symposium on psychology of time, San Marino (RSM) 2-3 May 1996, in press.

Vicario, G.B.& Tomat, L. (1997). Length estimation of lines in complex evolution. *Fechner Day 97.* Proceedings of the thirteenth Annual Meeting International Society for Psychophysics, 309-314.

Vidotto, G., (1990). The method of transitions: an adaptive procedure. *31th Annual Meeting of the Psychonomic Society.* New Orleans.

Vidotto, G.& Zambianchi E. (1991). Comparazione di tre procedure psicofisiche per la determinazione del punto di eguaglianza soggettiva [Comparison of three psychophysic procedures to determine the point of subjective equality]. *Contributi dei Dipartimenti e degli Istituti Italiani di Psicologia*, 3-4, 75-92.

Vidotto, G. Vicario G. B.& Tomat L. (1996). Length estimation of evolving lines. In: Masin. S. C. (ed), *Fechner Day 1996. Proceedings of the Twelfth Annual Meeting of the International Society for Psychophysics.* The International Society for Psychophysics. Padua 1996, 411-415.