Reverse asymmetry for whole-letter confusions in crowding

Hans Strasburger & Maka Malania

Letter crowding is likely not a uniform process and several distinctions for its source have been proposed (letter confusion vs. letter substitution, within-character vs. between-character crowding, feature-source vs. letter-source confusion, and more). We re-analyzed our data from a three-letter contrast-threshold crowding paradigm with transient ring cue, with respect to inward-outward asymmetry of confusions of the target with a flanker. Testing was at three eccentricities (2°, 4°, 6°) for a range of flanker distances and cue sizes in 20 subjects. The cue enhanced target contrast sensitivity but had no effect on flanker confusions. Surprisingly, confusions were asymmetric in a direction opposite to asymmetries reported for masking: The inward – not the outward – flanker was increasingly confused at increasing target eccentricities. The results support the above-mentioned distinctions of sources-to-crowding and suggest separate neural coding of pattern content and position, i.e., of *what* and *where*. The dependencies of confusions on flanker distance scale with eccentricity and are described by a generalized Bouma critical-separation rule. We propose underlying mechanisms to letter crowding where feature-binding decreases with eccentricity such that free-floating letter parts intrude from the periphery and whole letters from the center.

Key points:

1) Confusions are asymmetric but opposite to those reported before
2) Flanker confusions are not influenced by transient attention
3) Generalized Bouma rule for flanker confusions

What is new?

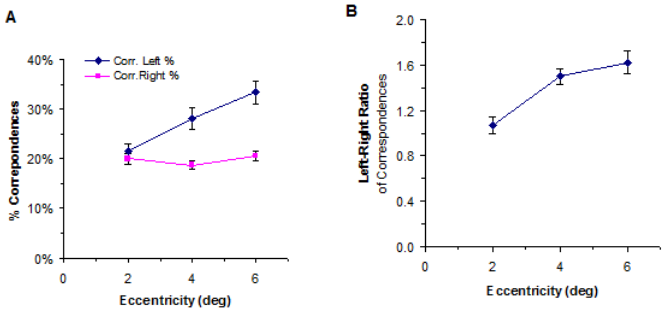
Data were presented in Strasburger & Malania (2013) http://www.journalofvision.org/content/13/1/24. **New here** is an **explanation** for the main result, to reconcile it with the "standard" view: Binding decreases with eccentricity, such that whole letters float outwards and letter parts flow inwards. An animation video will be prepared. Data, equations, and interpretation have not been reported at ECVP yet. The presentation is meant as a challenge for neuro-computational modeling.

Open question – This should be a challenge for neural computation!

1) There is, as yet, no – or at least no explicit – neuroanalytic / neurocomputational model or model idea that would implement the floating of features or characters, and at the same time binding.

In the pandemonium model (Selfridge 1959), for example, floating is intrinsic, i.e., positions are not coded.

Data



Correspondences of the subject's report with the left or right flanker for the present data; (a) left and right separately; (b) the resulting left/right ratio (Strasburger & Malania, JOV 2013).

Equations

$$conf_{inw} = 2.97E + 15.8\%$$

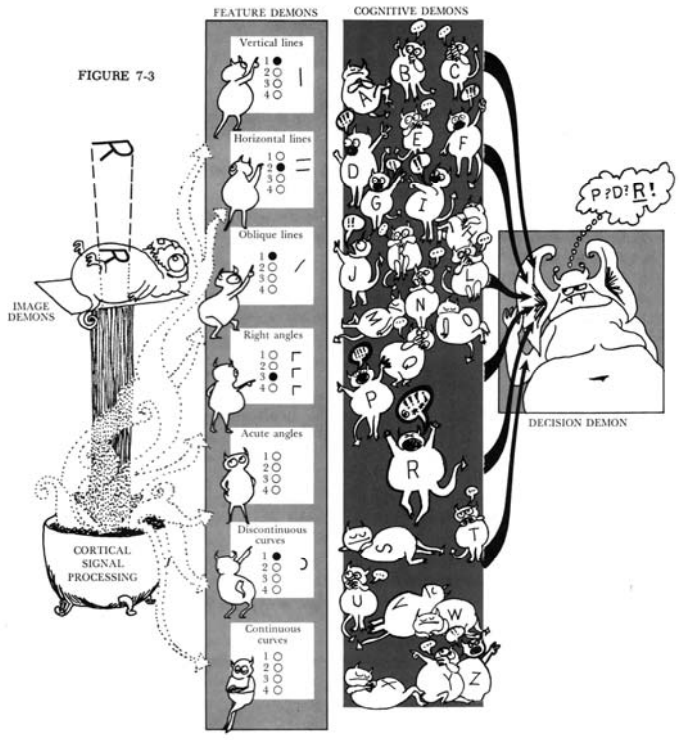
$$conf_{outw} = 19.8\%$$

Papers reporting "standard" asymmetry

Wagner (1918), Mackworth (1965), Bouma (1970), Estes & Wolford (1971), Estes et al. (1976), Krumhansl (1977), Chastain (1983), Bex et al. (2003), Petrov et al. (2007)

Papers reporting inverse asymmetry

Chastain (1982), Strasburger & Malania (2013)



Selfridge's (1959) pandemonium model (Lindsey & Norman, 1977). Demons are recognizing the letter "R"