Unfocussed spatial attention underlies the crowding effect in indirect form vision

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Introduction:

When targets are seen in the presence of neighboring patterns or contours, their visibility is reduced. This phenomenon, known as the crowding effect, is particularly pronounced in indirect view. By measuring recognition contrast sensitivity for a character with flankers to the left and right, we studied mechanisms underlying the crowding effect in indirect form vision. Attentional and featural contributions to the effect can be separated by a new paradigm that distinguishes pattern location errors from pattern recognition errors and further by manipulating the focussing of spatial attention through a transient positional cue, appearing 150 ms before the target.

Methods:

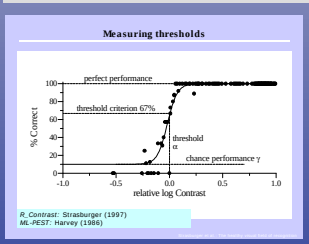
Contrast thresholds for the *recognition* of characters obtained by a maximum-likelihood adaptive procedure (R_Contrast, Strasburger 1997) as the point of inflection of a Weibull function.

Flanking condition: the target is surrounded by a neighboring character left and right, of same contrast.

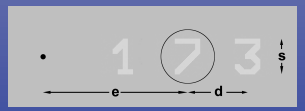
Cueing condition: A circle appears 150 ms before the stimulus.

„Loose attention“: Contrast thresholds in which localization errors, i.e. the correspondence of a response with a flanker, are treated as correct response.

20 subjects; 34,000 responses.



Stimulus arrangement



References:

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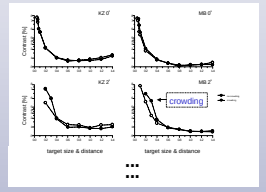
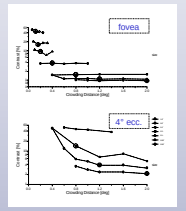
Results:

1991



Crowding sets in at 2° eccentricity!



Critical flanker distance mostly independent of target size

Correct recognition at wrong location

1991

Ecc.	Total # of errors	Correspondence with flanker…		
		left	right	l + r
fovea	400	11%	8%	19%
4°	498	21%	21%	42%

2004

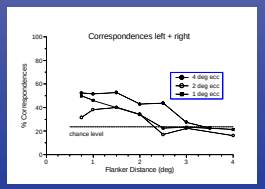
2° & 4°

	Correspondences with flanker…		
	left	right	either
flanked	20.2	18.4	38.6
cued	21.8	17.3	39.1
loose att.	16.0	17.5	33.5

!

Involuntary recogntion of wrong character increases with closer spacing:

Effect of imprecise locus of attention is largest at nearby flankers.



ANCOVA: all effects p<0.0001

Recognition contrast threshold for the target, at varying flanker's distance.

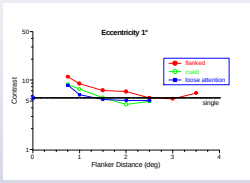
34,000 responses.

1)Performance is close to optimum for widely spaced flankers.

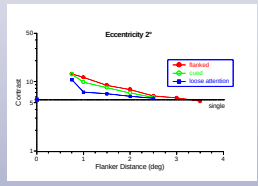
2) Cueing (unvoluntary attention) reduces crowding.

3) Compensating for the imprecise attentional focus (blue curve) has largest effect!

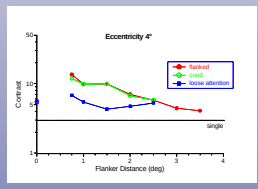
1°



2°



4°



Discussion:

(1) Gestalt closedness: Features „bound“ by an object are processed together
(2) Field of feature integration = attentional spotlight?
(3) Bouma's rule in correct form: $d = 0.5\,E + d_0$
(4) Larger ring cue probably better
(5) Crowding is unlike masking (Pelli 2004)

Conclusions:

(1) New paradigm allows separating attentional and featural contributions to the crowding effect
(2) Crowding is largely caused by spatially imprecise focussing of attention
(3) Psychophysical support of the *Where versus What* dichotomy