Grouping via emergent features: A systematic approach.

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Abstract

When basic elements combine and Gestalt grouping occurs, Emergent Features (EFs) arise. We identify the presence of EFs by observing a configural superiority effect (CSE) in an odd-quadrant task in which RT and accuracy are measured. We present a systematic way in which EFs can be created from the ground up and hierarchically, thus allowing for comparisons among them. Starting with simple stimuli such as two dots we obtain proximity and orientation; with more dots we get linearity, symmetry and surroundedness. Moving up to lines we get colinearity, symmetry, parallelism, inflection point and closure. Our results indicate that orientation, proximity, linearity, parallelism and colinearity are EFs, mixed results were obtained for the remaining EFs.

Introduction

Emergent Features (EFs) are properties of configurations that are not present in the component elements of those same configurations. Three line segments, for example, can combine to form a triangle possessing the EF of closure, a feature not present in any of the lines alone. We define an EF as such a property when those configurations are more discriminable than are their elements. Figure 1 shows the Odd Quadrant task we use to test discriminability. Panel A ("singleton") shows four dots, 1 of which differs in position. The task is to locate that different element as quickly and accurately as possible. Panel B ("context") adds four identical context elements. Panel C ("composite") shows the configurations resulting from combining Panels A and B. In Panel C, the orientation differences are discriminated from each other more quickly and accurately than are their component single dots in Panel A. This is called a Configural Superiority Effect (CSE), while the opposite pattern is a Configural Inferiority Effect (CIE). Because the context elements were all the same and thus were uninformative, the CSE must result from EFs appearing when the elements combine into configurations (orientation in this case).

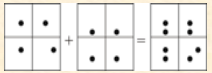


Fig. 1 Panel A Panel B Panel C

Logic of approach: To discover the most basic EFs, we started with dots and later replaced pairs of dots with lines for slightly more complex EFs. By varying the position and number of context dots, we created configurations that contain five potential EFs: **orientation, proximity, symmetry, linearity and surroundedness**. In the same manner, by varying the position and number of context lines, we created configurations that contain: **colinearity, parallelism, symmetry, inflection point and closure**. In each case it was changes only in the uninformative context that created these potential EFs; the baseline singleton discrimination remained unchanged. As a result, the EFs can be assessed on a common scale of measurement, namely the size of the CSE produced.

Method

60 Rice undergraduates performed odd-quadrant discriminations of 66 stimulus pairs, classified into 9 sequences differing in their starting singleton. Within these sequences, different sets of context dots or lines were added to create more complex composites. The displays subtended 6.6° of visual angle when seen at 30 inches. Participants responded by pressing keys 1, 3, 7 or 9 in the number pad, indicating which quadrant was different.

For all stimuli, there were 8 possible displays, representing 4 possible odd quadrants x 2 target/background combinations (i.e., A in a field of Bs or vice versa).

Results and Conclusions

The RT data for a selection of the sequences are presented in figure 2. The data show CSEs for composite displays containing difference in orientation, proximity, linearity, parallelism and colinearity.

Accordingly, we conclude that these features are fundamental EFs in human vision. Based on the magnitude of the CSEs recorded, proximity seems to be a stronger EF than orientation and linearity.

The evidence is inconclusive whether surroundedness, symmetry, inflection point and closure should be deemed EFs. Their lack of CSEs may simply indicate that although these are features we can detect, their presence provides little advantage over and above what earlier EFs provide.

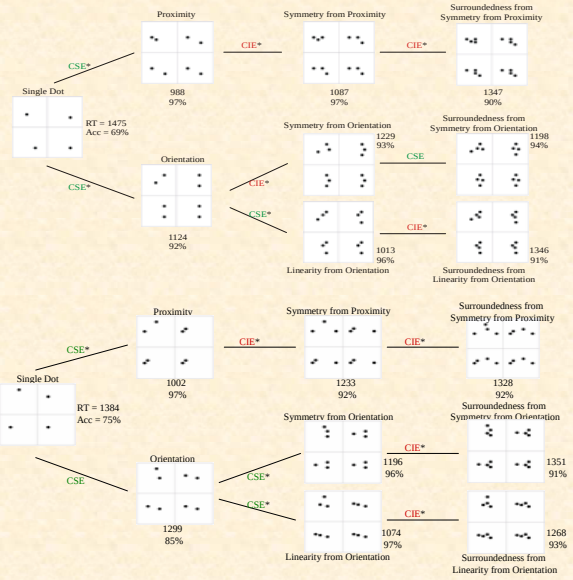
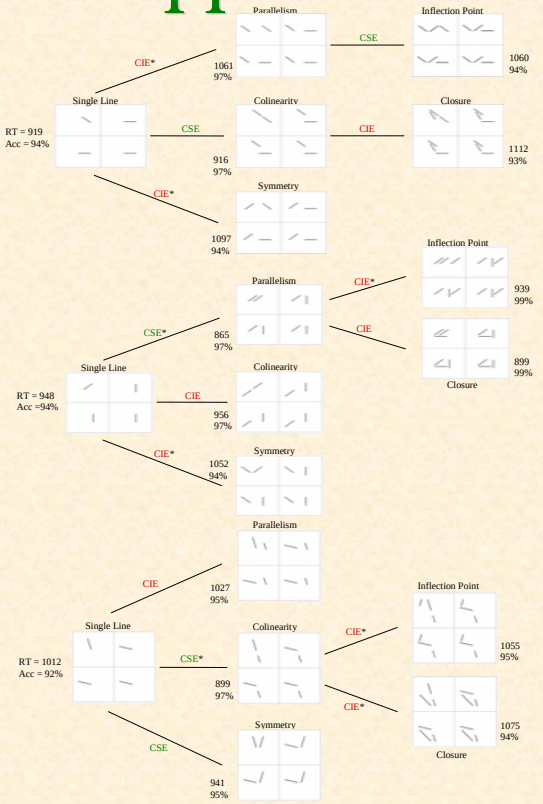


Figure 2. Emergent feature sequences.



References

Pomerantz, J. R. (1991). The structure of visual configurations: Stimulus versus subject contributions. In G. R. Lockhead & J. R. Pomerantz (Eds.), The perception of structure. Washington, D. C.: American Psychological Association.

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