

Negative and Positive Congruence Effects in Letters and Shapes

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Abstract

Letter and non-letter targets (geometrical shapes, pseudo-letters or rotated letters) were presented in choice response task, either in isolation or surrounded by a geometrical shape. The surrounding shape could be congruent or incongruent to the target. When the classification required a distinction between letters and non-letters, either explicitly (Experiment 1-3) or implicitly (Experiment 4) a negative congruence effect was obtained for letters, contrasting with a regular, positive congruence effect for non-letters. When no distinction was to be made, letters and non-letters invariably showed a positive congruence effect (Experiment 5-6). Thus the occurrence of negative or positive congruence effects for the same stimuli depended on the task. Feature interaction, target selection, and response competition explanations were tested against a feature integration approach; the results were explained in terms of different feature integration strategies for letters and non-letters.

Keywords: high level vision, attention, visual cognition

Purpose

Intrinsic stimulus characteristics alone fail to determine what is easy or hard to perceive; this depends on the task as well. It is easy, for instance, to perceive the geometrical structure in Figure 1 due to the symmetry, but the very saliency of this structure makes it difficult to identify the letters E that are embedded within it. This elementary observation may be relevant in a number of situations where fast and correct reactions are required. Traffic signs, as well as warning displays in power plant control-rooms or cockpits, put emphasis on symbols by surrounding them with attention-grabbing frames. But as Figure 2 suggests, the effect may sometimes be opposite from what is intended.

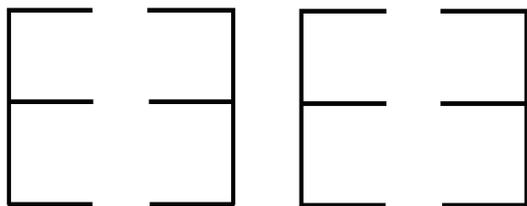


Figure 1. The recognition of the “E” is hampered by the symmetry and repetition, although these regularities normally contribute to overall figure Goodness and simplicity.

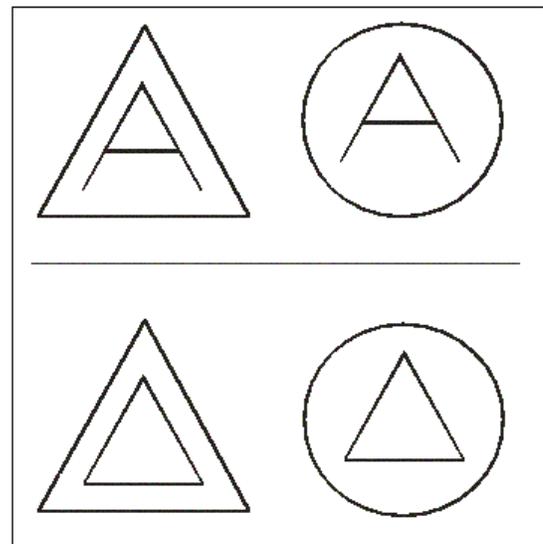


Figure 2. Letters (upper half) versus shapes (lower half) in congruent (left) versus incongruent (right) surroundings.

In Figure 2, a letter “A” is surrounded by a similarly-shaped triangular frame. The geometrical structure of the “A” may be emphasized and its perception facilitated, but the perception of its content, the “A” as a letter, is obfuscated by the frame. By contrast, the triangle in the lower half of the figure is emphasized by the surrounding shape when it is congruent.

We performed six experiments, in which we presented letters and shapes in isolation or surrounded by congruent or incongruent frames in a choice-response task (van

Leeuwen & Lachmann, 2004). The task involved classification as a “letter” or a “shape”.

Results

A typical result is shown in Figure 3. For letters, the time needed for classification is increased by a congruent frame. This is a negative congruence effect, which contrasts clearly with the positive congruence effect obtained for shapes. Subsequent experiments confirmed this initial result; the same effects were obtained when rotated letters or pseudo-letters were used as non-letter shapes. Further experiments used choice responses with letters and non-letters balanced across the response alternatives, for instance: Response 1: “square” or “A” versus Response 2: “L” or “circle”. With these response alternatives the task no longer depended explicitly on “letter” versus “shape” categories.

When the response alternatives involved a decision on content (for instance, “A” or “circle” versus “C” or “triangle”) we still observed a negative congruence effects for letters and a positive one for shapes.

By contrast, when response alternatives were based on form (for instance “A” or “triangle” versus “C” or “circle”), a positive congruence effect resulted both for letters and shapes.

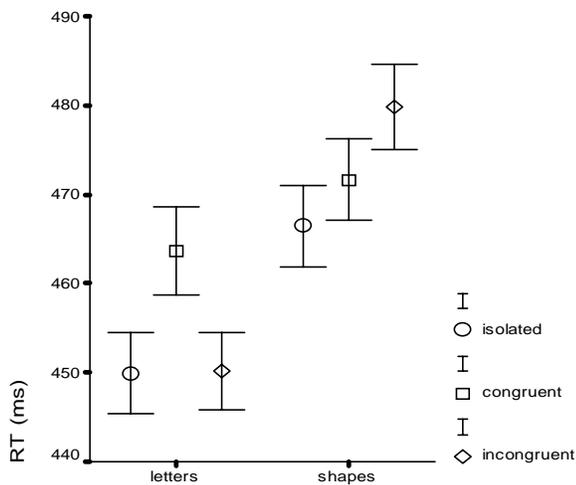


Figure 3. Average reaction times and SDs from van Leeuwen & Lachmann (2004), Experiment 1

Discussion

Positive congruence effects are understood to indicate integration of perceptual features, or holistic perceptual representation; absence of such effects indicates separation

of features, or analytic perceptual representation (Pomerantz, Pristach, & Carson, 1988). Negative congruence effects (Bavelier, Deruelle & Proksch, 2000; Briand, 1994; van Leeuwen & Bakker, 1995) result from competition between local and global structures for target selection. This is an early perceptual effect. The negative congruence effect for letters indicates that they are preferably encoded perceptually in an analytic fashion, and that this encoding strategy faces competition from the surrounding global shape. The analytic encoding is likely to be preferred, because it is least likely to interfere with the phonological representation concurrently given to letters (Posner, 1978). Non-letters, by contrast, are preferably given a holistic perceptual representation. The contrasting effects for letters and non-letter shapes suggest that abstract content (letter versus non-letter) has an influence on the early stages of perceptual organization.

Conclusion

Processing of letters and shapes starts to diverge in a very early, pre-attentional stage of perceptual encoding. Letters are perceptually encoded analytically, leading to negative congruence effects. Shapes are encoded holistically, leading to normal, positive, congruence effects.

Footnote

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