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SUBJECTIVE CORRELATION AND THE SIZE–NUMEROSITY ILLUSION [1]

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Judgments of the numerousness of patterns of dots vary with the size of the background on which the dots are presented The direction of this judgmental illusion depends upon the experimental correlation between background size and actual number of dots When the correlation is positive, judged numerousness varies inversely with background size, however, when the correlation is negative, the illusion is reversed The subjective correlations estimated from an expectancy-contrast model were found to be a monotonic function of the 7 actual correlations used in 2 experiments These results replicate and extend previous findings for the size–numerosity illusion

An expectancy-contrast model for the size–numerosity illusion was proposed and tested by Birnbaum and Veit (1973) According to the model, the judgment of numerousness reflects an additive contrast between the numerousness of the dots and an expectancy produced by the context The expectancy is assumed to depend upon the subjective correlation between numerousness and background size In simplified form, the model can be written

$$J = N - R_{NB}B,$$

where J is the impression of numerousness, N is the numerousness of the dots apart from the background effect, R_{NB} is the subjective correlation between numerousness and background size, and B is the subjective size of the background The product, $R_{NB}B$, is interpreted as the expectancy for numerousness, based on background size Overt ratings of numerousness are assumed to be a linear function of the impressions

Several implications of the expectancy-contrast model have received tentative experimental support First, it should be possible to reverse the direction of the illusion by changing the sign of the subjective correlation. Second, this interaction between background size and correlation is multiplicative and thus should be located in the bilinear component Third, the effects of background size and numerosity should combine additively, independent of the correlation Although the data appeared to be in general agreement with the first 2 predictions, a small but statistically significant discrepancy was obtained in 1 condition for the third prediction

This report replicates the previous work, with an improved experimental design, to provide larger and cleaner effects The second experiment employs more levels of correlation to examine the relationship between actual and subjective correlation and also explores the effect of changing the correlation

Method

The general experimental procedure was similar to that of Birnbaum and Veit (1973), with several improvements The main differences were as follows· (*a*) greater variation in background size relative to the variation in number of dots, (*b*) greater manipulation of the correlation, and (*c*) a longer series of warm-up trials

The stimuli were patterns of black dots, 2 5 mm in diameter, on square white cardboard back-

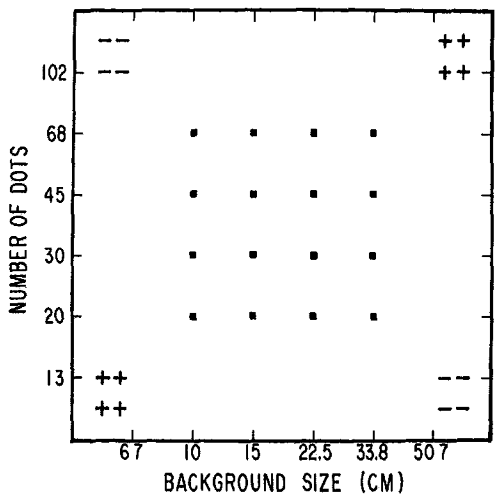

FIGURE 1. Diagram of the experimental design (Solid squares represent test stimuli which were the same for all conditions Plus signs represent contextual stimuli for positive correlations Minus signs represent contextual stimuli for negative correlation conditions Note that axes are spaced in logarithmic steps)

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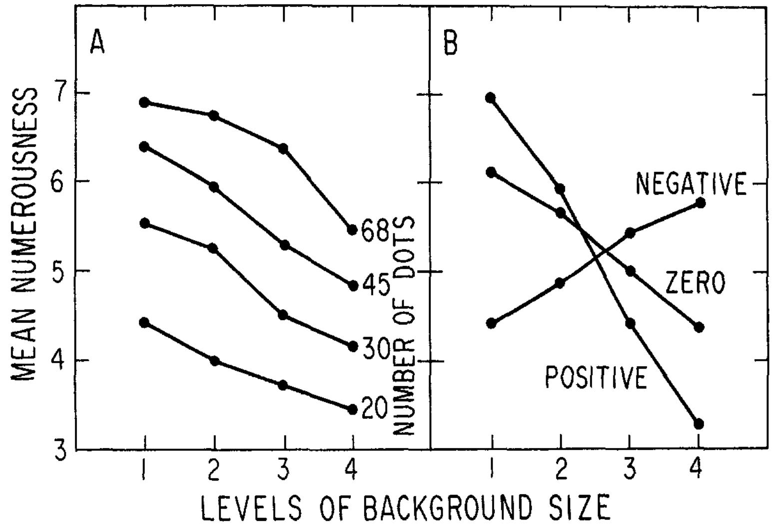

FIGURE 2 Panel A presents mean judgments of test stimuli, averaged across correlation conditions Panel B, mean judgments of test stimuli, averaged across levels of number and plotted as a function of size for each correlation condition (Experiment I)

grounds of varying size In presenting the stimuli, the blank side of the card was shown first, then the card was turned over so that *S* could see the dots for 5 sec The *S*s made their ratings on a 9-point scale, with 1 = very very few dots and 9 = very very many dots

The experimental design is shown in Figure 1 The test stimuli (solid squares) represent a 4 × 4 (Number × Size) factorial design, in which either 20, 30, 45, or 68 dots were presented on square backgrounds with side lengths of either 10, 15, 22 5, or 33 8 cm

The contextual stimuli were presented to manipulate the overall correlation between background size and number of dots The contextual stimuli for the *positive correlation* (plus signs in Figure 1) paired 8–13 dots with background sizes of 5 0–6 5 cm , and 102–135 dots with background sizes of 54–60 cm , thus, small numbers of dots appeared on small backgrounds and large numbers of dots appeared on large backgrounds Contextual stimuli for the *negative correlation* (minus signs in Figure 1) paired 8–13 dots with background sizes of 54–60 cm , and 102–135 dots with background sizes of 5 0–6 5 cm , so that small numbers of dots appeared on large backgrounds and large numbers of dots on small backgrounds The *zero correlation* condition included half of either type of contextual stimuli

In Experiment I, the 21 University of California, Los Angeles, undergraduates were divided into 3 groups of 7 *S*s each, with either positive, zero, or negative contextual stimuli for each group Each group received an inducing series of 24 randomly ordered presentations of contextual stimuli Following this series, there were 2 replicates of the 16 test stimuli randomly interspersed among 48 trials of contextual stimuli, giving a total of 104 trials.

In Experiment II, the ratio of contextual trials to test trials (and hence the correlation between size and number) was manipulated The *S*s were 30 University of California, Los Angeles, undergraduates divided into 6 groups of 5 *S*s each Each group received 16 presentations of contextual stimuli followed by either 36, 24, or 16 positive or negative contextual stimuli interspersed among the basic 16 test stimuli

After the first series came the counterinducing series, in which 16 contextual stimuli of the opposite sign were presented, followed by the 16 test stimuli interspersed among 24 contextual stimuli of the opposite sign from the first series

RESULTS

Experiment I Figure 2A plots mean ratings of numerousness as a function of background size, with a separate curve for each level of numerosity, averaged over correlation conditions According to the expectancy-contrast model (Equation 1), the curves in Figure 2A should be parallel, because the effects of background size and number of dots combine additively Although the graphical appearance is somewhat rough, there do not appear to be any systematic deviations from parallelism The parallelism prediction is supported by a nonsignificant overall Background × Numerosity interaction, F (9, 162) = 1 42 Analyzed separately for each correlation condition, this interaction was also nonsignificant, Fs (9, 54) = 1 39, 1 75, and 2 01 for the positive, zero, and negative conditions, respectively

Figure 2B shows mean judgments of numerousness as a function of background size, with a separate curve for each correlation condition Consistent with theoretical predictions, judgments vary *inversely* with background size when the correlation is *positive* and *directly* when the correlation is *negative* The illusion for the zero correlation group is intermediate, but similar in direction to the positive correlation, consistent with previous results (Birnbaum & Veit, 1973) The interaction between background size and correlation is statistically significant, F (6, 54) = 20 23, with about 98% of its variance in the bilinear component The residual interaction is nonsignificant ($F < 1$) as were the Context × Number, F (6, 54) = 2 11, and the Context × Background × Number interactions, F (18, 162) = 1 67 These results replicate previous findings for the size–numerosity illusion (Birnbaum & Veit, 1973)

The expectancy-contrast model implies that the curves in Figure 2B should be linear functions of B with slopes proportional to R_{NB} The curves are very nearly linear functions of the a priori levels of background size, which were chosen in equal log steps The slopes (reversed in sign) are 3 7, 1 7, and −1 4 for the positive, zero, and negative correlations, respectively The present illusory effects are much greater than those reported by Birnbaum and Veit (1973) The larger illusions are probably due in part to the improved experimental design and the greater manipulation of the experimental correlation Part of this increase may be due to a range effect on the category rating scale, attributable to the smaller variation in actual number of dots relative to the variation in background size

Experiment II. The values of R_{NB} for the first series, estimated from Equation 1, were 5 6, 3 9, 2 8, −1 1, −1 5, and −1 8 for the 6 conditions, in order of decreasing actual correlation The trend is clearly monotonic This finding lends further support to the notion of subjective correlation by showing that R_{NB} is sensitive to the actual correlation employed

The estimated values of R_{NB} for the second series of Experiment II showed a small and nonsignificant effect of the correlation used in the first series, they were positive when the second correlation was positive and negative when the second correlation was negative The intervening series of 16 reversed contextual trials may have been sufficient to largely erase the preceding experience

Discussion The fact that the illusion can be manipulated and reversed through manipulation of the correlation supports the expectancy interpretation of the illusion The slope for the zero correlation condition would be interpreted to imply that everyday experience produces a positive correlation between size and number (Birnbaum & Veit, 1973) By analogy, these results support an expectancy account of the size–weight illusion (Anderson, 1970)

These results replicate and extend the previous findings for the size–numerosity illusion The improved experimental design appears to produce larger and cleaner effects (Experiment I) The fact that subjective correlation estimated from the model is a monotonic function of actual correlation (Experiment II) provides further support for the expectancy-contrast model of Birnbaum and Veit (1973)

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SPATIAL STIMULUS GENERALIZATION AS A FUNCTION OF WHITE NOISE AND ACTIVATION LEVEL

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Three experiments (91, 42, and 68 *S*s) were conducted to study spatial stimulus generalization with voluntary *S* response as a function of white noise and activation level Activation was assessed by several verbal report measures Stimulus generalization consistently increased with noise, but changes were apparently unrelated to measured activation level The results do not entirely rule out activation as a mediator, and if a relationship exists, it could involve more than 1 activation dimension Arguments are made concerning use of the present experimental task and procedure to assess hypotheses concerning attentional selectivity

Several studies have been conducted on spatial stimulus generalization with voluntary responses Typically, *S*s are trained to respond rapidly to a

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