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Selective attention to global and local levels in the comparison of hierarchical patterns

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Selective attention to the global and the local levels of hierarchical patterns was studied, using a simultaneous comparison task. Subjects were asked to determine whether two simultaneously presented patterns were the same or different at the designated level. On half of the trials the comparison outputs on the two levels were compatible, and on the other half they were incompatible. With patterns composed of many relatively small elements, global and local sameness and difference were detected equally fast in the compatible trials. When incompatible output was present, irrelevant global sameness and difference interfered with "same"/"different" judgments on the local elements and on texture, but not vice versa. With patterns composed of a few relatively large elements, global dominance was observed in the compatible trials. In the incompatible trials the interference from conflicting irrelevant output was mutual and affected mostly "same" judgments. These results are discussed in terms of the interaction between the separability and integrality of the dimensions involved and task demands. It is proposed that dimensional analysis is necessary but not sufficient for successful selective attention to a stimulus dimension.

The relation between the perception of global and local aspects of a visual pattern is an important issue for theories of visual perception. Recently it has been proposed that perceptual processing proceeds from global structuring toward analysis of more local details (Broadbent, 1977; Navon, 1977, 1981). Using a set of converging operations, Navon (1977) demonstrated the perceptual priority of global forms. For example, Navon (1977, Experiment 3) found that conflicting information between the global and local levels (e.g., a large H made up of small Ss) had an inhibitory influence on responding to the local letter but not to the global letter.

Other researchers have demonstrated important boundary conditions of the phenomenon and pointed out some variables that can affect global versus local dominance. Such variables include stimulus size (e.g., Kinchla & Wolfe, 1979), sparsity of the local letters (e.g., Martin, 1979), and "clarity" or "goodness" of form (e.g., Hoffman, 1980).

Recent work by Kimchi (1982; Kimchi & Palmer, 1982, 1985) demonstrated that the perceptual relation between the global and local (elemental) levels of hierarchical patterns depends on the number and relative size of the local elements. Employing a speeded classification paradigm, Kimchi and Palmer (1985) found that when many-element patterns were processed in terms of form and texture, the global and the local levels were perceptually separable (Kimchi & Palmer, 1985, Experiments 1 and 3): Subjects could attend to either level without being affected by variation along the irrelevant level. On the other hand, the global form and the local elements of patterns composed of a few relatively large elements seemed to be perceptually integral (Kimchi & Palmer, 1985): They produced an increase in speed of processing when the two were combined redundantly, and a failure of selective attention when the two were combined orthogonally.

Although the effect of stimulus variables on the processing of global and local levels of hierarchical patterns has attracted a considerable amount of research effort, not much attention has been given to the study of the relationship between global/local processing and the particular tasks and processing strategies required of the subject. Indeed, most of the studies on the processing of the global/local aspects of a visual pattern have employed tasks requiring form identification of the global and elemental levels in different paradigms, such as the Stroop-type paradigm (e.g., Martin, 1979; Navon, 1977), the target-search paradigm (e.g., Kinchla & Wolfe, 1979), and the speeded classification paradigm (e.g., Kimchi & Palmer, 1985; Pomerantz, 1983). It is possible that the global/local interference effects found in these studies are due, to a large extent, to subprocesses that are particular to the identification task. Thus, for example, Kimchi and Palmer (1985, Experiments 2 and 4) found a failure of selective attention, indicated by both an orthogonal interference and a Stroop-type interference, even with

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separable dimensions (i.e., the many-element patterns), when the task required form identification of both the global and the local levels.

The purpose of the research reported in the present paper was twofold. To accomplish the first objective—to examine global/local dominance effects with a task that does not require, at least explicitly, identification of the stimuli involved—a simultaneous comparison task was devised. Subjects were instructed to respond "same" if two hierarchical patterns presented side by side were identical at the designated level, and "different" if they were different. One can possibly judge two stimuli to be identical or different without identifying them (i.e., recognizing them as instances of a certain category). The second purpose was to examine the differential relations between the global and elemental levels of few-element patterns and many-element patterns in a different paradigm.

EXPERIMENT 1

The subjects were asked to determine whether two simultaneously presented patterns were the same or different with respect to global form, regardless of any differences in local elements, and with respect to local elements, regardless of any differences in global form. The patterns involved were identical to the patterns used by Kimchi and Palmer (1985) with a speeded classification task. This allows a comparison between the two tasks. The main question was whether incompatible sameness or difference on the irrelevant dimension interferes with "same"/"different" judgments on the relevant dimension with few-element patterns and with many-element patterns.

Method

Subjects. Four females and 4 males from 21 to 35 years of age, with normal vision, served as subjects.

Stimuli. The two sets of patterns from which the stimuli pairs were created were identical to the sets used by Kimchi (1982, Experiment 6; Kimchi & Palmer, 1985, Experiments 3 and 4). The four patterns in each set were created by orthogonally combining two types of global forms (square and rectangle) with two types of local elements (squares and rectangles). The two sets differed with respect to the number and relative size of the elements in a pattern. One set—the *few-element* set—consisted of patterns made up of 4 relatively large elements. The other set—the *many-element* set—consisted of patterns made up of 16 elements (see Figure 1). Each pair of stimuli contained two patterns of the same set. The patterns in each pair either were identical to each other or differed from each other in one dimension (global form or local elements) or in both dimensions.

Drawings of pairs of patterns were made into slides and back-projected on a screen; the subjects were seated about 110 cm from the screen. From this position the global square subtended .94° of visual angle, and the global rectangle subtended 1.93° in width and .42° in height. Each individual square element subtended .20° in the many-element pattern, and .42° in the few-element pattern. Each individual rectangle element subtended .44° in width and .076° in height in the many-element pattern, and .94° in width and .17° in height in the few-element pattern. The distance between the center of a projected square and the fixation point was 15 mm (.78°), and the distance between the center of a projected rectangle and the fixation point was 24 mm (1.25°).

Design. The experiment employed a completely within-subject, four-factor design: pattern type (few-element, many-element), critical dimension (global form, local elements), response type ("same," "different"), and compatibility (compatible, incompatible). For each of the four combinations of pattern type and critical dimension there were 160 trials: 80 trials in which the relevant dimension was the same in the two patterns of a pair ("same" response trials), and 80 trials in which the relevant dimension was different in the two patterns ("different" response trials). On half the trials of each response type, the information on the irrelevant dimension was compatible with the information on the relevant dimension: The patterns in a pair either were the same on both dimensions (compatible "same" trials, e.g., the a-a pair; see Figure 1) or differed on both dimensions (compatible "different" trials, e.g., the a-d pair). On the other half of the trials, the information on the irrelevant dimension was incompatible with the information on the relevant dimension: The patterns in a pair were the same on the relevant dimension but different on the irrelevant one (incompatible "same" trials, e.g., the a-c pair for global judgments, and the a-b pair for local judgments), or they differed on the relevant dimension but were the same on the irrelevant one (incompatible "different" trials, e.g., the c-d pair for global judgments, and the b-d pair for local judgments). Half of the compatible trials involved pairs of congruent stimuli, namely, the global configuration and the local elements of each pattern in the pair had the same identify (i.e., the a-a and the d-d pairs for the "same" trials, and the a-d and the d-a pairs for the "different" trials; see Figure 1); the other half of the compatible trials involved pairs of incongruent stimuli (i.e., the c-c and the b-b pairs for the "same" trials, and the b-c and c-b pairs for the "different" trials). Each pattern appeared equally often to each side of the fixation point.

Each block of 160 trials was preceded by 32 practice trials. The order of trials within a block was random. Half of the subjects were presented first with the many-element set and then with the few-element set, and half of the subjects were presented with the reverse order. The order of the relevant dimension for each set was counterbalanced across subjects.

Procedure. The subjects participated individually. Before each block the subjects were told that they were going to "see figures which vary in the global form of the figure and in the elements that the figure is made of," and the relevant set of stimuli involved was presented. The subjects were instructed to attend to one dimension (global form or elements) while ignoring the other, and to make "same"/"different" judgments on the relevant dimension. Responses were made by pressing the leftmost or rightmost key on a six-key response panel. The subjects were instructed to make their responses with the index fingers of their left and right hands as quickly as possible while making as few errors as possible. Half of the subjects were instructed to press the leftmost key for a "same" response, and the rightmost key for a "different" response, and half of the subjects were given the opposite instruction. Feedback about the correct response was provided by presenting a light briefly over the appropriate key as soon as the subject responded. Error trials were retaken at the end of each block of 160 trials.

The sequence of events for each trial was as follows. First, a fixation dot appeared at the center of the screen for 500 msec. After a 500-msec interval the stimulus pair appeared and stayed on until the subject responded. At this time a feedback light came on above the correct key for 1,500 msec. The next trial began with the appearance of the fixation dot 3 sec after the previous response. The subject's response time on each trial was recorded. There was a rest period of 5 min between the two sessions within a set, and 10 min between the two sets.

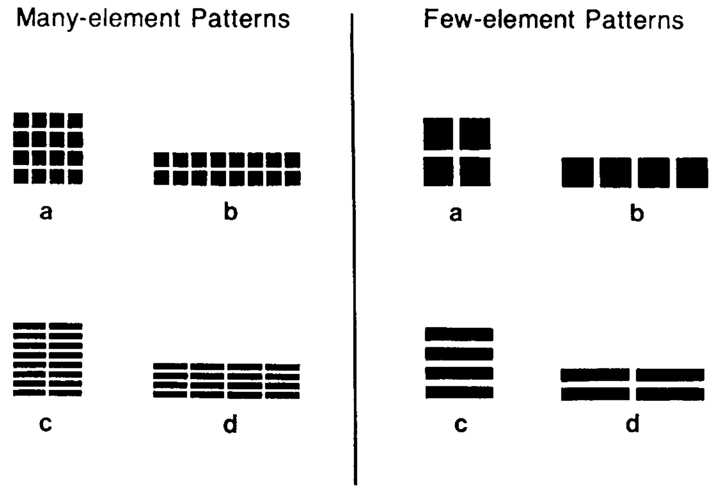

Figure 1. The two sets of patterns, the many-element set and the few-element set, from which the stimuli pairs were created. Each pair contained patterns from the same set.

Results

Mean reaction times (RTs) and percentage errors for compatible and incompatible trials for each response type are presented in Table 1.

The RT data were first analyzed by a four-factor repeated measures analysis of variance (ANOVA). The four factors were pattern type, critical dimension, response type, and compatibiltiy. The analysis indicated a significant effect of dimension [$F(1,7) = 10.158$, $p < .015$], a significant effect of response type [$F(1,7) = 19.463$, $p < .003$], and a significant effect of compatibility [$F(1,7) = 65.803$, $p < .001$]. There was no significant effect of pattern ($F < 1$). The interactions between compatibility and dimension [$F(1,7) = 31.360$, $p < .003$] and between compatibility and response type [$F(1,7) = 5.616$, $p < .05$] were significant. The interaction between pattern and dimension just approached significance [$F(1,7) = 5.287$, $p < .06$]. There was no significant interaction between pattern type and response type [$F(1,7) = 2.639$, $p > .10$], between dimension and response type ($F < 1$), or between pattern type and compatibility [$F(1,7) = 1.006$, $p > .30$]. The three-way interactions between pattern type, response type, and compatibility [$F(1,7) = 5.904$, $p < .05$] and between dimension, response type, and compatibility [$F(1,7) = 6.084$, $p < .05$] were significant. The interaction between pattern type, dimension, and response type ($F < 1$) and the interaction between pattern type, dimension, and compatibility [$F(1,7) = 2.680$, $p > .10$] did not reach significance. The four-way interaction between pattern type, dimension, response type, and compatibility was significant [$F(1,7) = 14.852$, $p < .006$]. Because of the latter interaction, the data for few-element patterns and the data for many-element patterns were analyzed separately.

Many-element patterns. A three-factor ANOVA showed a significant effect of response type [$F(1,7) = 10.672$, $p < .014$] and a significant effect of compatibility [$F(1,7) = 23.782$, $p < .002$]. The effect of dimension just approached significance [$F(1,7) = 3.644$, $p < .10$]. The only significant interaction was between dimension and compatibility [$F(1,7) = 19.568$, $p < .003$]. There was no significant interaction between dimension and response type ($F < 1$), between response type and compatibility [$F(1,7) = 1.861$, $p > .20$], or be-

Table 1
Mean Reaction Times (RTs, in msec) and Percentage Errors (%E) for Compatible (C) and Incompatible (IC) Trials for Each Response Type in Experiment 1

	Same						Different					
Critical	C		IC		Average		C		IC		Average	
Dimension	RT	%E	RT	%E	RT	%E	RT	%E	RT	%E	RT	%E
					Many-Element							
Global	419	3.75	425	5.62	422	4.69	447	5.93	439	8.43	443	7 18
Local	431	3.75	470	13.43	451	8.59	455	5.00	483	13.12	469	9 06
Average	425	3.75	448	9 53			451	5.47	461	10.78		
					Few-Element							
Global	394	5.62	412	11.87	403	8.75	428	7 18	437	12.50	433	9.84
Local	421	3.12	481	15.93	451	9.53	479	7.81	478	10.31	479	9.06
Average	408	4.37	447	13.90			454	7.50	458	11.41		

tween dimension, response type, and compatibility ($F < 1$). "Same" RT was faster than "different" RT by an average of 26 msec in the compatible trials, and by 13 msec in the incompatible trials. Further analysis revealed the source of the dimension × compatibility interaction: There was a significant effect of compatibility for the local dimension [$F(1,7) = 51.982$, $p < .0001$]. Difference on the global dimension inhibited "same" responses to the local elements by an average of 39 msec, and sameness on the global dimension inhibited "different" responses to the local elements by an average of 28 msec. Difference and sameness on the local dimension had no effect ($F < 1$) on "same"/"different" responses to the global dimension.

To examine the effect of directing attention to the global versus the local level on the "same"/"different" judgments when no conflicting information was present on the irrelevant dimension, the RTs to the two levels in the compatible trials were compared. Note that in these trials the two critical-dimension conditions involved the same pairs of stimuli. The only difference was the instruction to attend to the global form or to the local elements. No significant difference was found between detecting global sameness or difference and detecting local sameness or difference [$t(7) = 1.33$, $p > .10$, and $t(7) = 2.20$, $p > .05$, for "same" and "different" responses, respectively].

Few-element patterns. A three-factor repeated measures ANOVA showed a significant effect of dimension [$F(1,7) = 21.344$, $p < .002$], a significant effect of response [$F(1,7) = 21.915$, $p < .002$], and a significant effect of compatibility [$F(1,7) = 37.758$, $p < .001$]. There was a significant interaction between dimension and compatibility [$F(1,7) = 6.063$, $p < .05$] and a significant interaction between response and compatibility [$F(1,7) = 7.826$, $p < .05$]. There was no significant interaction between dimension and response type ($F < 1$). "Same" RT was faster than "different" RT by an average of 46 msec in the compatible trials, but it was faster by an average of only 11 msec in the incompatible trials. The three-way interaction between dimension, response type, and compatibility was significant [$F(1,7) = 18.489$, $p < .004$]. Further analysis revealed the source of the three-way interaction. The compatibility effect for the global dimension was significant [$F(1,7) = 10.886$, $p < .02$] and did not interact significantly with response type [$F(1,7) = 1.143$, $p > .30$]. Both "same" and "different" responses to the global form were interfered with by incompatible local output. The interference effect averaged 18 msec for the "same" responses and 9 msec for the "different" responses. On the other hand, there was a significant interaction between response type and compatibility [$F(1,7) = 11.905$, $p < .011$] for the local dimension. The compatibility between the two dimensions affected the "same" responses but not the "different" responses: Difference on the global dimension resulted in an interference effect (which averaged 60 msec) on "same" responses to the local elements; sameness on the global dimension did not interfere with "different" responses to the local elements.

Comparison of the compatible "same" and "different" RTs for the local and the global dimensions revealed that detection of global sameness and difference was faster than detection of local sameness and difference [$t(7) = 7.885$, $p < .01$, and $t(7) = 9.852$, $p < .01$, for the "same" and "different" responses, respectively].

Error analysis. The error-rates data showed effects similar to those of the RT data, but not all effects reached statistical significance. However, they suggest no speed-accuracy tradeoff. The four-factor repeated measures ANOVA indicated a significant effect of pattern type [$F(1,7) = 10.78$, $p < .02$], a significant effect of compatibiity [$F(1,7) = 23.29$, $p < .002$], and a significant interaction between dimension and compatibility [$F(1,7) = 6.88$, $p < .04$]. The interactions of pattern × response × compatibility [$F(1,7) = 3.68$, $p < .10$] and dimension × response × compatibility [$F(1,7) = 4.47$, $p < .08$] just approached significance. Analysis of the data for many-element patterns showed a significant effect of compatibility [$F(1,7) = 23.25$, $p < .002$] and a significant interaction between dimension and compatibility [$F(1,7) = 15.00$, $p < .006$]. Analysis of the data for few-element patterns showed a significant effect of compatibility [$F(1,7) = 17.23$, $p < .005$], but no significant interaction between dimension and compatibility ($F < 1$).

Congruity analysis. The following analysis examined the effect of congruity of identity of the stimuli in a pair on the comparison judgments. This analysis was limited to the compatible trials, since half of these trials had both stimuli in a pair congruent and the other half had both stimuli in a pair incongruent (see the Method section). None of the incompatible trials contained two congruent stimuli. Mean RTs for the pairs of congruent and incongruent stimuli in the compataible trials, for each type of response and for the two sets, are presented in Table 2.

The RT data were first analyzed by a four-factor repeated measures ANOVA. The analysis showed a significant effect of response type [$F(1,7) = 15.563$, $p < .006$], a significant interaction between dimension and pattern [$F(1,7) = 7.863$, $p < .026$], a significant interaction between pattern and response type [$F(1,7) = 11.868$, $p < .011$], a significant interaction between dimension and congruity [$F(1,7) = 8.502$, $p < .022$],

Table 2
Mean Reaction Times (in msec) for Congruent and Incongruent Stimuli for Each Response Type in Experiment 1

Critical Dimension	Same		Different	
	Congruent	Incongruent	Congruent	Incongruent
	Many-Element			
Global	414	424	448	446
Local	432	430	448	463
	Few-Element			
Global	403	386	429	428
Local	420	423	465	493

a significant interaction between response type and congruity [$F(1,7) = 6.310, p < .04$], and a significant three-way interaction between pattern, dimension, and response type [$F(1,7) = 9.299, p < .02$]. Two of the three-way interactions just approached significance: The interaction between pattern, dimension, and congruity [$F(1,7) = 4.938, p < .06$] and the interaction between pattern, response type, and congruity [$F(1,7) = 4.583, p < .07$]. Analysis of the data for many-element patterns showed a significant congruity effect [$F(1,7) = 6.681, p < .036$]. No interaction effect was significant. However, the effect was small (it averaged only 6 msec), and it may suggest that some processing up to the level of identification of the global and the local forms was going on. Analysis of the data for few-element patterns showed a significant interaction between dimension and congruity [$F(1,7) = 8.609, p < .022$] and between response type and congruity [$F(1,7) = 62.523, p < .001$]. A finer inspection of the data revealed that there was no interfering effect of incongruity on the responses to the global dimension. There was, however, an interfering effect (which averaged 28 msec) for the "different" responses to the local dimension.

Discussion

Subjects' performance with the few-element patterns and with the many-element patterns differed with regard to the subjects' speed of detecting global and local sameness or difference and with regard to their ability to ignore incompatible output from the irrelevant dimension.

When subjects made "same"/"different" judgments on the global form or the local elements of pairs of many-element patterns and there was no incompatible output on the irrelevant dimension (i.e., in the compatible trials), neither global sameness nor global difference was detected significantly faster than local sameness or difference. However, when the output on the irrelevant dimension was incompatible with the output on the relevant dimension (i.e., in the incompatible trials), a global dominance effect was observed: Subjects were unable to filter out irrelevant global matches and mismatches, but incompatible sameness or difference on the elemental level had no effect on responding to the global form.

In a speeded classification task that involved the same set of stimuli, Kimchi and Palmer (1985, Experiment 4) also found that subjects were unable to selectively attend to the local elements when the global form varied, but neither could they attend selectively to the global form when the local elements varied; that is, no global or local dominance was found in the speeded classification task.

When subjects made "same"/"different" judgments on pairs of few-element patterns and no incompatible output from the irrelevant dimension was present, global difference was detected faster than local difference (by an average of 51 msec), and global sameness was detected faster than local sameness (by an average of 27 msec).

When subjects made "same" judgments on pairs of few-element patterns in the incompatible trials, there was a mutual-interference effect of incompatibility. For the "different" responses, there was some interference from the local dimension, but no interference from the global dimension. This finding of mutual interference between the global form and the local elements is in accordance with previous findings with a speeded classification task that indicated that the global and local dimensions of such patterns are integral (Kimchi & Palmer, 1985).

The present results conflict with some results of Navon (1983, Experiment 2), who used a similar "same"/"different" task and found that the speed of detecting global differences between rectangular patterns was independent of the number of elements. However, with triangular patterns presented under the same conditions, Navon (1983, Experiment 1) found an effect of the number of elements. Thus, Navon's results were inconclusive with regard to the effect of number of elements and their relative size. It should also be noted that there are a number of differences between the present experiment and Navon's experiments. First, Navon was interested mainly in the speed of detecting global and local differences and not in the ability to selectively attend to either dimension. Thus there were no incompatible "same" trials in his experiment. Second, his stimuli differed from the present stimuli. In the present experiment, the local elements of the few-element patterns were identical to those of the many-element patterns except for a transformation in size. In Navon's stimuli, the local elements were themselves composed of elements, but their number differed for the local elements in the few-element patterns and for the local elements in the many-element patterns. Also, the overall size of the few-element patterns in Navon's experiments was smaller than the overall size of the many-element patterns; in the present experiment, the overall size of the patterns was kept constant. Any of these differences could possibly contribute to the discrepancies in the results.

In the present experiment, global dominance was observed with the many-element patterns only when incompatibility was present on the irrelevant dimension. With the few-element patterns there was global dominance in the compatible trials, and mutual interference in the incompatible "same" trials, with some global advantage. Performance with both types of patterns showed one of the typical findings with the "same"/"different" task: overall "same" RT was faster than overall "different" RT (the fast-"same" effect). With the many-element patterns the fast-"same" effect was present both in the compatible and in the incompatible trials. This effect diminished in the incompatible trials with the few-element patterns.

Taken together, these findings suggest that the processing of the global and local levels of hierarchical patterns is a function of an interaction between the dimensional structure of the stimuli involved and task demands. Garner (1974) differentiated between stimuli whose primary processing is dimensional (those that vary along separable dimensions) and stimuli whose primary processing is holistic (those that vary along integral dimensions). With stimuli that vary along separable dimensions, subjects can process each dimension independently, in parallel with the other, and as long as the outputs of the two dimensions are compatible, the appropriate response is given and no dominance of one output over the other is expected. This seemed to be the case with the many-element patterns in the compatible trials of the present experiment. The finding of global dominance only when there was a conflict between the outputs of the two levels may suggest that the global dimension had an advantage in response selection (see also Miller, 1981). For stimuli that vary along integral dimensions, dimensional analysis is only secondary. The primary holistic processing might be sufficient for responding to the global dimension when no incompataibility is present on the elemental level. However, when one has to respond to the local dimension, a decomposition of the stimuli is required for checking the local elements, resulting in slower RTs to the local dimension. This seemed to be the case with the few-element patterns in the compatible trials. When incompatibility between the two levels is present, holistic processing is not sufficient for comparison judgments on either dimension, and a decomposition of the stimuli is required. This decomposition process is a very plausible source of the mutual interference effects with the few-element patterns in the incompatible trials.

EXPERIMENT 2

The results of Experiment 1 showed that subjects were not able to selectively attend to the local elements of many-element patterns. Experiment 2 was conducted to examine whether subjects could selectively attend to *texture*. Kimchi and Palmer (1985) found that in a speeded classification task subjects could selectively attend to either global form or texture without interference from the irrelevant dimension. Also, texture perception is assumed to occur early in the processing of visual stimuli and without focused attention (e.g., Julesz, 1981). It is possible that these characteristics of texture discrimination will lead to a competition between responding to the global form and responding to texture, and thus will abolish the dominance effect of the global dimension with many-element patterns.

Method

Subjects. Five females and 3 males from 19 to 28 years of age, with normal vision, served as subjects.

Stimuli. The stimuli were the same as in Experiment 1.

Design and Procedure. The design and procedure were the same as in Experiment 1. The only difference was that in the present experiment the subjects were told that they were going "to see figures which vary in global form and in texture." The subjects were instructed to attend to one dimension while ignoring the other, and to make "same"/"different" judgments on either the global forms or the textures of two simultaneously presented patterns.

Results

Mean RTs and percentage errors for the compatible and incompatible trials for each response type are presented in Table 3.

The four-factor (pattern × dimension × response type × compatibility) repeated measures ANOVA performed on the RT data showed a significant effect of compatibility [$F(1,7) = 39.00, p < .0004$] and a significant effect of dimension [$F(1,7) = 7.20, p < .05$]. Compatibility interacted significantly with response type [$F(1,7) = 19.16, p < .005$]. The interaction between dimension and compatibility [$F(1,7) = 4.57, p < .07$] and the interaction between dimension and response type [$F(1,7) = 3.76, p < .10$] just approached significance. Also, the three-way interactions pattern × dimension × response type [$F(1,7) = 4.80, p < .07$] and pattern × dimension × compatibility [$F(1,7) = 3.59, p < .10$] just approached significance.

Analysis of the data for the many-element patterns showed a significant effect of compatibility [$F(1,7) = 13.47, p < .01$] and a significant effect of response type [$F(1,7) = 8.50, p < .03$]. There was no significant effect of dimension [$F(1,7) = 1.33, p > .29$]. The interaction between dimension and response type [$F(1,7) = 6.38, p < .05$] was significant: "Same" RT was faster than "different" RT by an average of 52 msec for the global form, but by an average of only 16 msec for the texture. Compatibility interacted significantly with dimension [$F(1,7) = 12.07, p < .01$]. Sameness and differ-

Table 3
Mean Reaction Times (RTs, in msec) and Percentage Errors (%E) for Compatible (C) and Incompatible (IC) Trials for Each Response Type In Experiment 2

	Same						Different					
	C		IC		Average		C		IC		Average	
Critical Dimension	RT	%E	RT	%E	RT	%E	RT	%E	RT	%E	RT	%E
					Many-Element							
Form	528	1.56	535	2.81	532	2.19	585	2.81	583	8.75	584	5.78
Texture	549	.93	612	5.62	581	3.28	591	1.87	602	4.69	597	3.28
Average	539	1.25	574	4.22			588	2.34	593	6.72		
					Few-Element							
Form	508	2.81	537	4.49	523	3.65	555	3.75	557	5.62	556	4.69
Texture	571	1.87	627	6.25	559	4.06	643	3.12	633	4.37	638	3.75
Average	540	2.34	582	5.37			599	3.44	595	5.00		

ence of the global form affected "same"/"different" responses to texture. The interference effect averaged 63 msec for the "same" responses and 11 msec for the "different" responses. Matches and mismatches on texture had no effect on "same"/"different" judgments of the global form. The interaction between response type and compatibility just approached significance [$F(1,7) = 5.51, p < .06$]: "Same" RT was faster than "different" RT by an average of 49 msec in the compatible trials, and by an average of 19 msec in the incompatible trials.

Comparing RTs to form and texture in the compatible trials indicated no significant difference between detecting form sameness or difference and texture sameness or difference [$t(7) = 1.647$, $p > .10$ and $t(7) = .915$, $p > .50$, for the "same" and "different" responses, respectively].

Analysis of the data for the few-element patterns indicated a significant effect of response type [$F(1,7) = 5.85$, $p < .05$], a significant effect of compatibility [$F(1,7) = 11.37, p < .012$], and a significant effect of dimension [$F(1,7) = 8.37, p < .025$]. The only significant interaction was between compatibility and response type [$F(1,7) = 7.98, p < .03$]. The incompatibility between the two dimensions affected the "same" responses only. The interference effect from mismatches on the global dimension averaged 56 msec, and the interference effect from mismatches on the local dimension averaged 29 msec. There was no effect of incompatibility on the "different" responses. "Same" RT was faster than "different" RT by an average of 60 msec in the compatible trials, but by an average of only 13 msec in the incompatible trials.

Comparison of the RTs to the two dimensions in the compatible trials indicated that global sameness was detected faster than local sameness by an average of 63 msec [$t(7) = 4.192, p < .01$], and global difference was detected faster than local difference by an average of 88 msec [$t(7) = 6.245, p < .01$].

Error analysis. Analysis of the error-rate data showed a significant effect of compatibility [$F(1,7) = 12.97$, $p < .009$] and a significant four-way interaction of patterns × dimension × response × compatibility [$F(1,7) = 9.21, p < .019$]. Analysis of the data for the many-element patterns revealed a significant effect of compatibility [$F(1,7) = 23.35$, $p < .0019$] and a significant dimension × response × compatibility interaction [$F(1,7) = 6.35, p < .05$]. There was a global-to-textural interference for the "same" responses, and a mutual interference with a larger textural-to-global interference effect for the "different" responses. Analysis of the data for the few-element patterns indicated a significant effect of compatibility [$F(1,7) = 5.21, p < .056$]. No interaction effect was significant.

Congruity analysis. Mean RTs for the compataible pairs of congruent and incongruent stimuli for each type of response are presented in Table 4.

The four-factor (pattern × dimension × response type × congruity) repeated measures ANOVA indicated a significant effect of response type [$F(1,7) = 16.16$, $p < .005$] and a significant effect of dimension [$F(1,7) = 5.67, p < .05$]. The only significant interaction was between pattern, dimension, and congruity [$F(1,7) = 5.85, p < .05$]. Analysis of the data for the many-element patterns showed no significant main effect of congruity ($F < 1$) and no significant interactions. Thus the small effect of incongruity found in the previous experiment was not replicated, suggesting that the subjects in the present experiment did not fully process the shape of the local element. Analysis of the data for the few-element patterns showed a just significant interaction between congruity and dimension [$F(1,7) = 4.70$, $p < .07$]. There was some inhibitory effect (an average of 9 msec) of incongruity for the global dimension, but not for the local dimension.

Table 4
Mean Reaction Times (in msec) for Congruent and Incongruent Stimuli for Each Response Type in Experiment 2

Critical Dimension	Same: Congruent	Same: Incongruent	Different: Congruent	Different: Incongruent
		Many-Element		
Form	526	529	587	583
Texture	540	540	588	601
		Few-Element		
Form	502	513	552	558
Texture	580	562	652	633

Discussion

In general, the results of Experiment 2 replicated the results of Experiment 1. Indeed, replication was expected for the few-element patterns: There is actually no texture in such patterns, inasmuch as a critical number of elements (around 7 ± 2) seems to be required for texture perception (Beck, 1982; Goldmeier, 1936/1972; Kimchi, 1982; Kimchi & Palmer, 1982), and therefore dimensional instructions should have no effect on the processing of these patterns (see also Kimchi & Palmer, 1985). The results with the few-element patterns indicated again a mutual-interference effect in the incompatible "same" trials. "Different" judgments were not affected by irrelevant sameness. This finding of a differential sensitivity of "same" and "different" judgments to irrelevant information has also been reported by other researchers (e.g., Besner & Coltheart, 1976; Dixon & Just, 1978; Santee & Egeth, 1980), and has been taken by some investigators as evidence that a holistic process mediates "same" judgments, whereas an analytic process mediates "different" judgments (see Farell, 1985, for an extensive review).

The present RT results with the many-element patterns replicated the interference effect from incompatible sameness and difference on the global form when subjects made textural comparisons. Although the RT data did not show a significant textural-to-global interference, the error-rate data indicated a significant effect of incompatible texture sameness on "different" responses to the global form. Except for the latter finding, the change in dimensional instructions did not seem to alter subjects' performance in the present experiment. Thus, although subjects in a previous experiment were able to ignore irrelevant variation in the global form or texture when classifying the other relevant dimension (Kimchi & Palmer, 1985, Experiment 3), subjects in the present experiment were unable to do so when they made comparison judgments on the texture or the global form. The finding of effective selective attention to a dimension in a speeded classification task and a failure of selective attention to the same dimension in a comparison task is reminiscent of Santee and Egeth's (1980) finding. Using the dimensions of form and size or shading, Santee and Egeth found that subjects were able to selectively attend to form when the irrelevant dimension of size or shading varied in a speeded classification task, but they were not able to efficiently filter out irrelevant disparity in size or shading in a comparably designed "same"/"different" task. Other researchers have also found an interference from the irrelevant dimension when it was incompatible with the relevant one in a simultaneous-comparison task, both with dimensions that produced orthogonal interference in a speeded classification task (e.g., heights and widths of ellipses, and hues and tints of color patches, Dixon & Just, 1978), and with dimensions that produced no such interference in a speeded classification task (e.g., shape and size, Hawkins, McDonald, & Cox, 1973; and shape, size, and orientation of an interior line segment, Keuss, 1977). All of these findings suggest a possible difference between the processing demands of the two tasks.

GENERAL DISCUSSION

The present experiments demonstrate that the processing of compound stimuli depends both on the type of stimuli involved and on the particular task demands.

Two major differences were observed in the subjects' performance with the many-element patterns versus the few-element patterns in the present "same"/"different" task. First, it was found that the subjects' ability to attend selectively to either the global dimension or the elemental/textural dimension depended on the number and the relative size of the elements. With the many-element patterns, the subjects were able to selectively attend to the global dimension but not to the elemental dimension, and interference was found for "same" and "different" responses. There was one exception to this phenomenon: When the elemental dimension was processed as texture, there was textural-to-global interference for the "different" responses. However, this interference effect was observed with the error-rate data only (see Experiment 2). With the few-element patterns, the subjects were not able to selectively attend to either the global or the elemental dimension, regardless of dimensional instructions. Interference was found mostly for the "same" responses. The mutual-interference effect found for the few-element patterns is in accordance with previous findings indicating that the global and local dimensions of these patterns are integral (Kimchi & Palmer, 1985). Integrality of the two dimensions predicts a mutual-interference effect for both "same" and "different" judgments. The differential effect found suggests an interaction between the dimensional structure of the stimuli and the processes involved in the two types of judgments. A dual-process model of the "same"/"different" task assumes that "same" and "different" judgments are mediated by different modes of processing: "Same" judgments are based on holistic comparisons, whereas "different" judgments are based on analytic comparisons (e.g., Bamber, 1969; Nickerson, 1969, 1978). If a "different" judgment is indeed mediated by an analytic process and the dimensions are integral, then a decomposition of the stimuli is required for making this judgment, which should result in relatively long "different" RTs even in the compatible trials. On the other hand, if a "same" judgment is mediated by a holistic process, "same" RTs are expected to be relatively short in the compatible trials and to increase in the incompatible trials. The results confirm this hypothesis: There was a large fast-"same" effect for the compatiable trials and a negligible effect for the incompatible trials.

Second, when there was no conflict between the outputs of the two levels, "same"/"different" judgments on the global and elemental/textural dimensions of the many-element patterns were made equally quickly. On the other hand, sameness and difference on the global dimension of few-element patterns were detected faster than sameness and difference on the elemental dimension. An account of these findings in terms of the interaction between the dimensional structures of the two types of patterns and the processes involved in the "same"/"different" judgments has been given elsewhere (see the Discussion of Experiment 1).

The effect of the particular task employed is also manifested in the discrepancy between the present findings and previous findings with the same set of stimuli in a speeded classification task. The present results with the many-element patterns clearly indicated that the subjects were unable to ignore conflicting irrelevant output on the global dimension when they made "same"/"different" judgments on the elemental or textural dimension. Generally speaking, there was no local-to-global interference effect on comparison judgments on the global dimension (see the exception mentioned above). Contrary to these findings, no global or local advantage was found with the speeded classification task: Subjects were able to selectively attend to either dimension when classifying global form and texture of many-element patterns, and they were not able to selectively attend to either dimension when classifying global form and local elements (Kimchi & Palmer, 1985). The finding of interference effects in the present simultaneous-comparison task, which does not require stimulus identification, together with the near absence of a congruity effect, suggest that an interference between the global and the local levels does not necessarily stem from an identification conflict between the global and the local forms. Rather, it seems that it is the presence of *conflicting output* in general that gives rise to an interference effect.

Before elaborating on the latter point, I will discuss a couple of factors that are extraneous to the tasks themselves but could nevertheless affect the results. In the speeded classification task, a single stimulus was presented in each trial in the center of the visual field. In the "same"/"different" task, a pair of stimuli were presented simultaneously—neither stimulus in the center of the visual field, but more peripherally. As a result, the comparison process could be affected by two factors. One factor is symmetry of the whole display (Fox, 1975). If global symmetry is salient in some way, it could facilitate "same"/"different" judgments on the global dimension (see also Navon, 1983). The other factor is eccentricity. Peripheral presentation has different effects on global and local processing. For example, Pomerantz (1983) found that local dimensions become harder to process than global dimensions in the visual periphery. It seems then, that both factors could contribute to a global advantage, which indeed was exhibited in some of the data. However, these factors cannot account for the absence of a global advantage in the compatible trials with the many-element patterns, or for the mutual-interference effects with the few-element patterns. Furthermore, Santee and Egeth (1980) found a failure of selective attention to separable dimensions in a comparison task, both with simultaneous presentation and with sequential presentation in which the above factors were eliminated.

Thus, although organization of the array and method of presentation might interact with the simultaneous-comparison task to produce some of the present results, an alternative, or an additional explanation, in terms of task diagnostics seems to be required. The speeded classification paradigm, which employs irrelevant variation along stimulus dimensions, is primarily a diagnostic for dimensional versus holistic processing. Integral dimensions are registered as unitary entities at an early perceptual stage and are analyzed holistically, whereas separable dimensions are registered separately and are analyzed dimensionally. Efficient selective attention to stimulus dimensions in the speeded classification task implies dimensional analysis (Garner, 1974). However, it is possible that a stimulus is processed dimensionally at an early stage of processing, but focusing on the relevant dimension—or, alternatively, ignoring the irrelevant dimension—becomes impossible at a later stage of processing, due, for example, to a conflict of responses. This imperfection of selective attention might not be uncovered unless there is a conflict between the two dimensions. In other words, dimensional analysis is a necessary but not sufficient condition for successful selective attention to a stimulus dimension.

It follows, then, that with separable dimensions, selective attention to a stimulus dimension can be possible in one task but not in another, depending on the likelihood of dimensional-output conflict. The Stroop-type paradigm is an example of a task that employs conflicting information between stimulus dimensions. Thus, for example, Kimchi and Palmer (1985) found that subjects could classify the local and global dimensions of many-element patterns without interference when the stimuli were processed in terms of form and texture, but not when the same stimuli were processed in terms of global and local forms. In the latter case there were conflicting identification responses to the two levels; that is, a Stroop-type factor was involved in this speeded classification task and it interfered with the classification process. In the present "same"/"different" task there were two Stroop-type factors. One, which was not directly relevant to the comparison task, had to do with congruent or incongruent identity of the global and local forms of a single pattern. Only negligible Stroop-type interference of this kind was observed. The other factor was directly related to the comparison process: There was a conflict between the outputs of the comparisons along the two dimensions in the incompatible trials, and it was present both when subjects had to attend to the local forms and when they had to attend to texture. The finding of no significant difference in detection of global sameness/difference and local sameness/difference in the compatible trials with the many-element patterns supports an explanation in terms of conflicting outputs. However, this notion does not predict a unidirectional interference. It seems that, at least for the present experiments, the results can best be explained by an interaction between the properties of the visual display discussed above, which made the global dimension more salient in some sense, and the properties of the task, which involved conflicting dimensional outputs.

Thus, the results of the present experiments suggest that an adequate processing model of subjects' performance should take into account the dimensions involved, the task requirements, and the properties of the visual display that might affect the relative perceptual salience of the stimulus dimensions. A complete understanding of the different tasks' demands awaits further investigation.

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