Perception & Psychophysics
1993, 53 (1), 34-42

Context influence on the perception of figures as conditional upon perceptual organization strategies

JOHN F. STINS and CEES VAN LEEUWEN
University of Amsterdam, Amsterdam, The Netherlands

Two experiments tested the effect of context on figure perception. Subjects were shown rapid sequences of three figures: a prime, a whole, and a part. They were asked to decide if the third figure was a part of the second (Experiment 1) or if the second and third figures were the same or different with respect to a particular angle (Experiment 2). The prime served to establish a context for stimuli that followed to be compared. Priming had influence on the part-whole comparison in Experiment 1, but not on the local comparison in Experiment 2. The results of Experiment 1 were interpreted as evidence for a role of prior information in perceptual organization. Experiment 2 showed that the task must require an integrative perceptual organization strategy for the priming effects to occur.

Studies in figure perception have emphasized the role of structural descriptions in both perception and recall of figures. Structural descriptions are generally regarded as hierarchical knowledge structures (Buffart, 1986; Palmer, 1977), of which the top level specifies the whole of the figure and lower levels specify its parts.

A paradigm for testing such descriptions, therefore, consists in the part-whole detection task (Krasselt, 1990; Reed, 1974). Reed presented subjects a whole, such as that in Figure 1, immediately followed by one of its parts. In the whole, some parts were recognized more easily than others (in Figure 1, Part A was preferred over B). The preferred ones were assumed to be components of the structural description, whereas the alternative ones were not.

The description, however, could have been assumed to have those parts prior to any experimenting, because they are phenomenally the most distinct in the whole. This allows alternative explanations that take phenomenal distinctiveness as their starting point—for instance, the Gestalt principles of perceptual organization. In the Gestalt tradition, part-whole tasks have been used (e.g., Gottschaldt, 1926) in order to show that there is little influence of context on the phenomenal distinctiveness. For instance, in Figure 2, two overlapping circles are perceived in the leftmost whole, no matter how many contexts of the right-hand type preceded. Absence of preceding-context influence could be considered more in accordance with Gottschaldt's views, in that the organization is the result

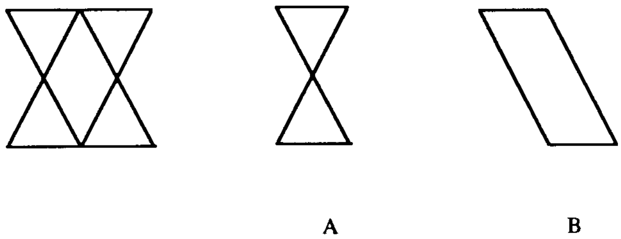

Figure 1. Whole and alternative Parts A and B.

of properties of the *perceptual* field and thus is entirely the consequence of the momentarily presented stimulus. In contrast, by assuming structural descriptions, which may be regarded as abstract conceptual knowledge structures (Sutherland, 1968), sensitivity to the earlier presented information would have been expected.

Under the assumption of structural descriptions, context influence may be expected to be mandatory because, as with semantic networks, search will take place through automatic spreading activation (Anderson, 1983; Collins & Loftus, 1975). The spreading activation will explain, among others, effects of priming (Meyer & Schvaneveldt, 1971). In the case of structural descriptions of figures, priming would lead to the selective activation of a segmentation for the figure (Henderson, Pollatsek, & Rayner, 1987). Since this is exactly what Reed (1974) found, and Gottschaldt (1926) did not find, our present experiments will introduce and test a hypothesis on what determines the occurrence or nonoccurrence of priming in the part-whole task.

The part-whole task draws subjects' attention to how components are integrated to form a whole. Integration does not always have such a predominant role in the way subjects perceive a figure. People can easily be made to regard the whole as only weakly constrained by the rela-

The present study was performed in preparation for the first author's master thesis. J. Stins is now at the Faculty of Human Movement Sciences, Free University of Amsterdam. The assistance of Menno Hogeboom in preparing the software for running the experiments is gratefully acknowledged. Correspondence concerning this article should be addressed to C. C. van Leeuwen, Faculty of Psychology, Roetersstraat 15, 1018 WB Amsterdam, The Netherlands (e-mail: ceesvl@uvapsy.psy.uva.nl).

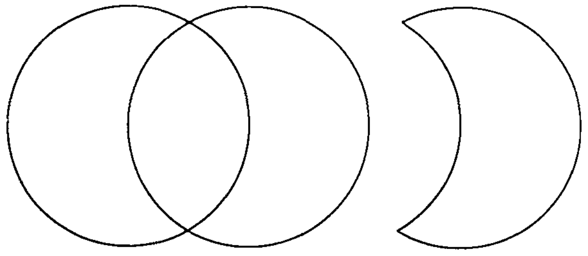

Figure 2. Whole and context.

tions between its part. This was shown, for example, by Peterson and Gibson (1991), who instructed their subjects to attend to certain parts of a figure. The figure was perceived as ambiguous, due to the fact that subjects did not incorporate disambiguating parts not in the focus of attention into their impression of the figure.

To account for effects of spatial attention, van Leeuwen, Buffart, and van der Vegt (1988) suggested that there are two perceptual organization strategies. One of these strategies is constrained to the detection of local parts of a segmentation (a nonintegrative strategy), and the other integrates local parts into a whole (integrative strategy). Which of these is dominant may depend on task, practice, instruction, or presentation conditions.

One of the factors responsible for the contrast between Gottschaldt's (1926) and Reed's (1974) results may therefore be the predominance of integrative versus nonintegrative perceptual organization strategies. The lack of context influences in Gottschaldt (1926) could be due to subjects' choosing a nonintegrative strategy, because instruction required them to memorize the context figures as separate from the wholes and because subjects were naive with respect to the presence or absence of context figures as components in the whole. In contrast, Reed's subjects may have used an integrative strategy, because he required them explicitly to compare whole and part. Neither author controlled or manipulated these factors systematically. However, in a follow-up study, Gottschaldt (1929) reported some instances of people showing context effects in conditions where they could infer from the instruction given beforehand that there would come wholes that could contain the context figures as components.

We varied the task between the experiments of the present study. In Experiment 1, by using a variant of Reed's whole-part task, we induced an integrative strategy. Conversely, a nonintegrative was induced in Experiment 2. Context effects were predicted for Experiment 1, but not for Experiment 2.

EXPERIMENT 1

Hypothesis

Reed's (1974) paradigm cannot be used without modification, in order to compare it with Gottschaldt (1926). Reed investigated a first-order effect of preceding context (viz., a facilitation by a preceding figure), whereas Gottschaldt investigated a second-order effect (viz., whether this facilitation is enlarged or reduced by context information preceding the task). We have therefore adapted Reed's task to make it in accordance with Gottschaldt. Before the presentation of whole and part, a prime is presented, which like the part is a component of a segmentation of the whole. The context may either correspond to or compete with the segmentation involved in the part-whole task. If there is context influence, an interaction is expected between prime and part conditions.

In a similar prime/whole-part task, performed by Mens (1988; Mens & Leeuwenberg, 1988), no effect of priming was obtained. Presentations of prime, figure, and target, however, were very brief (10 msec each, with an ISI of 30 msec). This could have been too brief for these figures to activate a structural description or obtain a clear perceptual impression of the figure and its component. Second, instead of deciding whether the target figure was part of the figure, subjects had to identify the target from three alternatives. Subjects therefore could choose not to integrate the information from prime and figure with the part. Like Gottschaldt (1926), who also found no priming effects, Mens (1988) required his subjects to memorize the primes separately. Given the load induced by the extremely short presentations, it is likely that subjects prefer not to integrate prime and figure information. In our present experiment, an integrative strategy was implied in the task of the first experiment, because recognition of the part in the whole was needed for the correct answer.

Moreover, Mens (1988) calculated no interactions. Instead, percentage correct identification was submitted to a correction procedure in order to remove a response bias before further analysis. The correction was made by subtracting the percentages obtained in a control condition, in which only the target was presented followed by the multiple-choice task. After the correction, equal preference was obtained for two alternative targets. Before correction, there was, however, a clear preference for one of the two parts. All these issues cast severe doubts on the validity of Mens's results.

We adopted, however, their basic idea in our experiments (i.e., the presentation of a rapid succession of three pictures, a prime, a whole, and a part). The whole was ambiguous; two segmentations were approximately equally preferred in the whole-part task. The prime was a component of the whole and thus could induce another segmentation or the same segmentation as the part, so that, given the influence of preceding context, the prime conditions should interact with those of the part conditions: facilitation should be obtained if prime and part corresponded to the same segmentation of the whole, relative to conditions in which they corresponded to different segmentations.

Method

Subjects. Twenty-four psychology students of the University of Amsterdam fulfilled course requirements by their participation in the experiment. One subject was male; the other 23 subjects were female.

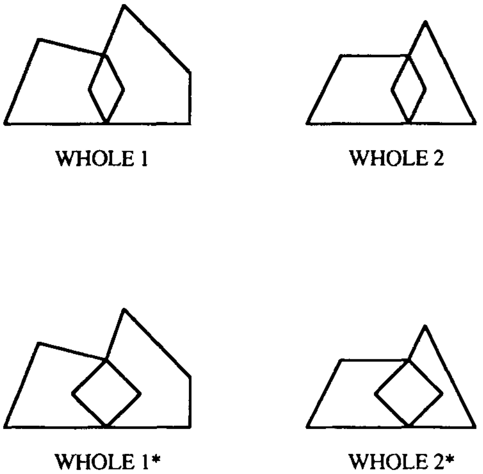

Figure 3. The wholes WHOLE 1 and WHOLE 2, WHOLE 1*, and WHOLE 2*.

Stimuli. Figure 3 shows WHOLE 1 and WHOLE 2; Figure 4 shows the components of their alternative segmentations. These could occur as either primes (before the whole) or parts (after the whole). To ensure that the outer contours of the whole alone would not provide sufficient information on whether the part belongs to a segmentation of a certain whole, a second set of wholes, WHOLE 1* and WHOLE 2*, was included. These were equal to WHOLE 1 and WHOLE 2 in their global contours, but differed in their area of overlap. Figure 3 shows WHOLE 1* and WHOLE 2*; Figure 4 shows the corresponding components.

There were at least two possible segmentations for the whole: one built of two concave components, and another built of two convex ones. The convex segmentation may be slightly preferred; for the present purpose, however, they may be called ambiguous.

Material. Stimuli appeared on a monitor screen at arm's length distance of the subject. The pictures appeared inside a light gray rectangle on a dark background. The size of the rectangle was 7.3×7.3 cm; the width of WHOLE 1-1* was 4.3 cm and WHOLE 2-2* was 4.0 cm. The position on the screen of prime and the part completely matched their position in the whole. As response keys the "D" and "K" on the computer keyboard were used; the "yes" key was marked green, and the "no" key was marked red. The "yes" and "no" keys were exchanged between subjects. The experiment took place in a normally lit room and was supervised by a (male) experimenter.

Procedure. Before the experiment, the subjects read a written instruction, followed by a practice session of 32 trials. To correct for individual differences in accuracy, scores on training trials were used to determine the presentation time of the whole for each subject. With less than 23 correct responses in the practice session, wholes were shown for 250 msec. Between 22 and 29 correct responses, wholes were shown for 200 msec. With more than 28 correct responses, wholes were shown for 150 msec. Midway through the experiment, the subjects could take a short pause; the entire experiment lasted about half an hour.

Each trial consisted of a prime, a whole, and a part. The prime was shown for 350 msec and was immediately followed by the

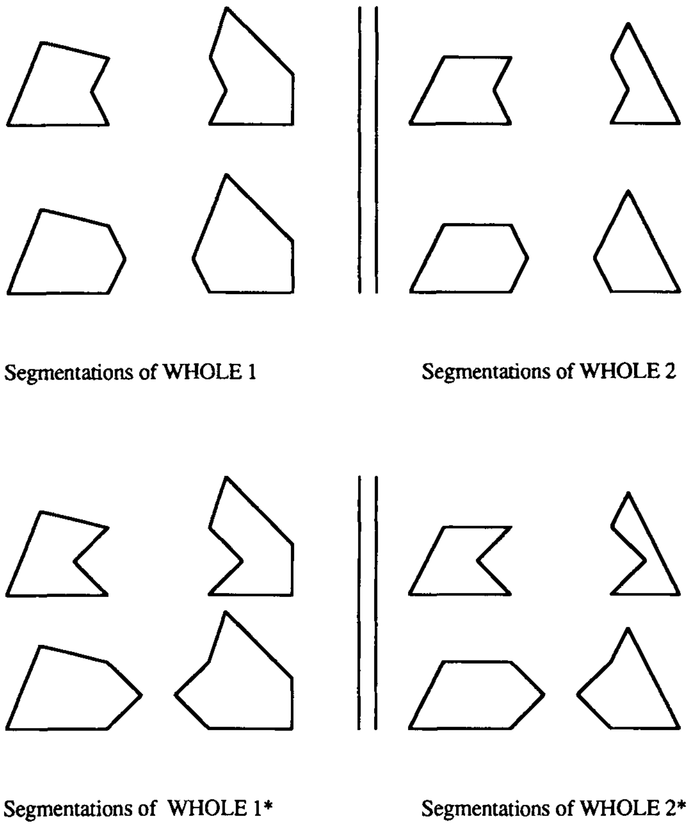

Figure 4. Alternative segmentations of WHOLE 1 and WHOLE 2, WHOLE 1*, and WHOLE 2*.

whole, which was shown for 250, 200, or 150 msec. The screen then remained clear for 200 msec, after which the part was presented for 150 msec. Afterwards, the screen remained clear until a response was given. The subjects responded as quickly as possible, indicating whether the part was a component of the whole by pressing the "yes" or "no" key. After a response key was pressed, the screen remained clear for 1,000 msec, after which the next trial started. Prime, whole, and part thus were shown long enough to create a clear, though short, visual impression on the perceiver. The subjects were to decide as quickly and as accurately as possible, whether the part belonged to the whole, as a component of one of its segmentations. Reaction times (RTs) and number of correct responses were recorded. If an RT exceeded 2,500 msec, the answer was taken to be incorrect.

In contrast to the studies of Mens (1988), Gottschaldt (1926), and Reed (1974), equiprobability was realized for all the relevant factors: *prime fit* (positive/negative prime), a component is said to be positive when it actually belongs to a segmentation of the whole presented at that trial, and negative otherwise; *part fit* (positive/negative part); *prime shape* (convex/concave prime); *part shape* (convex/concave part); and *location* of context. The factor of location of context had two levels: if the prime was a leftmost component of a whole, then the part following was a rightmost component, and vice versa. Thus, upon seeing the prime, the subjects already knew where to expect the part. Subjects thus were stimulated to make a saccade.

To obtain equiprobability, four whole (and their parts) from Figures 2 and 4 were pairwise combined to obtain four subsets of stimuli. These combinations were 1-2, 1-1*, 2-2*, and 1*-2*. Each subset generated 64 trials: 2 (positive/negative prime)×2 (convex/concave prime)×2 (wholes)×2 (convex/concave part)×2 (location of primes and parts). The resulting 256 (4×64) trials were presented in random order.

Results and Discussion

One subject (the only male) was excluded from the analysis for having too many mistakes in one condition. Statistical analysis was performed on the remaining 23 subjects. For 4 of these, the whole was shown for 200 msec. For all the others, the whole was shown 250 msec.

Both (RTs) and number of correct responses were investigated with analyses of variance (ANOVAs). The relevant condition for testing the hypothesis is the one in which the part belongs to the whole (the "yes" responses). However, because of the balanced design, an ANOVA is possible for the full set of trial, including the "no" answers. Such a four-factor ANOVA was performed, with factors postive or negative prime, concave or convex prime, positive or negative part, and concave or convex part, and with subjects as a random factor.

Two main effects were significant. They were unpredicted, but pose no interpretation problems: A positive prime was responded to more quickly and more accurately than was a negative prime [for RTs, $F(1,22) = 6.946$, $MS_e = 18{,}254.9507$, $p < .015$; for number of correct responses, $F(1,22) = 5.744$, $MS_e = 3.0277$, $p < .025$]. A positive prime on a trial rendered a smoother succession of stimuli than did a negative prime. The prime had not been neglected, although it was irrelevant. This shows that some information of the prime was available for use (i.e., to integrate it with the whole).

The difference between positive and negative parts was significant [for RTs, $F(1,22) = 41.496$, $MS_e = 27{,}612.7108$, $p < .001$; for number of correct responses, $F(1,22) = 19.109$, $MS_e = 40.5509$, $p < .001$]. Correct "yes" responses were given quicker and more accurately than were correct "no" responses.

No main effects were obtained from convex versus concave primes, or parts, in accordance with the prediction of approximately equal preference for segmentations of the whole into concave and convex components.

Of interest for our hypothesis are the interactions. The largest one was a three-factor interaction between convexity and concavity of both prime and part by positive versus negative parts [for RTs, $F(1,22) = 6.795$, $MS_e = 20{,}301.1792$, $p < .016$; for number of correct responses, $F(1,22) = 17.539$, $MS_e = 8.7762$, $p < .001$]. Figure 5 shows these interactions for RT; Figure 6 shows these interactions for number of correct responses.

If we focus on the "yes" responses, it is observed that these are in accordance with the hypothesis. Fastest and most accurate responses were obtained when both prime and part were either convex or concave and slowest when one was convex and the other was concave.

The conditions where both prime and part were either convex or concave will be called *compatible*. Note that compatibility is a relation between global stimulus properties. It makes no difference whether the prime is positive or negative, as long as it has the same global structure (convexity or concavity) as a part.

Whereas for the "yes" responses, compatibility, as expected, yielded faster and better responses, the result appears to be complementary for the "no" responses. For these, *incompatibility* yields better scores. These results are not in conflict with the assumption of context influence on the preferred segmentation of the whole, assuming that the weakening of a segmentation through incompatibility may facilitate a "no" response.

Invoking such selectivity in response opens the way for an explanation of these results entirely in terms of response

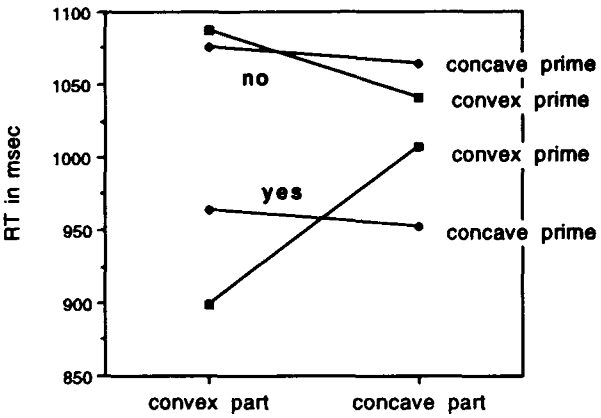

Figure 5. The concave or convex prime × positive or negative part × concave or convex part interaction. The upper half of the graph shows RTs (in milliseconds) for the negative parts and the lower half of the whole shows RTs for the positive parts, indicated by "no" and "yes," respectively.

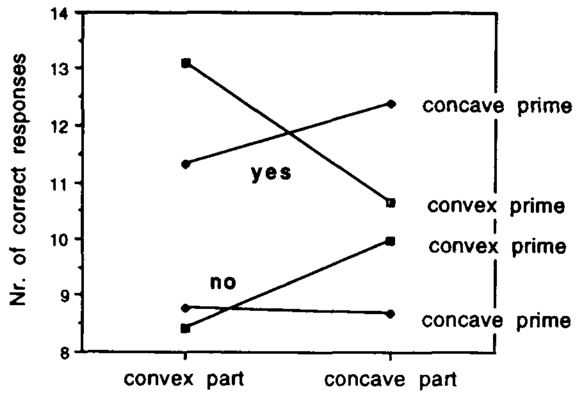

Figure 6. The concave or convex prime × positive or negative part × concave or convex part interaction. The upper half of the graph shows mean number of correct responses for the positive parts and the lower half of the graph shows mean number of correct responses for the negative parts, indicated by "yes" and "no," respectively.

biasing. For such an explanation to differ from the one just given, it must be assumed that response biasing operates independently of an automatic, perceptual process. Facilitation of "yes" responses by compatibility and facilitation of "no" responses by incompatibility then will still occur if the stimuli are the same, but the targets of comparison are changed. We shall deal with this consequence of the alternative explanation in Experiment 2.

The other significant interactions could be understood either as side effects of the main effects or from the three-factor discussed: A "no" response was given quicker when the prime was positive than when the prime was negative [for RTs, $F(1,22) = 7.885$, $MS_e = 12{,}771.7568$, $p < .010$]. This was the result of a superadditive combination of the two significant main effects of positive versus negative prime and part. Superadditivity of a prime and part factor are additional support for the integration of prime and part, because additivity would be more likely if both were processed in separate stages.

A "no" response was given quicker when the part was concave than when the past was convex, while the opposite was true when a "yes" was given [for RTs, $F(1,22) = 6.203$, $MS_e = 21{,}880.9859$, $p < .021$]. In both Figure 5 and Figure 6, this interaction can be ascribed to a difference in slope between the concave and convex prime conditions, the slope for the concave conditions being smaller. This means that compatibility exerted a stronger influence on convex parts than on concave parts. There may, therefore, be some preference not shown in the main effects to integrate convex, rather than concave, parts into the whole.

The effect of compatibility was larger for the "yes" response than the effect of incompatibility for the "no" response [for number of correct responses, $F(1,22) = 4.635$, $MS_e = 4.3365$, $p < .043$]. It could be assumed that the size of compatibility effects is inversely related to response latencies (e.g., because traces fade away). Since the "no" responses take longer, the response facilitation has already begun to fade away. No other interactions were near significance.

EXPERIMENT 2

Hypothesis

In Experiment 1, it was observed that compatibility of prime and part facilitated a "yes" response, whereas incompatibility of prime and part facilitated a "no" response. Therefore, priming *exclusively* of stages later than perceptual ones (response priming) could provide an alternative explanation for Experiment 1. For example, the convexity of the prime and the concavity of the part may bias the subject to give a "no" response. If the "yes" response, on that occasion, were the correct answer, the incongruence between the selected response ("yes") and the preferred response ("no") has to dissolve before an answer can be given.

Such a response-priming explanation, investigated in the domain of word recognition by de Groot (1984, 1985), was not tested in part-whole tasks in the studies of Gottschaldt (1926) and Reed (1974), nor was it acceptably tested in Mens and Leeuwenberg's (1988) study.

"Exclusively" here means that no variation in response is contributed by the outcome of the perceptual organization process. If subjects view the same stimuli and go through the same response stages as in Experiment 1, but with other targets for the comparison task, the same effects of compatibility will still be expected if this alternative explanation is correct. In Experiment 2, the subjects therefore compared whole and part with respect to a particular angle.

From the hypothesis that a difference exists between an integrative and a nonintegrative perceptual organization strategy, the local comparison in Experiment 2 leads to the expectation of a nonintegrative organization strategy. Therefore, given this assumption, no compatibility or incompatibility effects of priming were expected.

Method

The same experimental procedure as in Experiment 1 was used, but with different targets. The subjects compared the size of an angle in the whole and the part: the wholes and components marked with the * in Figures 3 and 4 differ from the unmarked ones in the size of their inner angles. The subjects were asked to identify these angles and respond "yes" if they were equal for whole and part, and "no" otherwise.

Three different versions of Experiment 2, resembling Experiment 1 in different respects were run. Like in Experiment 1, by forming pairs of wholes and using the full variation of their components, four subsets of stimuli were created that were randomly mixed. One version (Experiment 2A) used the same subsets of stimuli as those in Experiment 1. Note that, with this design, the local comparison yields a "yes" response for 75% of the trials. Other versions were therefore introduced to yield equal numbers of "yes" and "no" responses. So, in Experiment 2B, the combinations WHOLE 1-WHOLE 1*, WHOLE 2-WHOLE 2*, WHOLE 1-WHOLE 2*, and WHOLE 1*-WHOLE 2 were used to generate four subsets of stimuli. A third version was run (Experiment 2C) in which local and global characteristics of the wholes were maximally independent. To get equal numbers of "yes" and "no" responses, the combinations WHOLE 1-WHOLE 2 and WHOLE 1*-WHOLE 2*, which by definition yield a "yes" response, were used here, together with the combinations WHOLE 1-WHOLE 1*, WHOLE 2-WHOLE 2*, WHOLE 1*-WHOLE 2, and WHOLE 1-WHOLE 2*, from which only trials were used that yield a "no" response.

Thirteen subjects participated in Experiment 2A (3 males, 10 females), 15 in Experiment 2B (2 males, 13 females), and 13 in Experiment 2C (6 males, 7 females). All subjects received course credit for their participation. Each experiment lasted about half an hour. The statistical analyses were performed only on the RTs of the correct responses because, in general, too few errors were made to conduct a separate analysis on the number of correct responses, with the exception of a small number of subjects who had an extremely high error rate.

Results

Experiment 2A. Two subjects (both female) were excluded from analysis due to their extremely high error rates. The whole was shown for 150 msec on six occasions, 200 msec on three occasions, and 250 msec on two occasions.

A four-factor ANOVA was performed, with factors concave or convex prime, concave or convex part, equal angle prime, and equal angle part. This analysis belongs to the local comparison of part and whole required in Experiment 2 and is therefore called the *local* analysis. Table 1 shows the mean RTs for the 16 different conditions.

The effect of equal angle prime was significant [$F(1,10) = 11.166$, $MS_e = 45{,}056.4081$, $p < .007$], indicating that a response was more rapid when the size of the angle of prime and the whole was equal. The effect of equal angle part was significant [$F(1,10) = 22.525$, $MS_e = 14{,}063.3821$, $p < .001$], indicating that a "yes" response was quicker than a "no" response. The effect of concave or convex prime was significant [$F(1,10) = 7.280$, $MS_e = 7{,}200.9089$, $p < .022$], indicating that a convex prime was responded to more quickly than was a concave prime. We note, however, that a concave part was responded to more quickly than was a convex part, although this effect did not reach significance. Finally, the interaction of equal angle prime × equal angle part was significant [$F(1,10) = 6.810$, $MS_e = 8{,}923.2587$, $p < .026$]. This interaction resulted from the very low RTs in the condition where both prime and part were equal angle components. It was therefore in the opposite direction of compatibility in Experiment 1. Another four-factor ANOVA was performed, with factors concave or convex prime, concave or convex part, positive or negative prime, and positive or negative part. Such an analysis uses the same factors as the ones discussed in Experiment 1 and is therefore called the *global* analysis.

Table 1
Mean RTs (in Milliseconds) for the 16 Different Conditions

	Context							
	Equal				Unequal			
	Convex		Concave		Convex		Concave	
	RT	*SE*	RT	*SE*	RT	*SE*	RT	*SE*
Equal								
Convex	700	37	726	35	863	44	880	68
Concave	676	31	680	33	803	53	813	40
Unequal								
Convex	807	26	871	58	875	54	955	66
Concave	784	36	809	62	835	48	885	72

Table 2
Mean RTs (in Milliseconds) for the Convex/Concave and Context/Part Conditions

	Context			
	Convex		Concave	
Part	RT	*SE*	RT	*SE*
Convex	751	17	784	22
Concave	723	18	736	19

Table 3
Mean RTs (in Milliseconds) for the 16 Different Conditions

	Context							
	Equal				Unequal			
	Convex		Concave		Convex		Concave	
Part	RT	*SE*	RT	*SE*	RT	*SE*	RT	*SE*
Equal								
Convex	857	62	856	66	905	65	984	101
Concave	803	81	804	49	877	80	931	76
Unequal								
Convex	928	59	906	71	971	77	1,036	83
Concave	903	69	870	49	948	67	938	69

The effect of concave or convex prime was significant [$F(1,10) = 12.120$, $MS_e = 1879.3612$, $p < .006$], indicating that a convex prime was responded to more quickly than was a concave prime. Furthermore, the effect of concave or convex part was significant [$F(1,10) = 5{,}475$, $MS_e = 11{,}729.6056$, $p < .041$], indicating that a concave part was responded to quicker than was a convex part. These main effects are similar to the results we found using a local analysis. No further significant effects were found. Table 2 shows the mean RTs for the four (convex prime, concave prime, convex part, and concave part) different conditions.

Experiment 2B. Two subjects (both female) were excluded from analysis due to extremely high error rates. The whole was shown for 150 msec on seven occasions and 200 msec on six occasions. Because an equal angle part on a local analysis was also a positive part on a global analysis, and vice versa, the factors were the same for a test for local and global effects.

The local factors equal angle prime and equal angle part overlapped fully the global factors positive or negative prime and positive or negative part. A four-factor ANOVA was performed, with factors concave or convex prime, concave or convex part, equal angle prime, and equal angle part. Table 3 shows the mean RTs for the 16 different conditions.

The effect of equal angle prime was significant [$F(1,12) = 16.550$, $MS_e = 21{,}681.1640$, $p < .002$], indicating that a response was given quicker when the size of the angle of prime and whole was equal (i.e., when the prime was a positive part). Second, the effect of equal angle part was significant [$F(1,12) = 10.622$, $MS_e = 17{,}736.7474$, $p < .007$], indicating that a "yes" response was given quicker than was a "no" response. Third, the effect of concave or convex part was significant [$F(1,12) =$

5.060, MS_e = 22,063.2053, $p < .044$], indicating that a concave part was responded to quicker than was a convex part. We note, however, that a convex prime was responded to quicker than was a concave prime, although this effect did not reach significance. Finally, the interaction of equal angle prime × concave versus convex prime was significant [$F(1,12) = 5.372$, MS_e = 8,786.6758, $p < .039$], indicating that a concave prime was responded to quicker when it was an equal (or positive) part, whereas a convex prime was responded to quicker when it was an unequal (or negative) part.

Experiment 2C. Three subjects (2 male, 1 female) were excluded from analysis due to their extremely high error rates. The whole was shown for 150 msec on five occasions, 200 msec on two occasions, and 250 msec on three occasions. A local analysis could not be performed for Experiment 2C because there was no experimental condition in which the prime was an equal angle part and the part was an unequal angle part. A global four-factor ANOVA was performed, with factors positive or negative prime, positive or negative part, concave or convex prime, and concave or convex part. The only significant effect we found was a positive or negative part main effect [$F(1,9) = 23.068$, MS_e = 8,796.9469, $p < .001$], indicating that a positive part was responded to quicker than was a negative part. The mean RT for the positive part condition was 850 msec (SE = 22); the mean RT for the negative part condition was 921 msec (SE = 21).

Discussion

The results of the three versions of Experiment 2 consistently show that subjects have a preference for convex primes and concave parts. Both preferences can be understood by assuming that, in accordance with the task, subjects locally attend to prime, whole, and part, where the relevant line segments are located. These are easier to distinguish for a concave part than for its convex counterpart, so a concave part is responded to quicker than is a convex part. Whereas a concave part is easier to detect, a concave prime is harder to ignore and therefore causes more disturbance. The primes are attended to in spite of their irrelevance, suggesting mandatoriness also under a local strategy. However, global characteristics can be ignored effectively: the global analyses showed no effect whatsoever that was independent of the ones obtained in the local analysis. The pattern of results in this respect is very different from those obtained in Experiment 1, where an integrative strategy was used.

GENERAL DISCUSSION

The prediction that influence of preceding context on the interpretation of an ambiguous whole occurs only in an integrative task was confirmed by our experiments. The difference between integrative and nonintegrative perceptual organization strategies was introduced in van Leeuwen et al. (1988), using the terms global and local preference, respectively. Experiment 1 showed that the global shape of the prime influences the segmentation process that follows it. When prime and part were compatible to the same segmentation with respect to their global structure (both convex or both concave), the subsequent identification of a part in the whole was facilitated. In accordance, therefore, integration and global preference seem to be two sides of the same coin.

Facilitation by compatibility was absent in Experiment 2, where the same stimuli were compared locally (with respect to a particular angle). Instead, there were effects of detectability of the angle, both in the task-relevant part and in the irrelevant prime. These effects show that even if the perceptual strategy prescribes that information not be integrated, the irrelevant prime information was let through and processed further. This result is in accordance with the view that the difference between local and global strategies is a matter of perceptual organization type, not of selective attention. That information was not used in Experiment 2 (here, integrated with the whole) does not imply that it was unavailable.

The compatibility or incompatibility of two stimuli could therefore be communicated in principle also to post-perceptual processing components, explaining why "yes" and "no" responses show opposite compatibility effects. An explanation of Experiment 1 in terms of compatibility influencing the response phase only was considered in Experiment 2. With the same decisions to be made in the response phase over exactly the same stimuli, but with different, more local parts of the figures as targets, the priming effects disappeared. The alternative explanation could therefore be ruled out on account of the contrast between Experiments 1 and 2. In addition, our results accord to what is known in the domain of word (Meyer & Schvaneveldt, 1971) or scene perception (de Graef, Christiaens, & d'Ydewalle, 1990). These authors used the genuine on-line measure of fixation durations. These were shown to increase when objects appeared unexpectedly in a scene. Their interpretation is similar to ours: context effects similar to priming were obtained.

Like the priming effects obtained earlier in word and scene perception, the present results are a challenge to perception as driven only by actually given information. These results fail to support a static account of the part-whole task based on perceptual goodness of the parts into the whole (Garner, 1974; van de Helm & Leeuwenberg, 1991). Perceptual organization can make use of earlier information if this is required by the task.

But neither are these results in accordance with the predominant alternative to this view (e.g., Biederman, 1987), that perception is mediated by the unconditional recognition of a fixed set of components and mandatory integration into higher order structures. The assumption of mandatoriness of these processes is not in accordance with their absence in Experiment 2. Instead, it appears that the extent to which components are integrated is, also under rapid viewing conditions, under strategic control. For the same reasons, structural descriptions in general (Palmer, 1977) are only partially in accordance with the results obtained. They could explain the context effect in Experiment 1, as the result of automatic activation processes. But such an account requires additional assumptions to explain why there was no context effect in Experiment 2 after a change of task that left the perceptual conditions invariant. It is difficult at present to see how knowledge of a task could have such a specific effect on the flow of activation as blocking the flow from a certain part to a certain whole.

An account based on goodness still seems possible on the basis of these data, if it is assumed that goodness itself depends on context. The second author of this article has helped develop such an account (van der Vegt, Buffart, & van Leeuwen, 1989; van Leeuwen & Buffart, 1989; van Leeuwen, Buffart, & van der Vegt, 1988; van Leeuwen & van de Hof, 1991). In this model, there is the possibility to explain the difference between the integrative strategy used in Experiment 1 and the nonintegrative strategy used in Experiment 2, in principle, as the result of a self-organizing tendency. Using restricted viewing conditions led to the dominance of local organization in van Leeuwen et al. (1988). Instruction could have the same effect, as shown by Peterson and Gibson (1991). They interpret their results in terms of spatial attention. The present experiments suggest that these results (and perhaps others dealing with spatial attention) are to be explained in terms of global or local organization or, equivalently, in terms of integrative or nonintegrative perceptual strategies.

The model proposed by van Leeuwen et al. (1988) has an inherent tendency toward global organization, but it can also explain the persistence of local organization in the presence of viewing restrictions or instruction. When the system is already in a condition of local dominance, it receives negative feedback on the tendency to escape into a global organization from momentarily incoming local information. With restricted viewing conditions, this negative feedback is even enlarged because relatively more local information is coming in, so the system cannot escape; with a task that requires search for a local element, something similar happens. Detection of the local element will lead to new strengthening of the negative feedback.

This explanation is only acceptable if it can be assumed that the perception of figures goes through an initial local stage from which the system in some conditions cannot escape. That there is such an initial local stage is suggested both by Biederman (1987), who showed that recognition of an object is mediated by its components, and by de Graef et al. (1990), who obtained influence of local context violations on first fixations (unexpected objects), but global violations (objects at unexpected locations in a scene) only for later fixations.

It is not impossible that a structural-description account could provide an alternative explanation to the one presently suggested. Future experiments will have to aim at testing these models based on an economy principle against the structural-description models based on prior knowledge or the principle of likelihood.

REFERENCES

Anderson, J. R. (1983). A spreading activation theory of memory. *Journal of Verbal Learning & Verbal Behavior*, **22**, 261-295.

Biederman, I. (1987). Recognition by components: A theory of human image understanding. *Psychological Review*, **94**, 115-147.

Buffart, H. (1986). Gestalt qualities, memory structure, and minimum principles. In F. Klix & H. Hagendorf (Eds.), *Human memory and cognitive capabilities: Symposium in memoriam Hermann Ebbinghaus* (pp. 189-204). Amsterdam: North Holland.

Collins, A. M., & Loftus, E. F. (1975). A spreading-activation theory of semantic processing. *Psychological Review*, **82**, 407-482.

Garner, W. R. (1974). *The processing of information and structure*. Potomac, MD: Erlbaum.

de Graef, P., Christiaens, D., & d'Ydewalle, G. (1990). Perceptual effects of scene context on object identification. *Psychological Research*, **52**, 317-329.

de Groot, A. M. B. (1984). Primed lexical decision: Combined effects of the proportion of related prime-target pairs and the stimulus-onset asynchrony of prime and target. *Quarterly Journal of Experimental Psychology*, **36A**, 253-280.

de Groot, A. M. B. (1985). Word-context effects in word naming and lexical decision. *Quarterly Journal of Experimental Psychology*, **37A**, 281-297.

Gottschaldt, K. (1926). Über den Einfluß der Erfahrung auf die Wahrnehmung von Figuren: I. Über den Einfluß gehäufter Einprägung von figuren auf ihre Sichtbarkeit in umfassenden Konfigugurationen. *Psychologische Forschung*, **8**, 261-283.

Gottschaldt, K. (1926). Über den Einfluß der Erfahrung auf die Wahrnehmung von Figuren: II. Vergleichende Untersuchungen über die wirkung figuraler Einprägung und den Einfluß spezifischer Geschehensverläufe auf die Auffassung optischer Komplexe. *Psychologische Forschung*, **12**, 1-88.

Henderson, J. M., Pollatsek, A., & Rayner, K. (1987). Effects of foveal priming and extrafoveal preview on object identification. *Journal of Experimental Psychology: Human Perception & Performance*, **13**, 449-463.

Krasselt, A. (1990). *Chronometrische Analysen zur Erfassung von Teil-Ganzes-Relationen in Punktmustern und geometrischen Linienfiguren*. Unpublished doctoral dissertation, University of Leipzig, BRD.

Mens, L. (1988). *Can perceived shape be primed? The autonomy of organization* (pp. 81-102). Doctoral dissertation, University of Nijmegen.

Mens, L., & Leeuwenberg, E. (1988). Hidden figures are ever present. *Journal of Experimental Psychology: Human Perception & Performance*, **14**, 561-571.

Meyer, D. E., & Schvaneveldt, R. W. (1971). Facilitation in recognizing pairs of words: Evidence of a dependence between retrieval operations. *Journal of Experimental Psychology*, **90**, 227-234.

Palmer, S. E. (1977). Hierarchical structure in perceptual representation. *Cognitive Psychology*, **9**, 441-474.

Peterson, M. A., & Gibson, B. S. (1991). Directing spatial attention within an object: Altering the functional equivalence of shape description. *Journal of Experimental Psychology: Human Perception & Performance*, **9**, 183-193.

Reed, S. K. (1974). Structural descriptions and the limitation of visual images. *Memory & Cognition*, **2**, 329-336.

Sutherland, N. S. (1968). Outlines of a theory of visual pattern recognition in animals and man. *Proceedings of the Royal Society of Belgium*, **171**, 297-317.

van de Helm, P. A., & Leeuwenberg, E. L. J. (1991). Accessibility: A criterion for regularity and hierarchy in visual pattern codes. *Journal of Mathematical Psychology*, **35**, 151-213.

van der Vegt, J., Buffart, H., & van Leeuwen, C. (1989). The

"Structural Memory": A network model for human perception of serial objects. *Psychological Research*, **50**, 211-222.
van Leeuwen, C., & Buffart, H. (1989). Facilitation of retrieval by perceptual structure. *Psychological Research*, **50**, 202-210.
van Leeuwen, C. C., Buffart, H., & van der Vegt, J. (1988). Sequence influence on the organization of meaningless serial stimuli: Economy after all. *Journal of Experimental Psychology: Human Perception & Performance*, **14**, 481-502.
van Leeuwen, C., & van den Hof, M. (1991). What has happened to Prägnanz: Coding, stability, or resonance. *Perception & Psychophysics*, **50**, 435-448.

(Manuscript received September 20, 1991;
revision accepted for publication June 16, 1992.)