

EMBEDDEDNESS EFFECTS ON PART VERIFICATION IN CHILDREN AND UNSCHOOLED ADULTS

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Children from kindergarten, first- and second-grade, and unschooled adults were tested on a version of Palmer's (1977) task, which requires to detect a part within a figure. In positive trials, each part was paired with several figures that contained it so that different degrees of embeddedness were obtained. In this situation, any effect of the degree of embeddedness cannot be attributed to either the intrinsic properties of the part or an incorrect notion of part, as might be the case with the material previously used by Kolinsky et al. (1987). However, the main findings of this study were replicated. Unschooled adults, even those who have learned to read and write in special classes, were both very poor at detecting parts of low and medium goodness value, and not better than kindergarteners. First- and especially second-graders displayed much better detection performance. Thus, processes of visual postperceptual analysis that seem relatively unsophisticated may not develop spontaneously but rather under the influence of specific training provided in primary school.

Following Pomerantz (1986), one may define a form as "a collection of parts that possess emergent features" (p. 20), and a part as "any spatial component of the form" (p. 3). It is quite obvious that the same part may, depending on the form to which it belongs, be more or less accessible by scrutiny. The more a part configures with other parts into a form, i.e. the more its own features vanish behind the features of the whole, the less it will pop out of the figure. To Pomerantz (1986), "the likely reason (of the difficulty in recognizing embedded figures) is that the embedding process destroyed one set of features while it created another set" (p. 28).

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In the part-probe task the subject is required to say whether or not a form (the part) is contained in another form (the figure). In a former paper (Kolinsky, Morais, Cary & Content, 1987), we argued that this task might involve both a perceptual and what we call a postperceptual level of processing. In this view, we assume that the process of perceiving a figure is both analytical and constructive, i.e. that there is an early extraction of elementary parts (or features) and that these parts are progressively integrated until the final perceptual representation (let us call it percept) of the figure is attained. It is likely that, as suggested among others by Reed (1973) and Palmer (1977, 1978), at least some of these parts are encoded in the percept of the figure. Detection of these parts would require no postperceptual inspection. On the contrary, detection of the other parts would require some effort of conscious scrutiny, in other words, some postperceptual processing. This effort would be a function of the degree of embeddedness of the part-probe in the figure, i.e. of the degree to which the features of the part-probe are replaced by features emerging from the relationships between this part and the other parts of the figure.

A context-sensitive metric of the embeddedness of a part in a figure was developed by Palmer (1977) to predict the likelihood that various parts are encoded as structural units in the perceptual representation of figures like those presented in Figure 1. The method used consisted in representing the relationships between any pair of segments within a figure as numbers, and in formulating an algebraic function that would integrate these numbers in an appropriate way. The relationships between segments are based on the following Gestalt principles of grouping: continuity, proximity, connectedness, similarity in orientation, and similarity in length. For example, the closer together segments are to each other, the higher would be their value along the proximity dimension. A given pair of segments has a scale value for each grouping dimension; besides, each of the dimensions has some weighting parameter associated with it, whose magnitude depends on its salience for perceptual organization. The scale values are then combined to obtain a "total value" for the relationships between any pair of segments across all dimensions. For a given pair of segments, the total relational value is simply the sum of the products of weights and scale values over all grouping dimensions. So long, each segment has some relational value to each other segment in the figure. In order to combine relational values in a context-sensitive way, the author distinguished two classes of relationships: those that hold between pairs

within the group of segments (the part) whose goodness is being computed, and those that hold between pairs containing one group member and one non-group member. The numbers representing these relations are integrated into the goodness measure by computing, for all

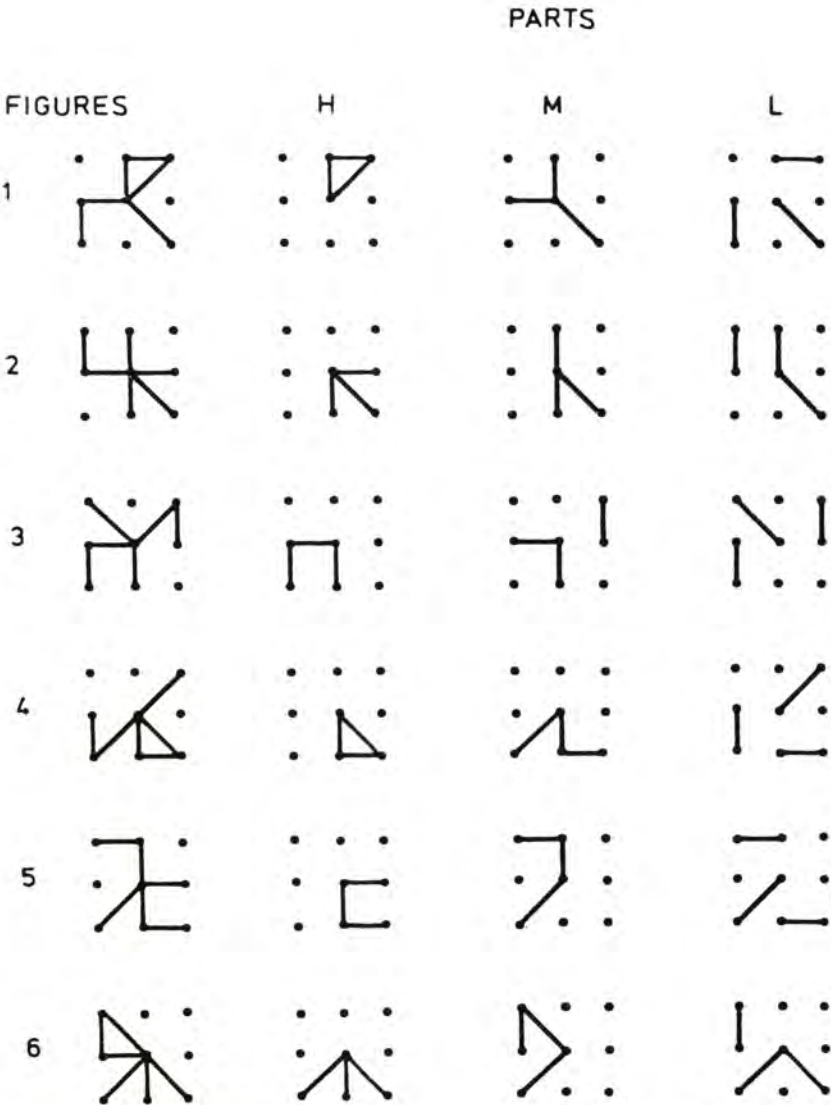


Figure 1. Total set of positive pairs used in Kolinsky *et al.* (1987), adapted from Palmer (1977).

within-group segments, the average difference between the values for within- and between-group relationships. Thus, the same part may have different goodness values in different figures.

On the basis of the measures derived from this function, Palmer (1977) constructed part-figure pairs of high, medium and low goodness value. These pairs provided the material for a part-probe task. Subjects' reaction times in this task showed that positive responses to part-figure pairs of high goodness value were much faster than to pairs of medium or low value. The process of part verification can thus not be only one of template or of segment-by-segment comparison. The parts of the pairs of high goodness value are likely either to be encoded as units in the percept of the corresponding figures, or, if they are not encoded in this way, at least to require much less effort of postperceptual inspection than the parts of the other pairs.

Kolinsky et al. (1987) carried out a developmental study of part verification using the kind of material devised by Palmer (1977). The subjects were 4- to 7-years old children and unschooled adults, rather than university students. Accuracy, not reaction time, was the dependent variable. On the average, all groups of subjects obtained relatively good scores on the part-figure pairs of high goodness value, but neither the preschool children nor the unschooled adults were able to find the more deeply embedded parts. This provides some additional support for the idea that, depending on the degree of embeddedness of parts, different processes (perceptual *vs* postperceptual) or unequal efforts of scrutiny are involved. It indicates moreover that the postperceptual processes necessary to find a deeply embedded part in a figure are neither built-in nor the consequence of cognitive maturation, but depend on instruction or experience usually provided at school.

There was however an important problem in our previous study (Kolinsky et al., 1987). As positive pairs, we only used what Palmer (1977) called "same-figure" trials, formed by pairing each figure with its own parts (Figure 1). With this material, the goodness of the part itself is highly correlated with the goodness of the relationship between the part and the figure. Indeed, the parts of the pairs of high goodness value have connected segments and, but for one exception, occupy only one quarter of the matrice, whereas the parts of the other pairs tend to be more extended over the matrice and, in many cases, consist of scattered segments. So it is possible that the children and the unschooled adults obtained a poor score on the trials of medium and low value because their notion of part was inconsistent with something large or

with a collection of three dispersed segments, rather than because they were deficient in visual postperceptual analysis. The literature on cognitive development has shown many examples of apparent inability which were actually due to a conceptual disagreement between the examiner and the subject.

Palmer (1977) also used another kind of positive trials (see Figure 2), formed by pairing a same part with several figures that contain it. He

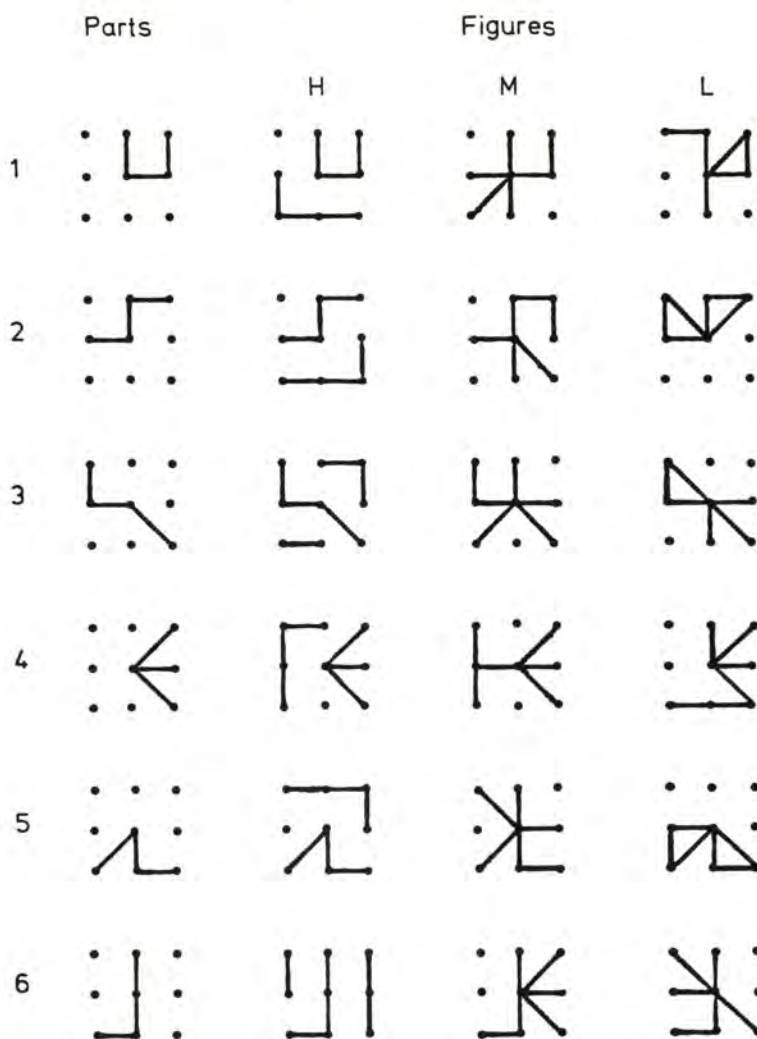


Figure 2. Total set of positive pairs used in the present experiment (adapted from Palmer, 1977).

obtained similar results for both types of trials. The interesting point is that, with this "same-part" material, any effect of degree of embeddedness cannot be related neither to the intrinsic properties of the part itself nor to a misunderstanding of what the target is. The present study, which used "same-part" rather than "same-figure" trials, was thus essentially aimed at avoiding this kind of biases, and thus at verifying the conclusion of a dramatic development of the ability of visual postperceptual analysis in relation with schooling.

METHOD

Stimuli

The stimuli (see Figure 2) were a subset of the Palmer (1977) part-probe task material. As in that study, we used three ranks of goodness values, called *high* (*H*), *medium* (*M*), and *low* (*L*). The goodness of each part-figure pair was computed by Palmer (1977) using his algebraic function described above. Figures and parts were always made out of six and three segments, respectively. For experimental trials, 6 different parts were used. For a particular part, there were three positive pairs (one for each level of goodness) and three negative ones. Negative pairs were those in which the part was actually not contained in the figure. One half of the negative pairs included parts that shared only one segment with the figure, the other half included parts that shared two segments with the figure. There was thus a total of 36 experimental pairs, 18 positive (6 for each goodness value) and 18 negative. Eight additional pairs were used as examples and training trials. Each stimulus was drawn in black ink on a 3 x 3 dot matrix. The matrice, 2 cm high and wide, was centered on a white card. Separate cards were used for parts and figures.

Procedure

On each trial, the experimenter showed first the six-segments figure, next the three-segments part. Both cards remained in view on a table in front of the subject until he gave an answer. The subject had to say whether he could "find the little part within the big drawing". The task was presented as being a hiding game in which "somebody had sometimes hidden the little part in the big drawing". The game consisted in "finding whether the part was present even when hidden". The instructions emphasized the non-figurative nature of the drawings.

The session began with two examples, 1 *M* pair and 1 negative pair. Then, 6 pairs were presented for a short training phase, including three positive pairs (one for each level of goodness) and 3 negative ones. During the training phase the responses were verbally approved or corrected. For the examples and the training trials the examiner used a transparent card on which the three-segments part was drawn in dashed line. The transparent was first superimposed on the part card, showing that they were identical. Next it was superimposed on the figure card, and the examiner called the subject's attention to the exact match between the three segments drawn on the transparent card and the corresponding segments in the figure. On experimental trials, all subjects received the trials in the same order, established to avoid the occurrence of more than three consecutive identical levels of goodness and of more than three consecutive identical responses (negative or positive). The whole session took about half an hour.

Subjects

Four groups of 12 children were taken from public schools in Brussels, Belgium. Each included 6 girls and 6 boys. One group (*2nd-level KG*) consisted of children in the second level of kindergarten: their ages varied between 57 and 65 months (mean: 5;2 years). Another group (*3rd-level KG*) consisted of children in the third (i.e. last) level of kindergarten: their ages varied between 62 and 80 months (mean: 6;0 years). The two remaining groups of children came from first and second grade classes in primary schools (1st graders, 2nd graders). The first-graders were aged 78 to 89 months (mean: 7;0 years). The second-graders were aged 91 to 101 months (mean: 8;0 years). All these groups were tested during the second part of the school year.

Twenty-four unschooled adults were found in Portugal, in peripheral areas of Lisbon. For social reasons these people did not attend school during childhood. At the time of testing, most of them were working as servants. Two groups of 12 subjects were constituted. One included 8 persons who had been attending evening literacy classes for 5 to 7 months, and 4 persons who never attended such classes. In order to distinguish them from the illiterate adults of Kolinsky et al. (1987), who had never received literacy instruction, this group will be called "nearly illiterates" (*NI adults*). They included 9 women and 3 men, aged 19 to 61 years (mean: 44;4 years). The subjects of the other group, which included 11 women and 1 man, aged 28 to 59 years (mean: 45;3 years), will be called "ex-illiterates" (*Ex-I adults*). They were people of the

same social origin as the NI adults but they had attended evening literacy classes as adults for at least two years and obtained, after successful examination, the corresponding certificate. They are roughly comparable to the ex-illiterates tested in Kolinsky *et al.* (1987).

RESULTS

Table 1. — *Mean Number of Correct Responses for Each Type of Pair, in Each Group*

Pairs	H (6 trials)	M (6 trials)	L (6 trials)	Negative (18 trials)
2nd-level KG	6.0 (0)	2.67 (0.47)	1.17 (0.69)	17.75 (0.43)
3rd-level KG	5.75 (0.6)	2.92 (1.32)	1.50 (1.5)	17.2 (0.80)
1st-graders	5.92 (0.28)	4.0 (1.35)	2.67 (1.37)	17.5 (0.65)
2nd-graders	5.92 (0.28)	4.25 (1.09)	3.67 (1.70)	17.67 (0.62)
NI adults	4.33 (2.01)	2.50 (1.66)	2.25 (1.63)	15.58 (2.33)
Ex-I adults	5.67 (0.62)	2.92 (1.11)	1.58 (1.04)	16.5 (1.50)

Note: Standard deviations are presented in parenthesis.

Table 1 shows for each group the mean number of correct positive responses according to goodness level, and the mean number of correct negative responses. An analysis of variance was carried out on correct positive responses, using group and goodness level as factors. It shows significant effects of group ($F(5,66) = 5.16, p < .001$) and of goodness level ($F(2,132) = 231.28, p < .0005$), as well as a significant interaction between the two factors ($F(10,132) = 4.07, p < .0005$). Let us first consider the group effect. Groups were compared to one another using Scheffé's tests with $p < .05$: both first- and second-graders are significantly better than each of the other four groups; no other comparison is significant. The goodness level effect was analyzed in the same way. Performance was better for pairs of high goodness value than for pairs of either medium or low value, and for pairs of medium than low value. Finally, note that even if the interaction between group and goodness level is significant, the group effect is significant within each goodness level ($F(5,66) = 5.31, p < .001$, $3.94, p < .005$, and $5.02, p < .001$, for pairs of high, medium and low value, respectively); similarly, the effect of goodness is significant within each group ($F(2,22) = 279.65, p < .0005$,

50.92, $p < .0005$, 26.48, $p < .0005$, 18.05, $p < .0005$, 9.42, $p < .005$, and 71.79, $p < .0005$, for 2nd-level KG, 3rd-level KG, 1st-graders, 2nd-graders, NI adults and Ex-I adults, respectively). Comparisons two per two of the performances obtained for levels of goodness in each group are all significant, except the comparison between pairs of medium and of low value in both the 2nd-graders and the NI adults.

The interaction between group and goodness level does not concern all possible pairs of groups. It comes out significantly when comparing 2nd-level KG to 1st- and 2nd-graders and to NI adults ($F(2,44) = 6.17$, $p < .01$; $F = 17.6$, $p < .0005$, and $F = 11.9$, $p < .0005$, respectively), and also when comparing 3rd-level KG to 2nd-graders, NI and Ex-I adults ($F(2,44) = 6.03$, $p < .01$; $F = 5.13$, $p < .025$, and $F = 6.25$, $p < .005$, respectively). The comparison between NI and Ex-I adults is also significant ($F = 5.07$, $p < .025$). All these interactions can be visualized in Figure 3.

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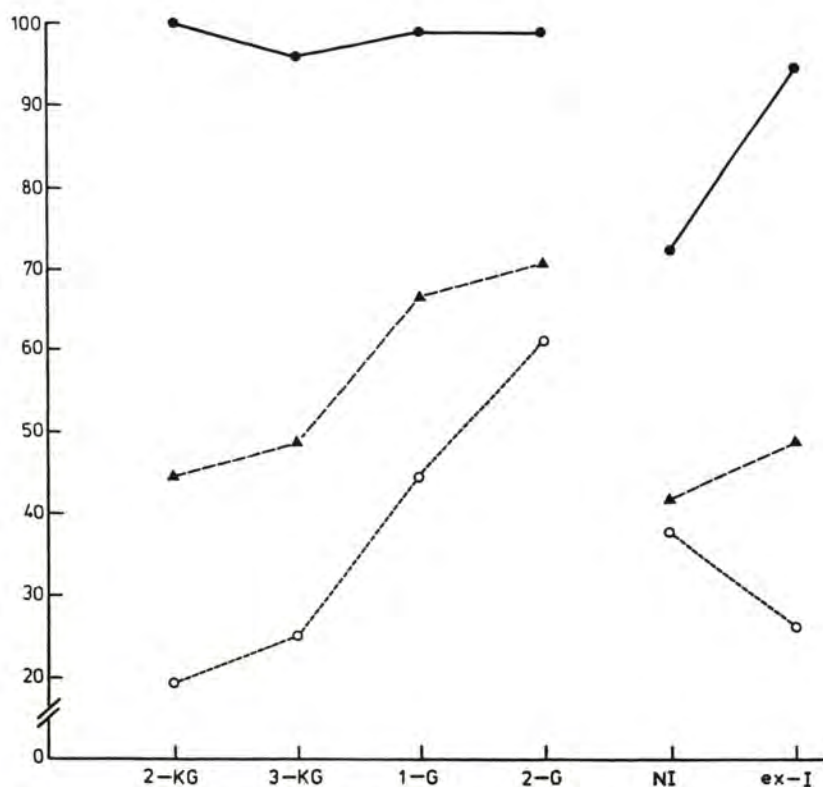


Figure 3. Percent correct detections for each group on positive pairs of high (●—●), medium (▲---▲) and low (○-----○) goodness values.

Moreover, it is worth noting that some groups presented large interindividual differences. The distributions of individual scores for the 12 pairs of medium and low value are presented in Table 2. For the pairs of high value, four NI adults obtained low or null scores (3, 2, 1, and 0). The pattern of performance of the 12 NI adults may thus be described in the following way. Two subjects were very good at all three kinds of trials. Six were very good at the trials of high value but obtained lower scores at the other trials. And four subjects were poor at every kind of trial.

Table 2. — *Number of Subjects Falling in the Following Categories of Performance: 0 to 3, 4 to 6, 7 to 9, and 10 to 12 Correct Responses, for the Twelve Positive Trials of Medium and Low Goodness Value*

Group	Number of correct responses			
	0 to 3	4 to 6	7 to 9	10 to 12
2nd-level KG	5	7	0	0
3rd-level KG	6	4	1	1
1st-graders	0	6	5	1
2nd-graders	0	4	4	4
NI adults	5	5	0	2
Ex-I adults	3	7	2	0

The percentage of correct detections for each positive pair is presented in Table 3. The six trials of high goodness value yielded the best scores. However, contrary to what might have been expected on the basis of both the goodness ratings and the reaction times obtained by Palmer (1977) on the same material with university students, trial P6,H did not yield the lowest but the highest score of its category. In addition, two trials of medium goodness value (P4,M and P6,M) yielded scores that were almost as good as the trials of high goodness. The very low score obtained for trial P2,M was consistent with the slow mean reaction time obtained by Palmer (1977) for this trial, but it was unexpected on the basis of the goodness rating. On the whole, however, there are strong correlations between the present scores and either the goodness ratings or the mean reaction times obtained by Palmer. Even if one takes into account only the trials of medium and low value, the correlation of these scores, averaged over the six groups, is .78 ($p < .001$) with the goodness ratings, and -.63 ($p < .001$) with the reaction times. No such associations were found in the previous experiment

for the pairs of medium and low value of the "same-figure" material: the correlations with the goodness ratings and the reaction times were .22 and .16, respectively.

Table 3. — *Percentage of Subjects Who Have Correctly Detected the Target in Each Group and for Each Positive Trial*

Item Goodness RT ratings			Percentage correct detection						Total
			Kindergarten		Primary		Adults		
			2nd	3rd	1st	2nd	NI	Ex-I	
P2,M	5.25	1887	0	8.3	16.7	25.0	25.0	0	12.5
P1,L	3.50	1202	0	8.3	16.7	50.0	16.7	0	15.3
P2,L	3.06	1493	0	8.3	16.7	41.7	25.0	8.3	16.7
P5,L	2.62	1252	0	16.7	25.0	58.3	41.7	8.3	25.0
P3,L	3.19	1440	0	25.0	50.0	66.7	25.0	8.3	29.2
P3,M	5.56	1495	0	8.3	41.7	66.7	41.7	16.7	29.2
P5,M	6.37	1386	0	41.7	58.3	41.7	16.7	33.3	31.9
P6,L	5.50	1093	33.3	33.3	83.3	91.7	58.3	66.7	61.1
P4,L	5.00	1208	83.3	58.3	75.0	58.3	58.3	66.7	66.7
P1,M	8.75	917	33.3	75.0	91.7	91.7	41.3	50.0	69.4
P4,M	8.75	1136	100	66.7	100	100	58.3	100	87.5
P6,M	7.75	1284	100	91.7	91.7	100	66.7	91.7	90.3
P3,H	9.81	901	100	100	100	100	58.3	91.7	91.7
P2,H	9.81	751	100	100	100	100	66.7	83.3	91.7
P1,H	9.94	755	100	91.7	100	100	66.7	100	93.1
P4,H	9.87	812	100	91.7	100	100	75.0	91.7	93.1
P5,H	9.87	790	100	100	100	91.7	75.0	100	94.4
P6,H	8.19	1092	100	91.7	91.7	100	91.7	100	96.0

Note: Pairs are listed according to the labels (figure number and goodness level) in Figure 2, and presented in increasing order of the performance estimated over the entire sample. The second and third columns indicate the mean goodness ratings (on a scale from 1 to 10) and mean reaction times obtained by Palmer (1977).

DISCUSSION

Large differences were observed in detecting a part within a figure as a function of the goodness of the relationship between the part and the figure. Since in the present "same-part" material devised by Palmer (1977) each part intervenes in one trial of each goodness category, high, medium and low, the effect of goodness category cannot result from intrinsic properties of the part nor from inadequacy of some targets to the subjects' notion of part. Performance on the trials of medium and low goodness value was rather poor (less than 40% correct detections)

in kindergarteners but clearly increased in first- and second-graders (around 55% and 65%, respectively). Quite interestingly, performance on these trials was not better in unschooled adults than in kindergarteners. The present results thus confirm what had been concluded from those previously obtained with the "same-figure" material on similar populations (Kolinsky et al., 1987): the processes necessary to verify the presence of a part in a figure are poorly developed in people who did not benefit from the kind of instruction provided by the primary school. Thus, these processes are not the consequence of mere cognitive growth but develop under the influence of some training.

In the Introduction, we assumed that perception is an analytical and constructive process starting from features that are integrated in a final representation. This general model is represented for example by Treisman's feature integration theory (Treisman & Gelade, 1980). The odd thing about the present research is that it uses what seems to be a Gestalt-like, anti-analytical and anti-constructive phenomenon (e.g., Gottschaldt, 1926). Indeed, the embeddedness effect is often taken as showing that perception starts from the whole and requires a lot of scrutiny to get at the level of more primitive parts. However this apparent contradiction between our theoretical framework and reported research disappears when one takes the (often overlooked) distinction between perceptual and postperceptual processing into account. As Treisman (1986, p.35-39) herself assumed, one of the differences between early and late processes (that we call perceptual and postperceptual, respectively), might be that the first ones are obligatory and built-in, whereas the second ones are optional, strategic, special-purpose, and may be set up through learning. So, the fact that schooling effects are observed on the detection of deeply embedded parts suggests that the process involved are postperceptual in nature. In other words, the embeddedness effect by itself does not allow one to draw a general conclusion regarding the order (or relative facility) of perceptual processes. That conclusion has to be restricted to the processes under inspection, which, in the part-detection task, are post-perceptual in nature. Of course, such a strong assumption needs independent, converging evidence. Such converging evidence was reported by Kolinsky (1988): unschooled and schooled people do not differ at the level of early, preattentive analytic capacities. As a matter of fact, illusory conjunctions (cf. Treisman & Schmidt, 1982), which are indicative of early attribute separability, were found to be as frequent in unschooled illiterate adults than in sophisticated people. For example, diagonal

lines of right-angle triangles were combined at similar rates in both populations with S signs to form illusory \$ targets (this material was originally designed by Treisman & Paterson, 1984, Exp. 4). If unschooled adults analyze segments preattentively in much the same way as schooled adults do, the present results as well as those reported by Kolinsky et al. (1987) should only concern later, postperceptual analytic processes. Thus, our general conclusion is that the kind of componential analysis that is involved in Palmer's (1977) test is a sophisticated cognitive ability which does not develop spontaneously but requires a great deal of relatively specific experience.

Some differences between the present and the previous results deserve commentary. One concerns the pairs of high goodness value. For these pairs, while with the "same-figure" material both the second- and the third-level kindergarteners obtained scores that were far from perfect, with the "same-part" material even four- year old children displayed perfect performance. This discrepancy is, in all likelihood, related to differences in the spatial relations between the target and the rest of the figure. In the "same-figure" material there is always one point of contact between the part and the rest of the figure, whereas in the present material the part and the rest of the figure are always spatially separated. Thus, in the "same-part" material, the part has to be perceived as identical to the probe in the card said to contain the figure, but its own features are maintained and it does not have to be recovered from the figure by some process of postperceptual analysis.

What also needs an explanation is the much lower performance of the nearly illiterates on the high goodness value trials, in comparison with every other group. As described in the Results section, eight of the nearly illiterates obtained good scores but four obtained poor scores on high goodness trials. Given that the postperceptual component of the task, as far as the trials of high goodness value are concerned, is at most very weak, and given that no subject complained of poor vision, the most likely explanation for the performance of those four subjects is that they misunderstood the task. Their performance on the negative trials was essentially correct. Thus, these four subjects may have accomplished the task as if it were a "same-different" one. It is worth noting that no problem of task comprehension seems to have aroused in the other groups, even in the youngest kindergarteners. The fact that the nearly illiterates form a heterogeneous group in terms of literacy classes attendance (see Method) does not seem to be relevant: two of the poor subjects were attending such classes and two were not. A few

months of exposure to reading instruction is thus probably insufficient to guarantee correct comprehension of the present kind of tasks.

All groups of children have shown a curious interaction between material (experiment) and medium *vs* low goodness category. While for the trials of medium value, performance did not largely differ between the two experiments, for the trials of low value much lower performance was obtained for the "same-part" than for the "same-figure" material. This last result may be linked to the fact that in the "same-part" material the target is made of connected segments while in the "same-figure" one the target is made of scattered segments. It is possible, of course, to look for the connected-segments target in the figure in a sequential way, i.e. segment by segment. However, the results suggest that either the children did not use this strategy, or they used it but were negatively affected by the necessity to separate the segments of the target. Since the unschooled adults do not show the same material effect on the trials of low value, and instead display somewhat better performance with the "same-part" material, it is more likely that children tended to use a "holistic" strategy, i.e. to look for the entire target in the figure.

Also contrary to the previous experiment reported by Kolinsky et al. (1987), performance was better on the trials of medium than on the trials of low goodness value. On the whole, the goodness categories, the goodness ratings and the reaction times produced by Palmer's (1977) subjects represented a better prediction for the performance of our subjects with the "same-part" material than with the "same-figure" material used in our previous experiment. However, as suggested by Kolinsky et al. (1987), the goodness value derived by Palmer's algebraic function may provide an approximation of the degree of embeddedness that is precise enough to fit the performance of subjects who have a highly developed ability of visual postperceptual analysis, but may not be appropriate to account for the performance of less sophisticated people. Indeed, it is only indirectly that Palmer's (1977) algebraic function takes higher-order relationships between more than two segments (e.g., closedness) into account. For both children and unsophisticated adults, who might be less prone to disregard the emergent features of the figure, these higher-order relationships ought to be considered (see also the item analysis made by Kolinsky et al., 1987).

The effect of schooling seems to occur earlier with the present material than with the "same-figure" one. While with the "same-figure"

material there was still no sensible difference between kindergarteners and first-graders as a group, with the "same-part" one the difference between first-graders and kindergarteners is more marked than between second- and first-graders. Since the strategies of part verification may not be the same with both materials, more systematic work is necessary on this particular point. One possibility is that children begin to avoid the holistic strategy before they become able to verify the presence of each segment in the figure accurately.

Finally, it should be noted that the tremendous role that schooling plays in the development of the ability of part verification does not imply that this ability cannot develop out of schooling. Interestingly enough, one of the nearly illiterate subjects, who is house-painter, obtained an almost perfect score, missing the target in only one positive trial (P2M) and making only one false alarm on the negative trials. Some kind of experience, other than that provided in normal school, can thus elicit the ability of visual postperceptual analysis. That experience must nevertheless be quite specific. Both everyday life activities of the major part of unschooled adults and the reading and writing activities of ex-illiterates do not help them to detect embedded parts. On the other hand, ex-illiterates show no special difficulty in tasks requiring to analyze speech utterances into their phonemic constituents (see for instance Morais, Cary, Alegria and Bertelson, 1979, and Morais, Bertelson, Cary and Alegria, 1986). Thus, there seems to be no general competence of postperceptual analysis. Different abilities of postperceptual analysis would develop under the influence of specific kinds of experience to deal with particular types of objects and events. Indeed, schooling is a rather imprecise variable since it includes a large variety of activities. Thus, the study of schooling effects on the development of a particular postperceptual competence can hardly contribute to determine the exact nature of the crucial experiences. As a first approach to this problem, we are currently testing unschooled people with different kinds of professional experience. The preliminary results suggest that for example unschooled lace-makers and seamen navigating in the starlight do possess particularly well developed post-perceptual analytic capacities (Kolinsky, Verhaeghe, Grimm-Cabral & Morais, 1989; Verhaeghe & Kolinsky, 1988). Training programs would however be necessary to provide a better assessment of the crucial experiences.

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