axons – becomes PV, whereas the former PV and now PD would be the last to receive this fibres by day 12–13. On this basis, one of the possible explanations for the wave of increasing levels of CAT activities across the tectal surface could be the presence of this enzyme in the growing axons. The absence of regional differences in enzyme levels, both at the 6th and at the 13th day of development, could be related to the fact that the former still lacks retinal afferents while the latter is fully covered by them. Although it may be worthwhile to further explore this possibility, there is some evidence that seems to indicate that optic fibres are not cholinergic[11].

Table III. Activities of CAT and AChE in quadrants of 9-day-old tectum

	AChE		CAT	
PV	12.71 ± 0.56		1.78 ± 0.12	
		$p < 0.2$		$p < 0.005$
AV	11.20 ± 0.62		1.24 ± 0.15	
		$p < 0.2$		$p < 0.2$
AD	12.39 ± 0.97		0.90 ± 0.094	
		$p < 0.2$		$p < 0.01$
PD	11.48 ± 0.36		0.64 ± 0.092	

For references see Table I.

Table IV. Activities of CAT and AChE in D and V halves of 13-day-old tectum

	AChE		CAT	
V	19.56 ± 0.52		2.61 ± 0.15	
		$p < 0.1$		$p < 0.2$
D	18.12 ± 0.67		2.85 ± 0.18	

For references see Table I.

On the other hand, the augmentation of CAT activity might depend upon transneuronal influences exerted by the incoming retinal fibres upon the tectal cells. This possibility is suggested by the results obtained in our laboratory which showed that, when dissociated retina cells and optic lobe cells are allowed to form mixed aggregates in culture conditions, the activity of CAT but not of AChE is higher than that present when each cell type is cultured alone[12,13]. In order to account for the differences found between the two basal quadrants or the two dorsal ones, it would be necessary to postulate that the interaction is dependent either upon the number of optic fibres that are present or upon the time they have been in contact with the tectal cells.

Alternatively, the gradient in CAT activity present in the tectum of 9-day-old embryos could be the biochemical expression of the autonomous AV-PD wave of morphological differentiation[2,4]. For instance, the level of enzyme activity might depend on the differentiation of a certain type of cholinergic neuron, still absent in the 6-day-old embryo, preferentially localized in the ventral area of the tectum 3 days later and uniformly distributed throughout the optic lobe at the 13th day of development. Since there are some indications that up to the 12th day of development both the morphological and biochemical differentiation of the tectum are independent of the presence of retinal afferents[4,14,15], the sequential increase of CAT activity can also be an intrinsic property of the tectal cells.

Although this study clearly shows the existence of regional differences in CAT activity in the developing tectum, the causal relationship between the retinal fibres and the increased levels of CAT activity in the tectal regions covered by them, remains a critical question. Experiments in progress in our laboratory are aimed to determine the effect of early deafferentation on the temporal sequence of biochemical differentiation of the tectum.

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Dyslexia and Specifically Distorted Drawings of the Face - a New Subgroup with Prosopagnosia-Like Signs

A. A. PONTIUS[1]

New York University, School of Medicine, Department of Psychiatry, 550 First Avenue, New York (N. Y. 10016, USA),
22 March 1976.

Summary. Identification of a subgroup (38%) of dyslexics (new syndrome?). These, against controls (5.5%), drew 'neolithic' face configurations analogous to those visually experienced in prosop-agnosia. Essential symptoms of this subgroup are seen as result of specific early ways of processing visual data: lexical shapes (letters, words) and facial features, as if these were concrete entities, not abstract component parts. Thus, with letters, taken as entities, d = q, d = b, N = Z.

This study is based on the following two positions, discussed by CRITCHLEY[2] and based on the definition of dyslexia by the World Federation of Neurology as 'a disorder in children, who, despite conventional classroom experience, fail to attain the language skills of reading, writing and spelling commensurate with their intellectual abilities'[2]: 1. In general, the incidence of dyslexia is known to decrease with increasing age, but in particular cases it may persist. 2. This suggests that specific neurological dysfunctioning exists alone or combined with a developmental lag in a certain subgroup of dyslexics. (Both these factors may show a familial trend as well.) The purpose of the present study is to attempt a delineation of some specific neurological factors in such a subgroup of dyslexic children. About children with dyslexia there is, however, no direct neuro-pathological evidence available[2] for classical clinical-pathological correlation. Therefore the indirect approach of testing the following working hypothesis will be used.

Based on the above mentioned aspects and on analyzing essential symptoms of dyslexia, it is hypothesized that in a subgroup of dyslexic children the *form* aspect of their reading disabilities is reflected analogously in specific distortions in these children's drawing (and most probably experiencing) of the human face pattern. The lexical shapes and the facial features are selected for comparison, since for both the recognition of fine nuances is essential in order to differentiate the individual class members, an ability that develops later, while at first the child reacts to the face pattern in a global way and may do so with the lexical symbols too.

Method. To test the hypothesis, 304 school children between 7 and 14 years of age and, according to the school records, of at least average intelligence, were each asked to draw by themselves one picture of any person

Results of draw-a-person tests

Reading ability			
Drawings of face	Dyslexic	Normal	n
'Neolithic'	40	11	51
Normal	65	188	253
Total	105	199	304

$\chi^2 = 49.91$; $p = <0.001$. Distribution between the 2 'neolithic' types (Figure 1) and 'normal' types of face drawings: NGr-drawing (10 boys and 2 girls); NGl-drawing (22 boys and 4 girls; 'normal'-drawing (47 boys and 19 girls).

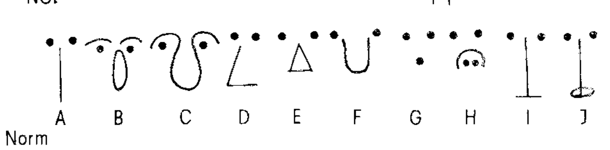

Fig. 1. Patterns of forehead-nose-eye sector of face on frontal view. NGr and NGl, 'neolithic': direct continuation of forehead into nose in the vertical mid-sector. NGr, line swinging along upper border of eyes or eye-brows and around the contour of the nose without any narrowing or indentation at its bridge. NGr-subtypes A and B are common, C–G are rare in this sample. NGl, straight, non-indentated, uninterrupted midline vertical as the nose, which begins above upper border of eye level. NGl-subtypes, A is common, B–E are rare. NR, not ratable intermediary type. Though its nose starts above eye level, its narrow angle nose in half-profile indicates bridge of the nose. Norm, 'normal' variations A–J. All depict the bridge of the nose through one or more of the following indicators: a) narrowing or b) indentation at the bridge, c) nose begins at or below eye level, d) there is no direct emerging of the nose out of the forehead.

on frontal view but otherwise any way they wanted. The Ss consisted of 105 dyslexic school children (78 boys and 27 girls) and a control group of 199 normal readers (92 boys and 107 girls). The whole group was composed of 1. the entire population of all the classes that were available for testing in an elementary school in Heidelberg, Germany – including its one special class for dyslexics; 2. the total population of a special extra-curricular remedial reading program for dyslexics, attended by dyslexic children, also of age 7 to 14, from various schools in the vicinity of Heidelberg. The classification of dyslexia (operationally defined) had in all cases been made by the respective professional personnel. The drawings obtained were classified according to whether or not they showed one of the two types of 'neolithic' face configuration (Figure 1, NGr or NGl), or whether they used the usual other ways of representing a human face in a recognizable manner. The latter, which showed some kind of representation of the bridge of the nose, were all rated as 'normal' in context of this study. None of the Ss was said to have had any instruction about how to draw a human face, the drawing of which was only taught in the last years of schooling, i.e. to youths older than the Ss. (As an aside, it may be of interest that there also exists no custom comparable to the American Hallowe'en, a feature of which is the 'face' cut in a pumpkin with the characteristic tiny, deep set triangular nose. This could influence some American children's face drawings, as may be attested to by the observation that such a face constellation is one of the frequent responses to card I on the Rorschach test.)

Results. These are summarized in the Table and confirm the hypothesis that there is a statistically significant (p 0.001) difference in the occurrance of 'neolithic' types of face representations in the drawings by dyslexic children as compared with those made by the control group. Figure 2, A and B depicts all the 'neolithic' face configurations drawn by 40 dyslexic Ss, ordered by age-range.

Discussion. The results could be judged as being non-relevant only if the face pattern would not hold a specific significance. However, the human face apparently represents to the onlooker a specific pattern[3,4] and thereby contributes specifically to the neuro-development of certain cognitive functions, as may the hand. KLEIN[5] associates the cognition of the hand in its fine nuances of form and movement (in contrast to its function as a 'primitive organ of grasping') with the process of learning to calculate and to write. He recalls the often documented association of finger-agnosia with acalculia and agraphia, such as in the GERSTMANN[6] syndrome. (It is irrelevant in the present context, whether or not this syndrome in its entirety is fictitious[7].) The present findings suggest an analogous association between the maturation of the ability to recognize individual nuances of letters, syllables or words, i.e. to read (and thereby to write) for

[1] This study was made possible by a visiting professorship at the University of Heidelberg, Department of Neurology. Thanks are due to its Director, Professor Dr. HEINZ GÄNSHIRT, as well as to Director SCHMITT of the Heidelberger Schulamt and to Psychologist Gret RUDER-TRÜMPY for facilitating the collection of the drawings.

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one and secondly of the ability to recognize fine nuances in the individual variations of the human face pattern. BENTON and VAN ALLEN[8] gather from the literature that in prosopagnostics there frequently exists also 'defective recognition of symbols (e.g. red cross and swastika)'.

In the context of neuro-developmental phases, the results identify a subgroup of dyslexics. These draw the human face in specific configurations that are seen in 'neolithic' art[9] and are also preferentially reacted to with the infant's 'smiling response' up to 18 weeks of life[10]. Finding 'neolithic' types of face drawings in 38% of the dyslexic Ss is of heuristic value by itself, even if no further known symptoms or signs were associated with this combination. (It has to be recalled, that 'neolithic' face drawings are not only rare among the control Ss (5.5%), but even more rarely are they depicted in the literature on children's drawings, nor have they, to my knowledge, ever been commented upon in such works[11,12], nor in the relevant neurological literature, not even when a brain-lesioned (right parieto-occipital) patient produced them[13,14]. It is only in a later phase that the face pattern is analyzed in all its actual details and synthesized in a manner that apparently also contributes to the ability to read.

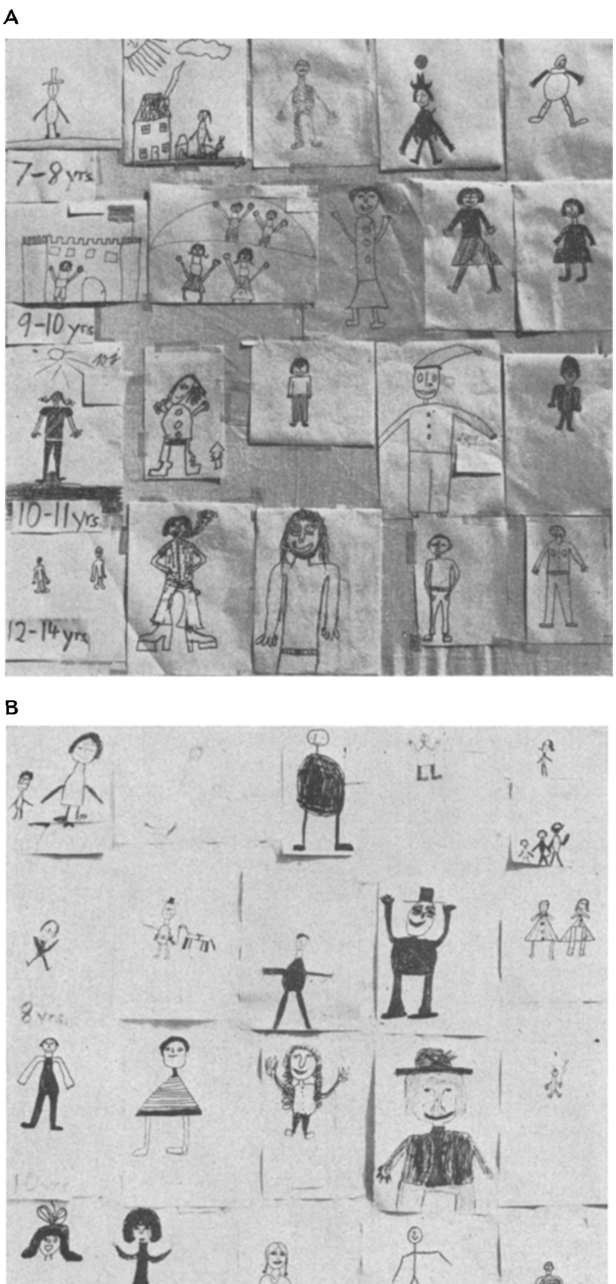

Fig. 2. A) and B). Complete set of 'neolithic' face configurations drawn by 40 dyslexic Ss (38%), ordered by age-range.

Based on such new theorizing, the two symptoms of the new subgroup (dyslexics drawing 'neolithic' face patterns) reveal a common denominator of being based on a concretistic, immediate and inflexible reaction to globally experienced ideograms or ideogram-like face patterns, respectively. By contrast, the children who read well and who draw the human face in the usual 'normal' way (Figure 1) use in both these abilities an analysis and synthesis of lexical symbols (be they the size of words, syllables or letters) or of facial features, respectively, while experiencing these as abstract component parts. By contrast, certain dyslexics still react to them, as if they were concrete entities in themselves, building blocks, as it were. In so doing, the exact position of a lexical symbol loses its meaning and therefore may not be remembered either when writing. Thus, taken as such a concrete 'building block', a lexical symbol might be turned upside down (e.g. d = q), or turned by 90° (e.g. N = Z), or turned right or left (d = b), nor would its exact position of detail matter (e.g. e = c = o), nor what the sequence of such concrete entities should be (e.g. form = from).

The data may reveal a new syndrome. Since persons draw objects the way they experience it, and since there exists a structural analogy between 'neolithic' face representations and the prosopagnostic's way of experiencing the face[10,15], it appears reasonable to assume that either in the past or still at present, this subgroup of dyslexics may also have been actually perceiving the face as a global pattern, i.e. in a prosopagnosia-like manner. This may not have occurred necessarily to a grossly distorting degree, but may have been sufficient to induce 38% of the Ss to draw the face in a configuration analoguous to that experienced in prosopagnosia. (The term prosopagnosia-like is used to emphasize the difference between the dysfunctioning of a brain-lesioned adult (involving mostly right occipital region[16,17]) who had previously attained the ability to read and then lost it, and a child in a developmental phase wherein he has not yet learned to read.) As had been discussed previously[10,15], prosopagnostic patients experience the faces as 'flattened out' or 'without any relief'[16]. Such characterization is also the hallmark of 'neolithic' face configurations in art: the 'flattened out' appearance gives the impression of a

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forehead-nose continuum, whereby the bridge of the nose is obliterated, by not showing any indentation, narrowing or other indications for it (Figure 1, NGr- and NGl-types).

For delineating a new syndrome, the present data would be greatly enhanced if additional information were available on the Ss's acumen in recognizing actual individual faces. They themselves would most likely be unaware of any disability in this respect, as are most prosopagnostic adults, who orient themselves by features other than the most involved upper portion of the face. Tests on face recognition have grave limitations too, as MEADOWS[17] emphasizes, moreso as clinically prosopagnostic patients often do well on such tests.

A review[18] of the neurological literature on brain-lesioned prosopagnostic patients shows some reports in which there also existed reading disturbances – at least in the beginning (JOSSMANN[20], HOFF and PÖTZL[21], FAUST[22], BODAMER[16], HEIDENHAIM[23]), while others did not report about such association (HÉCAEN et al.[18], WILBRAND[24], DONINI[25], FAUST[26]). In addition ENGERTH[19] discusses the case of a brain-lesioned prosopagnostic with 'reading disturbances'. Their specific pattern, though not commented upon, supports the here postulated analogy between the global manner of approaching the face pattern (especially its upper part 'eye and nose') and letters, syllables or words (frequently 'turning letters up or down', distorting words by reading and writing them 'in a reversed manner'). Another patient of ENGERTH[19] with cerebral contusion had a temporary defect in reading and drew a neolithic-like face configuration, though again not commented upon. (Supporting KLEIN's[5] hypothesis, this patient had also finger agnosia, acalculia and right-left distortion and drew a 'paw-like' hand.)

Thus, these brain-lesioned cases[19] also suggest that a '*de-differentiation*'[5] *in experiencing* hand and face reveals specific features, that are congruent with an early and more primitive utilization and cognition, respectively, of both these essential body parts.

Identification of a new clinical subgroup or new syndrome – aside from its heuristic value – opens the way for an early diagnosis with practical implications.

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Experimental Coupling of Crab (*Carcinus maenas*) Second Maxilla Neural Motor to an Alternating Current

J. B. PILKINGTON[1]

Department of Zoology, University of Otago, Box 56, Dunedin (New Zealand), 20 April 1976.

Summary. Movements of the crab gill bailer were entrained to an alternating current applied to the thoracic ganglion. There was little distortion of the muscle recruitment cycle, both absolute and relative coordination were observed, and the phase of the driven system in the driving cycle was a function of the difference between free running and driving frequencies.

The suboesophageal ganglion of decapod crustaceans generates a rhythmic pattern of motor activity driving the muscles of the 2nd maxilla in a restricted number of recruitment sequences to produce either forward or reversed beating of the gill bailer[2]. Loose bilateral coupling of the bailers in a preferred phase relationship has been observed[3]. Experimental coupling of the 2nd maxilla neural motor to an external signal could be used to locate the neural oscillator, and, if the coupling were tight, to set its period so that signal averaging techniques could be used for analysing small electrical events recorded in the neuropile.

The possibility of achieving an experimental coupling was investigated using *Carcinus maenas*. The animals were dissected to expose the suboesophageal ganglion and the muscles of the 2nd maxilla.

If the recruitment sequence is driven by quasi-sinusoidal variations in the membrane potential of a single oscillator neurone[4], a slowly alternating current might be a suitable entraining signal. This sort of signal was chosen for these experiments.

The entraining signal was applied to the dorsal surface of the ganglion through a suction electrode, orifice diameter 0.3 mm. Alternating current was drawn from a low impedance source and taken to the suction electrode through a 50 Ω series resistance. A silver chloride reference electrode encircled the suction electrode near its tip. The voltage developed across the electrodes and 50 Ω resistance was monitored using a chart recorder.

Entrainment was observed to signals of 0.3–11.0 V peak-to-peak; a signal of about 5.0 V peak-to-peak was generally used in these experiments. It is probable that with the concentric electrode system the electric field strength attenuated rapidly with distance from the suction orifice.

Electromyograms from 2 bailer muscles were also recorded, so it was always possible to determine whether the bailers were being driven in the forward or reverse modes. The results here are derived from forward mode recordings only.

A short section of a recording is shown in Figure 1. The muscle recruitment sequence became entrained to the driving signal within one cycle, although in other experiments the stable phase relationship was reached only

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