Through The Looking Glass Darkly: A Story of Trace Mineral-Induced Behavioral Disturbance and Hair Mineral Analysis

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In 1871 Charles Lutwidge Dodgson, alias Lewis Carroll wrote his elegant allegory Through the Looking Glass. This dream narrative, which exploits aberrant logic and altered states of consciousness, is unique in the use of a bizarre medley of characters. Each of these characters can be looked at in light of today's evolving view of the molecular aspects underlying mental dysfunction. Although Carroll himself may have meant characters such as Tweedledum and Tweedledee to represent Berkeleian metaphysicians that bespeak the influence of Leibnitz, Alice herself a step ahead of Frege in discovering the difference between Sinn and Bedeutung, and the Hatter, March Hare and Dormouse all other philosophical personalities during the Middle Ages and Renaissance period, we may reinterpret these characters (and the story in general) in light of their biochemical typology as be-haviorally dysfunctional individuals. The Mad Hatter obviously can be looked at in terms of his excessive body burden of the toxic minerals, such as mercury, which cause neurologic change. The Queen, whose obesity, excessive eating, and mood changes suggest a glucose intolerant individual with the potentiality of an excessive copper body burden which produces behavior changes reminiscent of schizophrenia, is another reinterpretation of Carroll's character. The Rabbit, of course, with his hyperactive, never-quiet cast in the story is obviously an individual suffering from environmental sensitivities, be it colors, petrochemical additives, or possibly the caffeine consumed at the tea party. The King, with his inability to make decisions and milk-toast approach to problem solving, is obviously an individual suffering from a zinc deficiency and hypotestosteronism, whereas the Caterpillar is the active partaker in psilocybin-induced altered states of consciousness. Given this beautiful allegory, using this symbolism to explore the potential biochemical mechanisms underlying behavioral dysfunction, it can be noted that many of the characters' behavioral problems can be traced to essential mineral imbalances or toxic mineral excesses. As was the case in the 19th Century with regard to excessive exposure to many of the toxic elements, so it is even more in the 20th Century, where we are as a society being constantly exposed to elements such as mercury, cadmium, lead, aluminum, and arsenic in excessive levels and, coupled with this, experiencing a deficiency in our foods of many of the essential minerals such as zinc, iron, and manganese which can counteract the deleterious effects of the toxic minerals.

Two recent case histories from our clinic illustrate this point very nicely. The first is that of a fifteen-year-old young man, J.R.,

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who has been traditionally a high achiever in school, with a straight-A average, and a very accomplished musician. Over a period of several years, however, going through junior high school into high school, he was afflicted with ever-increasing severity of headaches, eyesight problems, and the inability to concentrate. His problem became so acute that it jeopardized his whole scholastic record and made his life both with parents and himself a great worry for future achievement. Several physicians had been unable to locate the root of his particular problem and attributed much of his behavior change to his inward psychological pressure to achieve, coupled with his parents' aspirations for him. Upon reviewing his laboratory data, however, it was found that the tissue mineral analysis of his hair showed patterns of all the nutritional elements being extremely low. Copper, iron, zinc, manganese, and chromium were all found to be two standard deviations or more lower than the acceptable mid-line normals. This result encouraged us to examine his serum and urinary levels of the various trace minerals and they were also subsequently found to be quite low. This pattern is often found to accompany malabsorption syndrome caused by potential gastrointestinal mucosal changes, hypo-chlorhydria, or pancreatic insufficiency, or a potential hyperproliferation of colon bacteria (Berg et al., 1978). Upon further workup it was found that J.R. had an elevated urinary indican, suggesting that bacterial hyperproliferation may have been contributing to the malabsorption. He was placed on a bowel detoxification program for some three months, and his hair and urinary levels of trace minerals were checked at the end of this time. Not only had his hair trace mineral pattern become much more normal, but his headaches had become much less severe and less frequent and his vision had returned to normal so that he could once again read for long periods of time and participate once again in his school band and orchestra. After six months on these programs his headaches had completely gone into remission and his grades returned back to normal and his

parents expressed the fact that he was like a new boy.

The second notable example in this regard is the case of a one-and-a-half-year-old child, who was recently seen in our clinic with the complaint that the child cried excessively and seemed to be a very unhappy baby, even in the face of considerable loving by the parents and a very supportive environment. Again, the workup included a hair tissue trace mineral analysis and it was found in this case that the hair pattern suggested extremely elevated lead and calcium levels for this youngster. The parents had their hair tissue checked for lead, as well, and it was found that the mother had excessively elevated lead, whereas the father had high-end-of-normal lead concentration in his hair. Serum studies done on the youngster indicated that the blood lead was elevated at 40 mcg/dl (normal range 0-20 mcg/dl). The physician attending the child prescribed a program which was focused at displacing the lead and facilitating its removal by the use of oral chelating supplements, coupled with appropriate toxic mineral binding foods, such as unsweetened apple sauce. The parents remarked after the first two weeks of the program that the child's behavior and demeanor had changed appreciably. The child smiled more, was more attentive and responsive, and cried much less frequently. After three months on the program a hair tissue sample was again obtained and the lead level was found to be significantly less than the previous sample. Although this is not absolute confirmation of the intimacy of lead and the behavioral changes observed in this child, it is certainly highly suggestive an,d once again points the finger toward trace mineral imbalances and toxic mineral excess contributing to behavioral dysfunction. Consider the teen-age boy. If he had continued over a period of years to suffer from a lack of nutrients essential for his growth and development, both mental and physical, what might have happened to him? It is quite likely that he would have dropped out of high school, and because of the severe headaches, would have lost his interest in music. By the time he would have

reached his twenties, he probably would have become estranged from his parents. His parents, who would have been told over this period of years that their son's condition was mostly their fault, would have suffered a great deal of unnecessary guilt and anguish at their inability to find help for him. All the knowledge and insight they had acquired about their child during the years he was growing up would not be considered pertinent, thereby causing them to question their own judgment and perhaps one day to go along with a recommendation that he be committed to a mental institution.

Then consider the baby girl. If her family remained in the same environment where she acquired the high body burden of lead, she would be started much earlier down the same path. The hyperactive child in preschool, kindergarten, and elementary school presents an almost unbearable problem to both parents and teachers. One of the most unfortunate results of this whole picture is that the child can see the helplessness and insecurity on the part of the adults, who should be furnishing him or her with the ingredients of a safe and secure life. Often, the teacher hates to go to work in the morning and the parents dread seeing the child come home from school. Finally, they both come to the end of their resources and reject the child.

Although hair tissue mineral analysis was certainly not available in Lewis Carroll's day, it can be seen today that the technique provides a very powerful entry into diagnosing potential trace mineral imbalances and ascertaining their contribution to behavioral changes. For some time, there has been controversy surrounding the merit of hair analysis as a diagnostically useful tool. Dr. Paul Lazar (1974), in an oft-quoted article in the **Journal of the American Medical Association,** has suggested "that in selected applications in forensic, clinical, or epidemiological medicine, trace metal hair analysis, along with other tests, is a useful tool. Nevertheless, present scientific knowledge does not support the use of the mineral levels in the hair for broad, sophisticated, subtle diagnostic purposes ... and certainly hair analysis is not desirable for routine use." In this article, he cites six major criticisms against the routine use of hair mineral analysis as a diagnostic modality. These include: 1) the variation in hair trace mineral levels as a result of differing hair colors and beauty treatments to which the hair may be subjected; 2) the change in trace mineral levels of the hair as it reflects differing washing procedures in the sample preparation for analysis; 3) the effect of environmental perturbances such as aerosol from automobile exhaust and constituents of hard water; 4) the absence of the relationship between the hair trace mineral level and a tissue level of that same mineral in question; 5) the variation in mineral levels as they relate to the color of hair and the position on the scalp from which the sample was taken; and, 6) variations in control of the analytical technique used to determine the levels of trace minerals in hair, including the lack of standard procedure within the industry which would result in uniformity of values from one laboratory to another. Recently we have had the opportunity to look at 3,564 hair trace mineral samples of individuals who have a variety of hair colors and to categorize the trace element composition of their hair as it relates to their hair color. In Figure I, the results of this study are represented. It can be seen that no major deviations in trace element levels occur as a result of hair color, other than lead being elevated in dark-haired individuals. This is presumably a result of the fact that we did not screen out those black-haired individuals who use Grecian Formula to prevent greying, which is known to contain lead, and therefore would cause a synthetically high lead level in our sample population.

With regard to criticism that Lazar has raised concerning the influence of beauty treatments on human hair trace mineral levels, the work of Dr. Joan McKenzie, as shown in Figure II, demonstrates that only cold waving and bleaching drastically influence hair trace mineral levels, whereas hair conditioners, hair sprays, tints, and permanent dyes have slight to insignificant influences on trace mineral levels

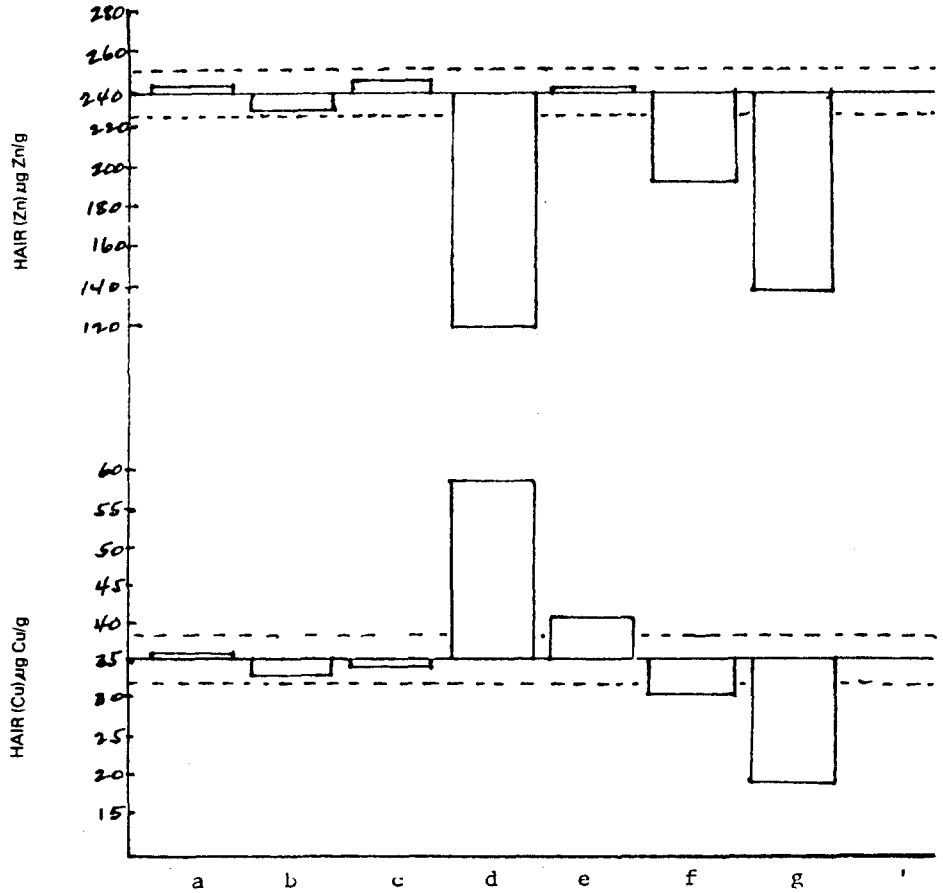
FIGURE I HAIR COLOR VERSUS MINERAL LEVELS

(All Values in mg%)

Hair Color: Element	Blonde	Black	Brown	Red	Gre
Ca	153	124	128	153	77
Mg	13.5	12.9	12.6	16.7	10.1
Na	17	19.7	18.4	21	18.7
K	4.5	6.7	5.1	5.4	5.4
Cu	3.2	2.7	2.9	2.7	1.8
Fe	2.0	2.2	2.2	2.0	2.2
Zn	15.7	18	17.7	17.3	16.1
Mn	0.1	0.1	0.1	0.1	0.1
Cr	0.1	0.4	0.1	0.1	0.1
Se	.30	.2	0.2	0.2	0.2
Pb	1.3	3.2	2.2	1.7	1.9
As	0.2	0.2	0.2	0.2	0.3
Cd	0.1	0.1	0.1	0.1	0.1
Hg	0.2	0.2	0.2	0.2	0.2
Al	1.3	1.4	1.3	1.2	1.1
Number in population	423	296	2229	135	457
Percent males	36	49	40	23	37
Percent females	64	51	60	77	63

FIGURE II

EFFECT OF HAIR PREPARATION



Influence of beauty treatments on hair zinc and copper concentration. Treatments: a) untreated; b) conditioner; c) hair spray; d) cold wave; e) tint: f) permanent dye; g) bleach.

Nonionic detergent + EDTA

FIGURE III

EFFECT OF WASHING PROCEDURES

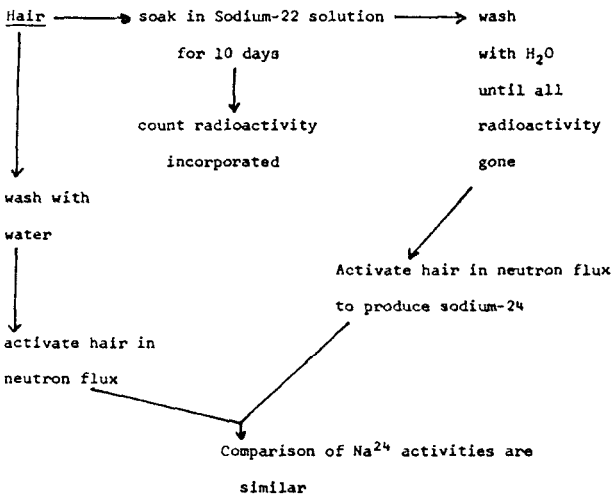
	*n»ig/g Treatment				Cu Treatment	ml%
	Control	100 *ug* Zn/ml	Zn/ml	1,ug Control	50 *tig* Cu/ml	0.1 jug Cu/ml
Not washed	228	407		270 61.7	1598	**70.4**
Ionic detergent	215	383		236 56.5	1425	70.7
Nonionic detergent	191	288		197 55.5	414	67.8
EDTA	198	255		192 **59.2**	273	59.7
Ionic detergent + EDTA	196	283		217 53.2	346	**63.4**
	184	247		183 51.8	214	57.7

(McKenzie, 1978). The hair, then, from individuals who have bleached their hair or used cold waves should be used with caution for trace element analysis, where other hair treatments will have only a minor perturbing influence. McKenzie has found also, as seen in Figure III, that soaking the hair in solutions containing high amounts of zinc and copper will not necessarily ruin the diagnostic usefulness of hair mineral analysis due to exogenous contamination of the hair. If the hair is appropriately washed by the reference laboratory in a dilute EDTA solution and detergent after it has been exposed to exogenous trace minerals, it was found that almost all of the adsorbed elements can be removed. This point is reinforced in an elegant series of experiments done by Kennington and seen in Figure IV. Once again, this work demonstrates that there are two forms of an element, one bound to the surface of the hair which can be removed by appropriate washing, and the other which is deposited in the core of the hair during-hair protein synthesis, which is reflective of systemic trace mineral levels, is tightly bound in the inner core of the hair, and cannot be removed easily.

FIGURE IV

SOLUBLE AND FIXED ELEMENTS IN MAMMALIAN HAIR

G.S. Kennington, **Science, 155**, 588 (1967).



Conclusions: Two forms of an element: one washed out with relative ease and bound to the surface, and the other fixed and remains at about the same level after extensive washing, presumably deposited during hair protein synthesis.

The question of whether trace mineral analyses of hair are related to tissue levels of the mineral in question has been explored recently by Klevay et al. (1978). Inspection of Figure V shows the results of the examination of hair tissue copper levels from test animals to that of their liver copper levels. It can be seen that there is a linear correlation between hair copper levels and liver copper levels, both in the microsomal and whole unwashed liver fractions. This is an excellent example of the relationship between systemic tissue levels of a particular essential trace element and its concentration in the hair tissue. This is an exciting result in that liver biopsy work for a particular element in question is considerably more difficult and invasive than the procurement of a trace mineral hair tissue specimen. The liver copper-containing metalloenzymes which are involved in drug detoxification and the liver mixed microsomal oxidase family of enzymes are extremely important in catabolizing many materials which could elicit long-term toxic effects if they were not oxidized and broken down. The use of hair tissue mineral samples then may be of considerable importance in relating the drug detoxification system and the hepatic oxidase enzyme function to that of a readily obtainable and easily analyzable hair source.

FIGURE V

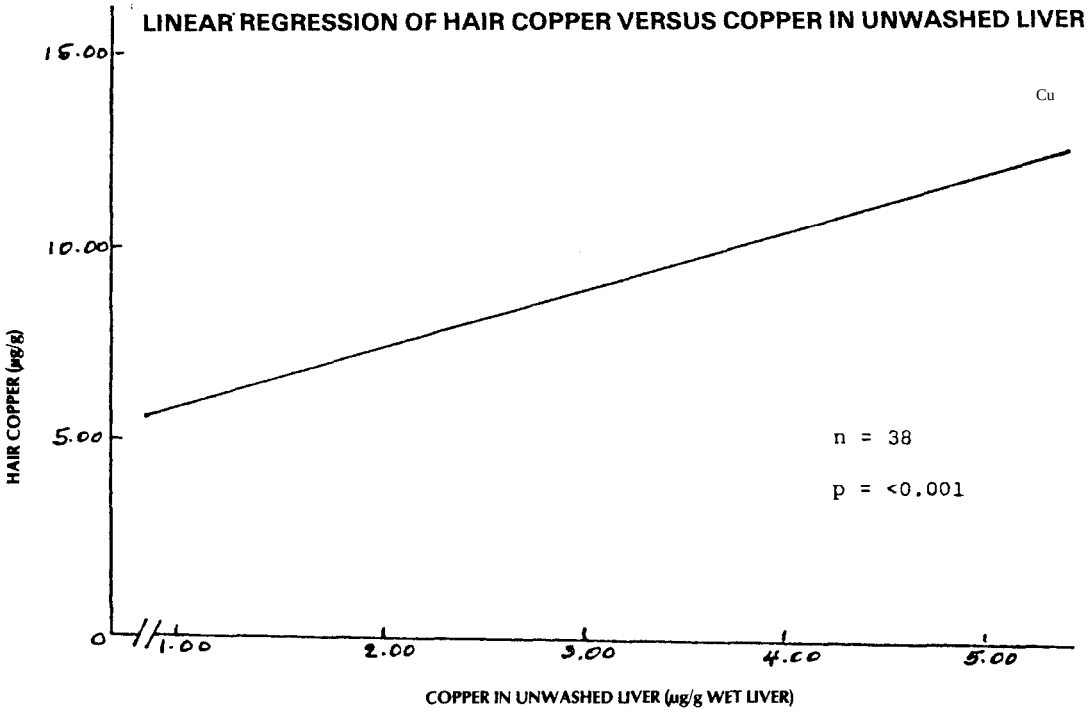


FIGURE VI

Effects of diets varying in vitamins, protein, and carbohydrate, but not minerals, on rat hair cation levels.

Diet[3]	Wt gain/12 wk	Zn	Mg	
1. low vitamins	190+8	257±28	69±5	21+3
2. low B vitamins	254±10	182±17	69±5	15+2
3. low vitamins A and D 4.	244+4	163±24	62+4	8+1
5. low vitamins, no gelatin	309±15	122+29	62+2	8+2
6. low vitamins, no gelatin, 16.5% casein	120±10	128± 6	56±3	10+2
7. low vitamins, 55.3% sucrose	212±13	150±11	48+4	10+2
8. 55.3% sucrose	206±18	155+17	53+8	9+1
	342+ 7	96+11	57+6	12±4

'**Unless otherwise stated diets** contain 10.5% casein, 6% gelatin, 49% lactose, and adequate vitamins.

FIGURE VII

SERUM ZINC AND HAIR ZINC

in Patients Showing Clinical Symptoms of Zinc Deficiency

Symptoms: white spots under fingernails, eczema, poor appetite, dysmenorrhea

	Number: 6 patients
Before Therapy	
Hair Zinc Level	32±6 mg%
Serum Zinc	64+6*Jg/100 ml.
After 24 mg. oral zinc/day Therapy IRetest after 90 days!	
Hair Zinc Level	22+2 mg %
SerumZinc	110±30ug/100 ml.

Clinical Note: Symptoms were markedly improved after therapy.

One question which is commonly asked with regard to the use of trace element analysis of hair is whether the levels of the element in the hair are, in fact, reflective only of the levels of ingestion of a particular element. The work of Cershoff et al. (1977), as seen in Figure VI, clearly indicates that the hair trace element levels are reflective of not only .trace elements in the diet, but vitamins and macronutrients as well. High protein diet encourages the uptake of zinc in the hair, whereas a high sucrose diet causes very low zinc levels to be realized. The use of hair trace mineral analysis, then, is much more than just looking at minerals in the diet. It is rather an observation of the total systemic flux of trace elements as it relates to all physiological parameters. One is looking at an interstitial level of trace elements, which differs from that of blood chemistry which observes the extracellular levels of trace elements. By the use, then, of hair mineral analysis, along with serum and urine analysis, one is able to explore the basic homeostatic balance of trace minerals as it relates to intracellular and extracellular levels. This can be seen very nicely in Figure VII, whereby it is seen that patients who present themselves with elevated hair zinc levels many times have the clinical symptoms of zinc deficiency. The treatment of choice in these individuals, then, is to administer zinc and vitamin B6.

It can be seen, then, that an elevated level of a particular element in the hair is not necessarily suggestive of excessive dietary intake, but rather of inappropriate metabolic utilization. Deeming and Weber (1978) have recently found that oral contraceptives also change the levels of trace elements in hair. Examination of Figure VIII shows that women taking oral contraceptives versus nonpregnant controls have higher hair zinc levels and lower hair copper levels, whereas their serum levels are exactly reversed. Again, this reflects the interesting inverse relationship between serum levels of the trace elements and hair levels of that same element in question.

Lastly, the question asked about the validity of the analytic techniques that are now employed by various laboratories for the determination of trace element concentrations at parts per million levels in hair remains to be dealt with. The technique which has most commonly been employed has been the atomic absorption spectrophotometric technique. This technique is reasonably sensitive and precise for many of the elements. However, for the ultratrace elements, such as chromium and selenium and others, in order to get data above background which are meaningful one must employ a carbon furnace. Many of the commercial firms have

FIGURE VII Effect of oral contraceptives on mineral levels

Subjects	No. of subjects	Hair Fe	Hair Mg	Hair Cu	Hair Zn	Serum Fe	Serum Mg	Serum Cu	Serum Zn	Dietary Fe	Dietary Mg	Dietary Cu	Dietary Zn
		PP™				>ug/100ml				mg/day			
Nonpregnant control women	7	62[a]	54[a]	70[a]	199[a]	I06[a]	1908[a]	203[a]	186[B]	17[a]	247[a]	2.0[a]	10[3]
Women taking oral contraceptives	7	73[a]	70[3]	34[a]	233[B]	109[a]	1813[a]	348[B]	149[a]	36[a]	230[a]	1.4[a]	n[a]
SEM		16	7.8	18	7.3	11	44	9.3	6.5	' 13	35	0.19	1.4

[a] Means having different superscripts are significantly different at the 0.05 level of probability.

not utilized this technology in the past and therefore the data which they have supplied with regard to the ultratrace minerals have been of some question. A new technology which has been receiving considerable attention in this area in the past year or so is the technique called plasma emission spectroscopy. As of the past few years, this technique has come out of the research laboratories and has now matured to the point where it can be used in routine analysis by competent reputable commercial firms. An elegant review article by Fassel (1978) has discussed the pros and cons of quantitative element analysis by plasma emission spectroscopy. It should be recalled, however, that the data produced on any machine are only as reliable as the care of the technician gathering the data. Interlaboratory variability still exists and no standard protocol or procedure is now a-vailable, such as one has with blood chemical determinations. This problem still serves to slow down the acceptance of trace element analysis of hair in that certain laboratories are producing data which are far from reliable and accurate. Until the industry has found a mechanism by which it can police itself, there will be continued discussions about the reproducibility of hair **trace** element data.

In conclusion, therefore, it can be said that in the intervening years since the article by Lazar was printed, considerable new amounts of information have become available discussing the usefulness, strengths, and weaknesses of the hair trace element analytic technique. Individuals who have had considerable experience in this field now conclude that the trace element concentration determinations of human hair is not a panacea and does not allow diagnosis of all metabolic problems, but does offer itself as an important contributor to the whole armamentarium of diagnostic techniques available to the practitioner. A recent review in **Science** magazine, a well-respected international journal, has suggested that hair analysis will in the near* future find its place along with blood and urine determinations for assessing metabolic fitness of a patient on a routine basis (Maugh, 1978). Because, as was pointed out in the two case histories discussed in the initial phase of this report, many behavioral dysfunctions are related to trace mineral imbalances or toxic mineral excesses, the use of hair tissue mineral analysis will find greater and greater use by psychiatrists and behavioral scientists in their diagnostic workups.

The recent work by Pihl and Parkes (1977) has demonstrated that there is a highly significant correlation between elevated hair lead levels in the hair of learning disabled (LD) children as compared to sex-age-and-socioeconomic-matched controls. A discriminate function analysis of their data also revealed that by using hair cadmium, cobalt, manganese, chromium, and lithium, all subjects could be classified as LD or normal with 98 per cent accuracy on the basis of hair mineral data alone. They conclude their paper by suggesting "....the high level of significance reported in this study....and the general failure of educative techniques with many LD children suggests that element patterns [of hair] may prove not only a fruitful diagnostic procedure, but may also provide answers pertaining to etiology and treatment." This sweeping suggestion of the implications of trace minerals in learning disabilities and the merit of the hair mineral analysis in diagnosis demonstrates the potential importance of this field in mental dysfunction. One might then ask the question: what would have been the outcome of Lewis Carroll's **Through the Looking Glass** had the medical diagnosticians in those days had the benefit of hair trace mineral analysis?

ACKNOWLEDGEMENT

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REFERENCES

BERG, N.O., BORULF, S., JAKOBSSON, I., and UNDBERG, T.: How to Approach the Child Suspected of Malabsorption. Acta. Paed. Scand., 67,403,1978.

DEEMING, S. and WEBER, C: Hair Analysis of Trace Elements in Human Subjects as Influenced by Age, Sex, and Contraceptive Drugs. Am. J. Clin. Nutr., 31,1175,1978.

FASSEL, V.A.: Quantitative Element Analysis by Plasma Emision Spectroscopy, Science, 202,183,1978.

GERSHOFF, S., McGANDY, R., NONDASTUDA, A., DISDYABUTRA, U,, and TANTIWONGE, P.: Trace Minerals in Human and Rat Hair. Am. J. Clin. Nutr., 30, 868,1977.

KENNINGTON, G.S.: Soluble and Fixed Elements in Mammalian Hair. Science, 155, 588,1967.

KLEVAY, L, JACOB, R., and LOGAN, G.: Hair as Biopsy Material: Index of Hepatic Metal; Copper and Zinc. Am. J. Clin. Nutr., 31, 477,1978.

LAZAR, P.: Hair Analysis: What Does it Tell Us? J. Am. Med. Assoc., 229 1908,1974.

MAUGH, T.: Hair: A Diagnostic Tool, to Complement Blood Serum and Urine. Science, 202,1271,1978.

McKENZIE, J.: Alteration of Zinc and Copper Concentrations of Hair. Am. J. Clin. Nutr., 31,470,1978.

PIHL, R.O. and PARKES, M.: Hair Element Content in Learning Disabled Children, Science, 198, 204,1977.

Letters to the Editor

To The Editor:

In my own practice as a psychotherapist I have been confronted by many instances of the controversial disease, hypoglycemia. A case presented to me while at a Community Mental Health Center revealed many of the problems inherent in the professional fields due to the disagreement and blindness over this camouflaged illness.

My client had a long history of mental illness and a series of psychiatrists and psychoneurotic diagnoses since the age of twelve and was in his early thirties when he came to see me. At twelve he was left the eldest son in the family, after his father died of unknown causes in a mental hospital. An autopsy later ascribed his father's death to starvation, dehydration and lung failure, (or perhaps a hidden disease?)

Instead of delving further into my client's background, which was reviewed sufficiently as evinced by his extremely large file, I inquired as to his day to day feelings and activities. He consistently disclosed suspicious hypoglycemic symptomology, but without a hint of such a diagnosis. My intervention at this point in his life is encumbered by his belief that he is a psychological cripple, and the treatment needed to undo this tragedy continues to rob this man of his productive years.

Consequently, the harm done to my patient is relentlessly reverberating when professionals avoid newer information which has been gained over the past few years about such a basic illness as hypo glycemia. Today's repetitious curative methods are too often aimed at the complex while a simple nutritional approach may be sufficient to heal.

Josephine Santillo, M.S.W., Psychotherapist

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Niacin Flushing, Prostaglandin E and Evening Primrose Oil A possible objective test for monitoring therapy in schizophrenia.

To the Editor:

Niacin causes flushing of the skin, especially that of the face. In normal individuals flushing occurs following an oral dose of 100mg or less, but in some schizophrenics very much larger doses are needed to induce a flush (Hoffer, 1962; Hoffer, 1979). This may explain why psychiatrists using high dose niacin rarely report side effects, while physicians using it to lower cholesterol levels report a very high incidence of side effects (Mosher, 1970).

Kunin (1976) suggested that niacin flushing might be due to increased prostaglandin (PG) formation because it could be blocked by drugs which inhibit PC synthesis. This has

been confirmed by Wennmalm and his colleagues (Eklund et al., 1979). They demonstrated that niacin flushing is associated with increased formation of PGE (the assay did not distinguish between PGE1 and PCE2) and that both the flushing and the rise in blood PGE levels could be blocked by drugs inhibiting PC synthesis. Since some schizophrenics are resistant to flushing, this considerably strengthens my proposal that in some schizophrenics there may be sharply reduced formation of PGE1 (Horrobin 1979a; 1979b; Horrobin et al., 1978).

Recently I have obtained evidence which suggests that the flushing may be used as an objective monitor of response to therapy with penicillin and evening primrose oil (Horrobin, 1979a; Vaddadi, 1979). A paranoid schizophrenic woman was being treated with penicillin, zinc, vitamin C and niacin (two 750mg doses per day). She had responded moderately to this regime but was still seriously disturbed. She had been observed to flush following a niacin oral dose of 1000mg but never did so with the 750mg dose. Evening primrose oil (Efamol, 2 capsules tds) was then added to the regime and over the next month paranoia and belligerence improved substantially and a previously disturbed sleep pattern became normal. In the fourth week after starting Efamol she began to flush sharply after each 750mg niacin dose. On testing, it was found that her threshold to niacin flushing had dropped to normal, around 100mg.

These reports support the idea that prostaglandin E1 formation may be inadequate in some schizophrenics. They also suggest the following: 1. Both the clinical state and the underlying biochemical lesion may improve during therapy with penicillin, evening primrose oil, zinc and vitamin C. 2. Mineral, vitamin and penicillin therapy may have little effect in the absence of the essential fatty acid substrates on which these agents act. 3. Monitoring of the flush threshold to niacin may offer a simple and wholly objective test by which response to therapy may be followed.

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REFERENCES

EKLUND, B., KAIJSER, L, NOWACK, J., and WENNMALM, A.: Prostaglandins Contribute to the Vasodilatation Induced by Nicotinic Acid. Prostaglandins 17:821 -830,1979.

HOFFER, A.: Niacin Therapy in Psychiatry. C.C. Thomas, Springfield, 1962.

HOFFER, A.: Personal communication, 1979.

HORROBIN, D.F.: Prostaglandin Deficiency and Endorphin Excess in Schizophrenia: the Case for Treatment with Penicillin, Zinc, and Evening Primrose Oil. Journal of Orthomolecular Psychiatry 8:13-19, 1979.

HORROBIN, D. F.: Schizophrenia: Reconciliation of the Dopamine, Prostaglandin and Opioid Concepts and the Role of the Pineal. Lancet 1: 529-531,1979b.

HORROBIN, D. F., ALLY, A.I., KARMALI, R.A., KARMAZYN, M., MANKU, M.S. and MORGAN, R.O.: Prostaglandins and Schizophrenia: Further Discussion of the Evidence. Psychological Medicine 8: 43-48, 1978.

KUNIN, R.A.: The Action of Aspirin in Preventing the Niacin Flush and its Relevance to the Anti-schizophrenic Action of Megadose Niacin. Journal of Orthomolecular Psychiatry 5:89-100,1976.

MOSHER, L. R.: Nicotinic Acid Side Effects and Toxicity: a Review. American Journal of Psychiatry 126:1290-1296,1970.

VADDADI, K.S.: Treatment of Schizophrenia with Penicillin and Essential Fatty Acids. Prostaglandins and Medicine 2:77-80,1979.