Journal of Medical and Biomedical Sciences (2014) 3(2): 24-31

doi: http://dx.doi.org/10.4314/jmbs.v3i2.5

ORIGINAL ARTICLE

Relationship between Palmar Dermatoglyphic Pattern and Academic Performance of Students in a Ghanaian Secondary School

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Dermatoglyphics which is a scientific study of epidermal ridge patterns on fingers (fingerprints) and palms (palmprints) is an important tool that has been used in the areas of personal identification, criminality as well as medical diagnosis of several congenital diseases. In this study, we hypothesized a positive relationship between academic performance and the dermatoglyphic pattern of the hand. The palmprints and fingerprints of 320 3rd and 4th year students of Ghana Senior High School, Koforidua were analyzed according to the number of Primary crease, Intersections of primary crease and Complete transverse Crease (PIC) model of classification and FBI system of fingerprint classification respectively. The dermatoglyphic patterns of each student were compared to the cumulative academic results of five consecutive academic terms. The study revealed that students with symmetrical palmprints performed better academically than those with asymmetrical palmprints ($p<0.001$). Strikingly, students with Central Pocket Loop Whorl located on the ring and middle fingers performed better academically than those with other fingerprints ($p<0.0001$). None of the students displayed PIC 101, 201 and 211 palmprint patterns which characterize individuals with learning difficulties. The results thus demonstrate a close association between dermatoglyphic pattern of the hand and brain cognitive functions. Dermatoglyphics can therefore be used to identify potentially weak students and to design teaching and counseling strategies for them. Further research using large sized samples are recommended for further elucidation of established linkages.

Journal of Medical and Biomedical Sciences (2014) 3(2), 24-31

Keywords: Dermatoglyphic pattern; palmprint; fingerprints, academic performance; PIC classification

INTRODUCTION

Dermatoglyphics is the scientific study of epidermal ridge (or papillary peaks) patterns on fingers (fingerprints) and palms (palmprints). Each person has distinct and unique ridges on the fingers and palms that are genetically determined (Gutierez *et al.,* 2012). Dermatoglyphic patterns are not influenced significantly after birth by environmental factors (Naffah, 1977). The ridges and their characteristics as they appear on the fingers and palms are unique, permanent and remain unchanged throughout life; thus aiding in investigations of palm-finger prints for the identification of individuals (Tay, 1979).

There are ample scientific evidences to suggest that the palm and fingerprints are closely associated with brain functions. For instance, the development of dermatoglyphical marking of the hand occurs at the same period the brain develops from embryonic ectoderm (Hirsch and Schweighel, 1973). That is why a number of genetic diseases have left marks on both the brain and the hand. Examples of such associations are demonstrated by the presence of Simian line and Sydney creases on the palm and mental retardation in the individuals with Down syndrome, Rubinstein-Taybi syndrome, Trisomy 18 (Edward's syndrome) and Trisomy 13 (Patau's syndrome). These individuals have delayed development, learning difficulties and/or behavioural disorders (Bagga, 1991).

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The areas of the brain (cortical) representing the face and hand are disproportionally larger compared to the other parts of the body. The digits of the hands particularly, the thumb and index finger, are well presented. Distorted presentations of the human body on the cortical areas are said to correlate with peripheral innervation density. Thus the hand and the fingers have high innervation density that is said to determine the dermatoglyphic characteristics of individual (Dell and Munger, 1986).

The academic performance of a student is a product of the student's cognitive (learning) ability (Rohde and Thompson, 2007; Leeson *et al.,* 2008). Cognitive abilities such as memory, speech and auditory capabilities are functions of the cerebral cortex of the brain. The academic performance also indicates the level of reasoning and understanding of the individual. Therefore qualitative and quantitative assessment of the academic performance of students would directly reflect on the students intellectual brain function. Students' academic performance at all levels of education shows stratifications (Etsey, 2005; Aguilar and Tansini, 2010; Ghazvini and Khajehpour, 2011; Mlambo, 2012). Some students perform well while others not so good; some very poorly. It is a known fact that a number of factors contribute to the academic performance of a student. Whatever the cause may be, the genotype of the mind is very crucial.

The hypothesis of the study was developed from the fact that (i) dermatoglyphic pattern of an individual's palm and fingers is genetically determined (Schaumann and Alter, 1976) likewise the individual's brain; hence intellect has genetic dispensation (Campbell, 1998). (ii) the brain and epidermal ridge (or papillary peaks) patterns on fingers (fingerprints) and palms (palmprints) develop at the same period from embryonic ectoderm (Hirsch and Schweighel, 1973). (iii) the hand and the fingers have high brain innervation density that is said to determine the dermatoglyphic characteristics of individual (Dell and Munger, 1986). (iv) individuals with a simian or single transverse palmar crease, Sydney crease have delayed development, learning difficulties and/or behavioural disorders (Johnson and Opitz, 1971; Bagga, 1991). The aim of the study, therefore, was to explore the relationship between individual's palm/finger dermatoglyphic profile and his or her academic performance (learning capability).

MATERIALS AND METHODS

Participants

The study participants comprised 320 students aged between 16 and 21 years recruited from Ghana Senior High School, Koforidua in the Eastern region of Ghana. Participation in the study was voluntary and informed consent was obtained from each participant. The study protocol was approved by the Committee for Human Research and Publications Ethics (CHRPE) at Kwame Nkrumah University of Science and Technology, Ghana.

Data acquisition and dermatoglyphics analysis

A digital scanner, HP Scanjet G2410 (Hewlett-Packard, USA) connected to a laptop computer was used to obtain bilateral palm/finger prints of each participant: the palms of each participant were clean-dried thoroughly and placed gently on the scanner with all five fingers touching the surface of the scanner. Palm prints were analyzed using the number of Primary crease, Intersection of primary creases and Complete transverse crease (PIC) criteria (van Mensvoort, 2009). Thumbprints were obtained separately using a stamp ink and white A4 sheets because scanned images were insufficiently visible due to the opposing orientation of the thumb. The stamp ink was applied to the pulp area of each finger, which was then pressed on the white A4 sheets and labeled accordingly. The palm/finger prints were analyzed using Microsoft Photo Viewer according to the standard classification criteria used by US Federal Bureau of Investigation (Parker, 1971).

The average scores for five consecutive term examinations was calculated for each student and stratified into three: high (70%-100%); satisfactory (54% - 69%) and low (less than 54%). The relationship between a student's academic score and dermatoglyphic patterns were then explored using relevant statistics.

Statistical Analysis

Continuous data were presented as mean ± standard deviation (SD) while categorical data were presented as frequencies and percentages. All statistical analyses were performed using GraphPad Prism Software for Windows version 6.0 (GraphPad Software, San Diego, CA, USA, www.graphpad.com). A value of $p<0.05$ was considered statistically significant.

RESULTS

Palmprint patterns

The different palmprint patterns observed in this study are recorded in Table 1. The frequency of 300 PIC and 310 PIC patterns were highest both unilaterally and bilaterally while the frequencies of other PIC palm print patterns were insignificantly low: 200 PIC (0.08% on the left; 0.04% on the right and 0.01% bilaterally); 321 PIC (0.01% on the left and 0% respectively for right palm and bilateral); 311 PIC (0.01% on the right and 0% respectively for left palm and bilateral).

Table 1: Distribution of various palm print patterns in left, right and both (bilateral) hands

Palmprint patterns	Left palm 76(23.8)	Right palm 76(23.8)	Bilateral 244(76.2)
300 PIC	34(10.6)	37(11.6)	124(38.8)
310 PIC	35(10.9)	35(10.9)	118(36.9)
200 PIC	6(1.9)	3(0.94)	2(0.63)
321 PIC	1(0.03)	0(0)	0(0)
311 PIC	0(0)	1(0.03)	0(0)

Data are presented as frequencies and percentages

The palm print patterns with low frequency (i.e 200 PIC, 321 PIC, 311 PIC) were grouped as "other PICs" and used for statistical comparison. Of the 320 students, 244 (76.2%) were found to have symmetrical PIC (i.e same PIC patterns bilaterally) while the remaining 76 (23.8%) had asymmetrical PIC (i.e different PIC patterns in either hands). Figure 1 illustrates the asymmetrical and symmetrical palmprints observed among the students.

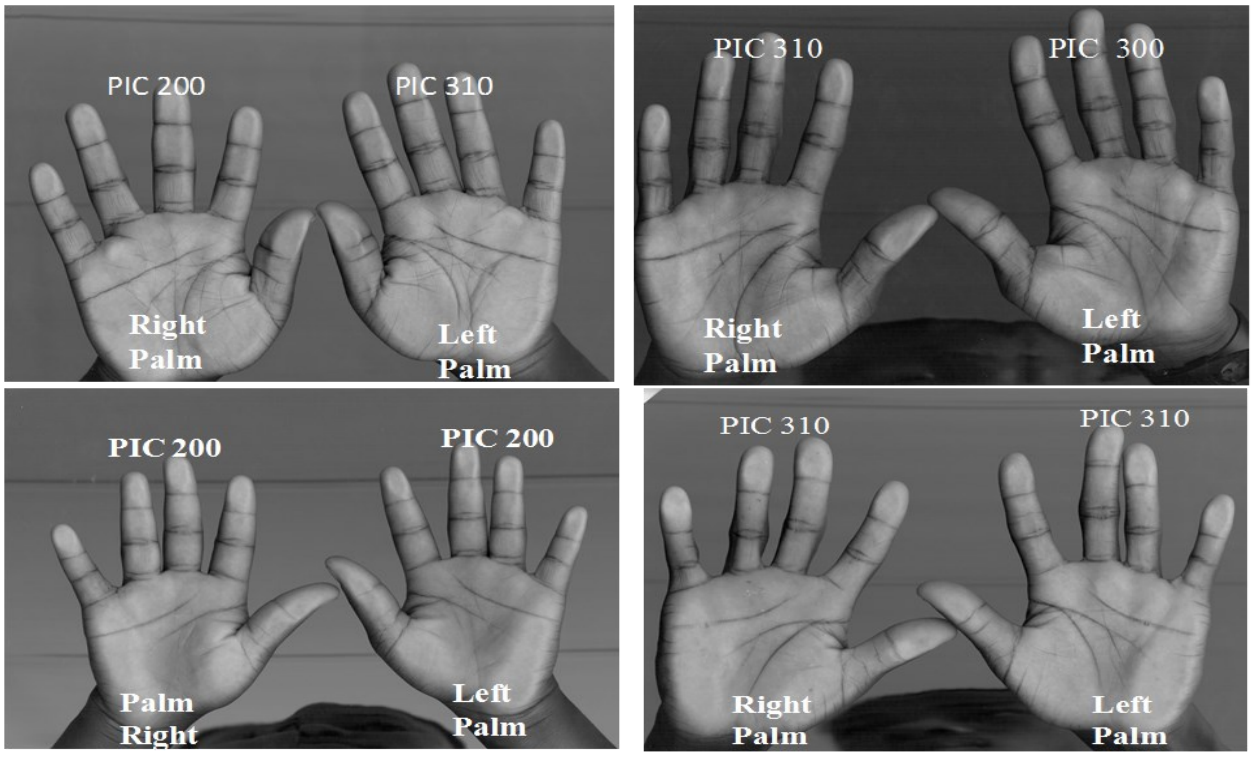

Figure 1: Asymmetrical (top row) and symmetrical (bottom row) PIC patterns of palm print in two students. [Note that one student shows 200 in the right palm and 310 in the left palm. The other student shows PIC 310 in the right palm and PIC 300 in the left palm]

Relationship between palmprints and academic performance

The standard percentage mean scores of the students (for the period under study) ranged from 44% -85%. The overall mean score (academic performance) of students with symmetrical palmprints (67.9±6.38) was significantly ($p<0.001$) higher compared to the students with asymmetrical palmprints (62.0± 5.69) (Table 2). The results also show that students having symmetrical palmprints were three times more likely to obtain 'high' scores than their counterparts with asymmetrical palmprints (OR=2.8; 95%CI=1.4-5.5; p=0.0015); the proportion of students that obtained 'satisfactory' marks was statistically comparable across the two groups (p=0.1810), while the proportion of students who obtained 'low' scores were significantly reduced in the symmetrical palmprint group (OR=0.2; 95% CI=0.1-0.6; p=0.0068).

Table 2: Academic performances of students stratified by symmetry of palmprints

Score	Total (n=320)	Symmetrical (n=244)	*Asymmetrical (n=76)	OR(94%CI)	P value
High	110(34.4)	99(40.6)	11(14.5)	2.8(1.4-5.5)	0.0015
satisfactory	199(62.2)	141(44.1)	58(76.3)	0.8(0.5-1.1)	0.181
Low	11(3.4)	4(1.6)	7(9.2)	0.2(0.1-0.6)	0.0068

Data are presented as frequencies and percentages. * Reference group

Categories of PIC and academic performance

Analysis of the mean academic performances of students with symmetrical and asymmetrical palmprints is as shown in Figure 2. The differences in mean academic scores of students' with 300 PIC, 310 PIC and other PICs in the right hand (p=0.2908), left hand (p=0.1027) and both hands (p=0.6884) were not statistically significant. For all the PIC patterns, the mean academic scores were significantly greater for students with symmetrical patterns ($p<0.05$).

Fingerprint Patterns

The different types of fingerprint patterns (Figure 3) observed in the population include Plain arch (PA), Tented arch (TA), Radial Loop (RL), Ulnar loop (UL), Plain whorl (PW), Central pocket loop whorl (CPL) and Double loop whorl (DLW). The results show that for both left and right hands respectively, the frequency of Ulnar Loop was highest (60.1% and 60.9) followed by Plain Whorl (17.3% and 17.6%), Plain arch (9.0% and 7.2%), central pocket loop whorl (5.0% and 5.8%) and double loop whorl (5.8% and 6.5%) while Radial Loop (1.1% and 0.4%) and Tented Loop (1.4% and 0.9%) were the least. Of the 320 students, 121 (37.8%) and 199 (62.2%) respectively had bilateral and unilateral presence of at least one type of fingerprint pattern while 4(1.3%) and 43(13.4%) had exclusively Plain arch and Ulnar arch respectively on all five fingers. The difference in mean academic score of the unilateral (66.62 ± 0.49) and bilateral (66.38 ± 0.59) group was not statistically significant (p=0.7600).

Fingerprint pattern and academic performance

Comparisons of academic performance of students with various fingerprint patterns are as shown in Table 3. With the exception of students who had central pocket loop whorl (CPLW), there was no statistically significant ($p>0.05$) difference in the mean academic scores of the students having other types of fingerprint pattern. In addition, the mean academic scores for students with CPLW on the ring finger (i.e 74.42±6.41 and 73.89±7.26 for left and right fingers respectively), middle finger (i.e 72.43±6.19 and 73.50±4.66 for left and right fingers respectively) and little finger (i.e 68.72±5.75 for the right finger only) were significantly higher than the mean academic scores of students with CPLW on the other fingers with the same laterality.

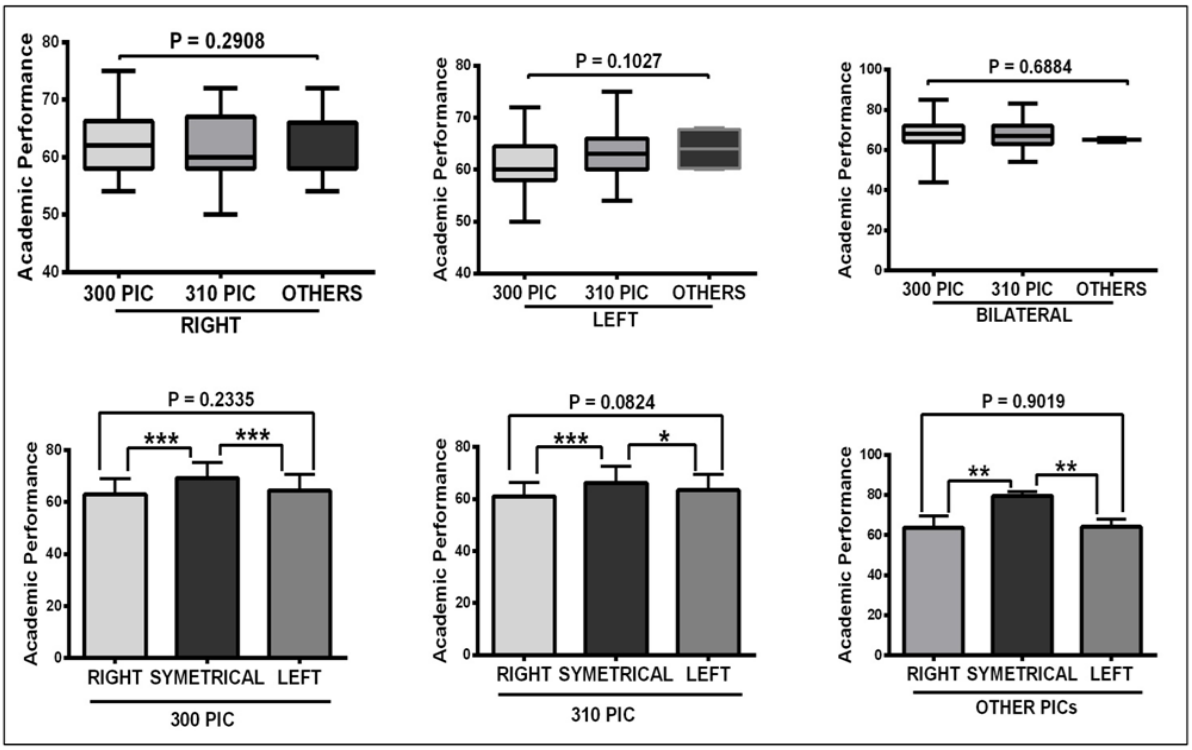

Figure 2: Academic performances of students with specific PIC in the palms. * p<0.05; ** P<0.01; *** P<0.001

Figure 3: Types of fingerprint pattern observed among the students

Table 3: Comparison of students' academic performances stratified by fingerprint pattern on left and right fingers

Finger	PA	TA	RL	UL	PW	CPLW	DLW	P value
Left hand								
Little	64.93±7.08	74	-	66.21±5.65	67.52±7.66	73.56±4.80	66.00±5.52	0.0174
Ring	64.06±6.38	67.60±2.07	58	64.93±6.12	67.31±5.51	74.42±6.41	66.86±7.07	<0.0001
Middle	64.87±7.33	63.40±3.58	73	66.27±6.32	68.11±7.40	72.43±6.19	64.69±9.18	<0.0267
Index	65.13±8.56	67.00±4.36	73.43±4.49	66.45±6.37	66.99±7.06	66.38±6.21	65.83±5.91	0.7181
Thumb	65.63±6.78	74	75	66.91±6.24	65.00±7.94	64.20±7.80	67.88±6.05	0.0966
P value	0.9611	0.1717	-	0.0604	0.2727	<0.0001	0.5866	-
Righthand								
Little	63.22±5.26	69.00	54.00	66.39±6.81	66.77± 6.13	68.72±5.75	65.40±7.58	0.3460
Ring	62.94±7.64	-	64.00±1.87	65.31±5.73	66.28±6.21	73.89±7.26	64.68±6.68	<0.0001
Middle	64.50±8.43	65.00±4.58	-	66.11±6.35	66.98±7.80	73.50±4.66	64.47±5.57	0.0056
Index	65.38±8.39	69.57±8.87	64.10±4.93	66.90±6.35	66.48±7.22	66.20±1.72	65.88±6.26	0.8934
Thumb	65.76±6.66	-	75	66.77±6.30	65.38±7.74	68.40±8.18	66.32±6.73	0.5459
P value	0.7117	0.8850	0.9663	0.1589	0.8142	<0.0001	07702	

Data are presented as mean±SD. Within-group comparisons were made using ANOVA (where n≤1, the corresponding values was excluded from the analysis). PA-plain arch; TA-tented arch; RL- radial loop; UL-ulnar loop; PW-plain whorl; CPLW-central pocket loop whorl; DLW- double loop whorl

DISCUSSION

The academic performance of a student is a product of the student's cognitive (learning) ability which includes memory, speech and auditory capabilities that are functions of the cerebral cortex of the brain. The academic performance also indicates the level of reasoning and understanding of the individual. The fact is that the individual's brain (intellect) has genetic dispensation (Campbell, 1998) likewise his/her palm and finger dermatoglyphic pattern (Schaumann and Alter, 1976). Again, the brain and epidermal ridge patterns on fingers (fingerprints) and palms (palmprints) develop at the same period from embryonic ectoderm (Hirsch and Schweighel 1973). Individual's with simian or single transverse palmar crease, which joins the proximal and distal creases to produce a single horizontal crease across the width of the palm, or with Sydney crease, which represents an extension of the proximal transverse crease near the ulnar border of the palm as seen in the individuals with Down syndrome, Rubinstein-Taybi syndrome, Trisomy 18 (Edward's syndrome) and Trisomy 13 (Patau's syndrome) are characterized by delayed development, learning difficulties and/or behavioural disorders (Bagga, 1991).

This study has demonstrated a striking relationship between dermatoglyphic pattern and student learning capability in a normal population. A majority (76.2%) of the subjects were found to have symmetrical palmprints comprising predominantly of PIC 300 or PIC 310 patterns. This finding correlates with other population studies (Wu *et al.,* 2004; van Mensvoort, 2009) suggesting that the current results could be a reflection of the prevalence of the symmetrical palmprint in the population of Ghana.

In a study of 276 children with a variety of disorders and 150 healthy children, a higher incidence of congenital abnormalities (52% to 30%) and borderline retardation or lower IQ (52% to 33%) were found in individuals with single palmar crease, also known as the Simian Line crease (Johnson and Opitz, 1971). The above literatures support the observation that palmprint has some relationship

with learning difficulties.

There was a significant difference between the mean academic performances of students with symmetrical palms and those with asymmetrical palms ($p < 0.0001$). Students with symmetrical palmprints were three folds likely to obtain high scores than students with asymmetrical palmprints. There are evidences that functional hemispheric asymmetries do exist, and are shaped by the interaction of many biological and environmental factors, beginning from fetus as it develops in uterus and continuing until old age (Grabowska *et al.,* 1994). For instance, the left hemisphere has been associated more with verbal and linguistic functions, for mathematical skills and for analytical thinking. The right hemisphere is mostly involved in spatial and holistic thinking, in many aspects of creativity such as art and music, and in some emotions (Milner, 1974). However functional asymmetry is not absolute; the degree of functional asymmetry may be associated with the individual's inherent ability. For example the differences in functional asymmetry of the brain are thought to underlie the differences in motor and visuo-spatial skills, linguistic performance (Kimura, 1992). It may be argued that students with symmetrical PIC palm prints have decreased asymmetry of cortical hemisphere. These students may have bilateral cortical areas that are well adapted and coordinated through the corpus callosum. Thus, students with symmetrical PIC palm prints perform academically better compared to those with asymmetrical palm prints. Alternatively, students with symmetrical palmprints may be associated with a large corpus callosum that allows better transfer and coordination of the two cerebral hemispheres. Hines *et al.,* (1992) suggested that a larger corpus callosum is associated with better inter-hemispheric transfer of information, which might contribute to the statistically superior verbal fluency in women than in men.

Surprisingly, none of the students displayed PIC 101, 201 and 211 palm print patterns. These dermatoglyphic characteristics are found in individuals with a *Simian* or single transverse palmar crease, which joins the proximal and distal creases to produce a single horizontal crease across the width of the palm, or with *Sydney* crease, which represents an extension of the proximal transverse crease near the ulnar border of the palm. Such individuals have delayed development, learning difficulties and/or behavioural disorders (Johnson and Opitz, 1971; Bagga, 1991).

The fingerprint pattern analysis showed that the Central Pocket Loop Whorl on any finger relates significantly with better academic performances of students ($p<0.0001$) compared to the other patterns. This observation correlates well with Parker (1971) who reported a statistically significant amount of whorl in both normal (I.Q 90-109) and above normal (I.Q 110-129) intellectual ranges compared to below normal (70-89) intellectual ranges.

Similarly, a predominant whorl pattern fingerprints were found in Albert Einstein (van Mensvoort, 2009). Albert Einstein was described as the scientist of the 20th century. In wider culture, the name "Einstein" has become synonymous with *genius*, after winning the Nobel Prize in Physics (1921). Consequently, it can be concluded that the central pocket loop whorl pattern corresponds to a more complex intellectual level.

CONCLUSIONS

The current study has demonstrated a relationship between the dermatoglyphic patterns observed on the hands and student's academic performance. All things being equal, students with symmetrical palm prints performed better than those with asymmetrical palm prints. The presence of central pocket loop on any finger, particularly the ring and middle fingers, corresponds to higher academic performance.

COMPETING INTERESTS

The authors declare that they have no competing interests.

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ISSN 2026-6294