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Minor Physical Anomalies as a Window into the Prenatal Origins of Pedophilia

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Abstract Evidence is steadily accumulating to support a neurodevelopmental basis for pedophilia. This includes increased incidence of non-right-handedness, which is a result primarily of prenatal neural development and solidified very early in life. Minor physical anomalies (MPAs; superficial deviations from typical morphological development, such as un-detached earlobes) also develop only prenatally, suggesting them as another potential marker of atypical physiological development during the prenatal period among pedophiles. This study administered the Waldrop Physical Anomaly Scale to assess the prevalence of MPAs in a clinical sample of men referred for assessment following a sexual assault, or another illegal or clinically significant sexual behavior. Significant associations emerged between MPA indices and indicators of pedophilia, including penile responses to depictions of children, number of child victims, and possession of child pornography. Moreover, greater sexual attraction to children was associated with an elevated craniofacial-to-peripheral anomalies ratio. The overall sample demonstrated a greater number of MPAs relative to prior samples of individuals with schizophrenia as well as to healthy controls.

Introduction

Pedophilia refers to the sexual attraction to children who are prepubescent (i.e., with Tanner Stage 1 features, typically under age 11); *hebephilia* refers to the sexual attraction to children who are pubescent (i.e., with Tanner Stage 2–3 features, typically ages 11–14; Blanchard et al., 2009; Glueck, 1955). The propensity to be sexually aroused by children is distinct from *child molestation,* which refers to the overt sexual contact with children. Not all child molesters prefer children sexually (as often occurs in cases of incest), and an unknown proportion of pedophiles and hebephiles suppress their sexual interests throughout their lives, never coming to clinical or forensic attention. Because the subset of child molesters who experience a genuine sexual preference for children is the most likely to recidivate sexually (Hanson & Bussière, 1998; Hanson & Morton-Bourgon, 2005), greater knowledge of the etiology of pedophilia and hebephilia may enhance society's ability to prevent such offenses.

Over the past decade, evidence has steadily accumulated, pointing to a neurodevelopmental basis of pedophilia and hebephilia. Relative to controls, samples of men sexually interested in children exhibit lower IQ scores (Blanchard et al., 2007; Cantor et al., 2004; Cantor, Blanchard, Robichaud, & Christensen, 2005a), poorer performance on tests of verbal and visuospatial memory (Cantor et al., 2004), more frequent head injuries before (but not after) age 13 (Blanchard et al., 2002, 2003), higher rates of non-right-handedness (Blanchard et al., 2007; Cantor et al., 2004, 2005b), and shorter physical stature (Cantor et al., 2007; McPhail & Cantor, 2015; Mellan, Nedoma, & Pondělíčková, 1969; Taylor, Myers, Robbins, & Barnard, 1993). In a large neuroimaging study, applying voxel-based morphometry analysis of structural

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MRIs, pedophiles showed significantly atypical white matter features, relative to men convicted of non-sexual crimes (Cantor et al., 2008; Cantor & Blanchard, 2012). Although these and other neuroimaging studies strongly implicate the brain in the development of pedophilia, the direction of causality is more challenging to ascertain: Some of these correlates, such as poorer neuropsychological functioning and atypical brain structure, might plausibly represent a result (such as from depression or stresses associated with being apprehended and incarcerated) rather than a cause of pedophilia. Another correlate—namely, non-right-handedness—is linked to very early (mostly prenatal) development, however (Hepper, McCartney, & Shannon, 1998), and therefore cannot be explained as a result of subsequent life events. Thus, the identification among pedophiles and hebephiles of still other correlates that manifest prenatally, that are permanent, and that remain immune to subsequent psychosocial experience, would corroborate the conclusion that the first developmental steps (or developmental risks) leading to pedophilia/hebephilia are prenatal.

One potential such set of markers of prenatal perturbations of development are the "minor physical anomalies" (MPAs; Compton & Walker, 2009; Green, Satz, Gaier, Gazell, & Kharabi, 1989; Lane et al., 1997; Sivkov & Akabaliev, 2003). MPAs are superficial deviations that appear on the skin, such as non-detached earlobes, and that bear no serious medical or cosmetic consequence to the individual (Ozgen, Hop, Hox, Beemer, & Van Engeland, 2010). They develop during the first and early second trimesters (Akabaliev, Sivkov, Mantarkov, & Ahmed-Popova, 2011; Compton & Walker, 2009; Trixler, Tenyi, Csabi, & Szabo, 2001). MPAs are diverse in nature and may appear anywhere on the body. Because these features develop in a sequence, their occurrence can help to suggest any sensitive periods of development. MPAs can result from factors such as prenatal nutritional deficiencies, prenatal exposure to viruses (e.g., influenza), prenatal alcohol and drug exposure, and obstetric complications (Compton & Walker, 2009; McGrath et al., 2002). For a more thorough review regarding MPAs in the intrauterine and perinatal periods, see Compton and Walker (2009).

MPAs develop in utero from the same ectodermal tissue that gives rise to the central nervous system (Tenyi, Trixler, Csabi, & Jeges, 2004). The number of MPAs a newborn infant can possess varies from few to many (Kalter, 2003). Findings from a preliminary study referencing MPAs suggested that 15 % of newborns had at least 1 of 26 different anomalies (Marden, Smith, & McDonald, 1964). More specifically, MPAs are elevated in frequency among newborns, preschool children, and elementary school children with disruptive behaviors, including hyperactivity and impulsivity (Compton & Walker, 2009). MPAs are similarly elevated in samples of adults with psychiatric or behavioral conditions, such as schizophrenia (Compton & Walker, 2009), fetal alcohol syndrome (Marino, Scholl, Karp, Yanoff, & Hetherington, 1987), and autism spectrum disorders (Ozgen

et al., 2010), and therefore, may help in the recognition and treatment of such conditions.

Consistent with pedophilia being highly sexually dimorphic—female cases being limited to a handful of individual reports—MPAs also appear to be sexually dimorphic: Akabaliev and Sivkov (2003) suggested that the increased number of MPAs among males, as opposed to females, with schizophrenia implies greater susceptibility of males to disruptive events during prenatal development. This elevation in MPAs indicates lower resistance of the male brain to maldevelopmental processes. Compared with healthy controls, male patients with schizophrenia showed a greater difference in MPAs, particularly for anomalies regarding fine electric hair, distance between eyes, and having a high/steepled palate. Gualtieri and Hicks (1985) also observed that the male fetus is more sensitive to adversities of ectodermal activity. The male fetuses examined in the study showed an increase in abnormal cell and tissue growth in conjunction with the expressed MPAs. Specifically, it has been found that the head and eye regions are more dysmorphic in males with schizophrenia, which potentially reflects the synchronized development of the brain and skull, thus rendering the male brain more vulnerable to neurodevelopmental insults (Akabaliev & Sivkov, 2003).

In the present study, we assessed MPAs among men undergoing sexological assessment.

Method

All procedures were approved and supervised by the Research Ethics Board of the Centre for Addiction and Mental Health (CAMH, Toronto, Canada).

Participants

Participants were recruited from clients referred to the Kurt Freund Laboratory of CAMH between 2005 and 2009 for assessment of distressing and/or illegal sexual behavior(s). The routine sexological assessment consisted of a forensic and medical file review, a semi-structured interview spanning offense and sexual history, a phallometric test for erotic preference (see following section), and a brief neuropsychological interview and battery. At the completion of the assessment, clients were invited to consent to the use of their data for research purposes. Those doing so (and who were at least 18 years of age, were fluent in English, and were not actively psychotic or under the influence of recreational substances) were thereafter invited to participate in an additional assessment and to receive a remuneration of $90 CDN. Interested clients were scheduled for an appointment during which a research assistant (masked to the results of the other tests) conducted the MPA assessment protocol.

Two hundred and six individuals were recruited. The majority identified themselves as White (75.3 %), followed by Black

(9.2 %), Asian (2.4 %), Aboriginal (2.4 %), Mixed (4.4 %), and Other (4.4 %). Prior research demonstrated that certain MPA items cannot be scored with some non-White ethnic groups, such as hair whorls among Blacks or epicanthal folds among Asians (Green, Satz, & Christenson, 1994; Lane et al., 1997; McGrath et al., 1995). Because there were too few participants for reliable statistical analysis of potential ethnic differences, 53 non-White participants were excluded from further analyses.

Eight participants reported having an acquired (rather than congenital) malformation involving their ears, feet, or hands. Of these eight, four were excluded (ear malformations secondary to use of forceps at birth in one participant, surgery to replace cartilage in two participants, and broken ear cartilage from a fight in one participant), and four were retained because the specific anomalies (e.g., two fingers severed, etc.) were unrelated to any items on the Waldrop scale.

Individuals with schizophrenia spectrum disorders are known to exhibit elevated MPA frequency (Compton, Chan, Walker, & Buckley, 2011). Therefore, participants with a prior diagnosis of a schizophrenia spectrum disorder ($n = 9$) were also removed.

The following analyses pertain to the resultant sample size of 140. Participants' mean age was 37.2 years (SD = 12.6), ranging from 18 to 74. The median level of education was high school graduation. Referrals originated primarily from parole and probation officers (51.8 %), followed by physicians (25.5 %), correctional institutions (14.6 %), and lawyers (8.0 %). Seventy-two percent of the sample had committed at least one sexual offense ($n = 99$); approximately a quarter of the sample ($n = 38$) had no identified victims. Of those with identifiable victims, 62.0 % ($n = 85$) had sexually offended against one or more children ages 14 or under, 8.8 % ($n = 12$) against one or more children ages 15–16, and 20.4 % ($n = 28$) against one or more individuals age 17 or older. Fifty-three participants (38.7 %) were either charged with or admitted to child pornography possession. These figures do not sum to the total due to some participants having victims in more than one age group.

Measures

Assessment of Minor Physical Anomalies

The Waldrop Physical Anomaly Scale (Waldrop Scale; Waldrop, Halverson, & Shetterley, 1989) is the most widely used instrument for assessing MPAs (Akabaliev & Sivkov, 2003; Weinberg, Jenkins, Marazita, & Maher, 2007). It quantifies the presence of 18 specific anomalies, involving: fine electric hair, hair whorls, head circumference, intercanthal distance, epicanthus, malformed ears, asymmetrical ears, adherent ears, low-set ears, soft and pliable ears, furrowed tongue, tongue with smooth and rough spots, high/steepled palate, curved fifth finger, single palmar crease, third toe longer than second toe, web toe, and an excessive gap between first and second toe. Most of these can be detected by

direct observation; some require a tape measure or sliding calipers. The scale takes approximately 15 min to administer.

Given that the research assistant was masked to the results of the other tests (e.g., phallometric responses), and also, given the easily observable nature of MPAs, there is no reason to suspect that the assistant may have been selectively biased towards a particular group. In addition, prior work has consistently reported high interrater reliability (93 % interrater agreement when anomaly was present, 97 % interrater agreement when anomaly was absent reported in Green et al., 1989; intraclass correlation coefficient of .84 reported in Ismail, Cantor-Graae, & McNeil, 1998), which in turn reaffirms the ease with which MPAs can be detected.

The individual items were weighted according to the values recommended by Waldrop et al. (1989): Each item is scored as 0 (not present), 1, or 2, depending on the degree of deviation. An unweighted scoring system has also been proposed (Lloyd et al., 2008). That method was also attempted but it yielded a highly non-normal distribution and was not pursued further. It was possible for participants to obtain a Total Anomaly Score of 0 (reflecting an absence of craniofacial and peripheral anomalies) in which case their ADI was 0 as well (see below).

The 18 Waldrop items were combined and expressed as a single ratio: the *Anomaly Distribution Index* (ADI; Akabaliev & Sivkov, 2003). That ratio comprises the *Craniofacial Anomaly Index* (the weighted sum of the face and head items), the *Peripheral Anomaly Index* (the weighted sum of the items pertaining to the limbs), and the *Total Anomaly Score* (the weighted sum of all 18 MPA items), and was calculated as (Craniofacial Anomaly Index − Peripheral Anomaly Index)/Total Anomaly Score. Thus, higher ADI values indicated an elevated proportion of anomalies appearing on craniofacial rather than peripheral anatomy, whereas lower ADI values indicated a decreased proportion of anomalies appearing on craniofacial rather than peripheral anatomy.

Penile Plethysmography

Penile plethysmography (i.e., phallometry) reliably distinguishes pedophiles from teleiophiles (i.e., individuals whose primary erotic interest is in adults; Barker & Howell, 1992; Blanchard, Klassen, Dickey, Kuban, & Blak, 2001). The Kurt Freund Laboratory at CAMH uses volumetric rather than the more common circumferential measure because the volumetric method is substantially more sensitive to changes in tumescence (Kuban, Barbaree, & Blanchard, 1999). The stimuli and procedures used at the CAMH facility have been repeatedly and consistently validated (Blanchard et al., 2001; Freund & Blanchard, 1989). Briefly, a computer records the amount of penile erection (i.e., penile blood volume change) in response to six categories of matched visual (slides of nude models) and auditory stimuli (audio recorded narratives): prepubescent females, pubescent

females, adult females, prepubescent males, pubescent males, and adult males. As part of the procedure, participants were instructed to view slides while simultaneously listening (through headphones) to narratives describing sexual interactions with individuals of the age and sex depicted on the slides. A seventh category, wherein landscapes are accompanied by narration of non-sexual activities, serves as a neutral condition.

Each participant's 28 trials were converted to standard deviation units, relative to his own penile responses over the full set of trials (i.e., converted to ipsative z-scores). These standardized scores were expressed as seven scores (one for each of the seven categories) by averaging the four scores within each stimulus category. A Phallometric Pedophilia Index score was calculated by subtracting the arithmetic sum of a participant's responses to stimuli depicting adults from the arithmetic sum of their responses to stimuli depicting children, ($\text{response}_{\text{prepubescent females}}$ + $\text{response}_{\text{pubescent females}}$ + $\text{response}_{\text{prepubescent males}}$ + $\text{response}_{\text{pubescent males}}$) − ($\text{response}_{\text{adult females}}$ + $\text{response}_{\text{adult males}}$). Thus, a greater Phallometric Pedophilia Index reflected greater genital response to erotic depictions of children.

For inspection purposes, participants were classified into three distinct groups: pedophiles, hebephiles, and teleiophiles (i.e., Cantor et al., 2007). Participants were categorized as pedophiles on the basis of (a) their phallometric response (i.e., responding more to prepubescent males or females than to any other category), and (b) one or more sexual offenses against prepubescent victims. In the absence of a valid phallometric response, self-reported higher sexual attraction to prepubescent males or females than to any other gender-age category was used to classify the participant as a pedophile. An analogous process categorized hebephiles. Participants were categorized as teleiophiles on the basis of (a) their phallometric response (i.e., responding more to adult males or females than to any other category) or, in the absence of a valid phallometric response, a self-reported sexual preference for adult males or females, and (b) no charges or admissions of possessing child pornography or any history that contradicted their phallometric response or their self-report. The teleiophilic group was composed primarily of sex offending teleiophiles ($n = 40$), but it also included non-offending teleiophiles ($n = 12$) referred due to hypersexuality concerns. The frequencies of individual MPA items for each group are presented in Table 1. For data analysis purposes, however, a continuous variable, the Phallometric Pedophilia Index, was employed.

Handedness

A modified version of the Edinburgh Handedness Inventory (EHI; Oldfield, 1971) was administered to assess participants' hand preference when performing the following activities: writing, drawing, throwing, using scissors, using a toothbrush, using a knife, using a spoon, striking a match, using a broom, and opening a box. The modifications to the original EHI inventory consisted

of (a) delivering the instructions orally instead of having participants fill out the EHI themselves, and (b) instructing participants to make a binary "left" or "right" decision, instead of indicating a weak or strong preference. Only the first eight of the 10 aforementioned activities were used to capture hand preference due to poor loading of the last two items (i.e., using a broom and opening a box) on the handedness factor (Fazio & Cantor, 2015). A Laterality Quotient (Oldfield, 1971) was calculated by subtracting "left" responses from "right" responses and then dividing the resulting number by the sum of "left" and "right" responses combined. Thus, lower Laterality Quotient scores corresponded to lower rates of right-handedness.

Data Analyses

The Peripheral Anomaly Index has a potential range of 0–2; however, in this sample, participants had either feet or hand anomalies but not both, which represents a de facto dichotomous coding of 0 (absence of peripheral anomalies) or 1 (presence of peripheral anomalies on either feet or hands). Thus, the Peripheral Anomaly Index was treated as a categorical variable. The remaining metrics—the ADI, the Craniofacial Anomaly Index, and the Total Anomaly Score—were treated as continuous variables. In reporting correlation statistics, Pearson r was used when both variables were continuous and relatively normally distributed, Spearman's rho was used when ordinal variables were involved, point-biserial correlation was used for correlations involving both categorical and continuous variables, and the phi coefficient was used when only categorical variables were examined. In line with Howell's (2013) assertion that dichotomous variables can be treated as ordinal without affecting the analysis, the relationship between dichotomous and ordinal variables was examined through Spearman's rho.

Results

The mean MPA score for pedophiles was 3.9 (SD = 1.4), as compared with 3.6 (SD = 1.6) for hebephiles, and 3.4 (SD = 1.4) for teleiophiles.

To serve as the omnibus test of association, set correlation was applied, with zero-order correlations as follow-up tests to identify the source of the omnibus effect. Whereas traditional correlation provides a measure of association between two variables, set correlation provides a measure of association between two groups (i.e., sets) of variables (Cohen, Cohen, West, & Aiken, 2003). This sequential approach comprises the protected t test method of controlling the familywise error rate (Keppel & Wickens, 2004).

For the omnibus set correlation test, the MPA indices were entered as one set (ADI and the Total Anomaly Score) and the indicators of pedophilia were entered as the second set (Phallometric Pedophilia Index, number of child victims, and any admission or charges of child pornography possession). The

Table 1 Frequencies of minor physical anomalies

Anomaly	Pedophiles (*n* = 24)	Hebephiles (*n* = 55)	Teleiophiles (*n* = 52)
Fine hair			
1 = Fine hair	0	0	0
2 = Very fine hair	0	0	0
Hair whorls			
1 = One hair whorl, counterclockwise	2 (8.3 %)	8 (14.5 %)	6 (11.5 %)
2 = Two or more hair whorls, any direction	1 (4.2 %)	3 (5.5 %)	0
Head circumference			
1 = 1.0–1.5 SD	1 (4.2 %)	6 (10.9 %)	7 (13.5 %)
2 ≥ 1.5 SD	3 (12.5 %)	8 (14.5 %)	5 (9.6 %)
Intercanthal distance			
1 = 1.0–1.5 SD	0	0	0
2 ≥ 1.5 SD	0	0	0
Epicanthus			
1 = Part cover	0	0	1 (1.9 %)
2 = Whole cover	0	0	0
Malformed ears			
1 = Malformed	2 (8.3 %)	2 (3.6 %)	2 (3.8 %)
Asymmetrical ears			
1 = Asymmetrical	18 (75 %)	31 (56.4 %)	29 (55.8 %)
Adherent ear lobes			
1 = Adherent to back of neck	3 (12.5 %)	13 (23.6 %)	11 (21.2 %)
2 = Adherent to crown	7 (29.2 %)	4 (7.3 %)	6 (11.5 %)
Low-set ears			
1 ≤ ¼ of ear above the outer corner of the eye	20 (83.3 %)	41 (74.5 %)	42 (80.8 %)
2 ≥ 0 cm below the outer corner of the eye	1 (4.2 %)	5 (9.1 %)	3 (5.8 %)
Soft and pliable ears			
1 = Soft and pliable	1 (4.2 %)	1 (1.8 %)	1 (1.9 %)
Furrowed tongue			
1 = At least one or more anomalous furrow(s)	0	3 (5.5 %)	2 (3.8 %)
Tongue with smooth/rough spots			
1 = Smooth-rough spots	9 (37.5 %)	21 (38.2 %)	20 (38.5 %)
High/steepled palate			
1 = Flat and narrow at top	4 (16.7 %)	16 (29.1 %)	7 (13.5 %)
2 = Steepled palate	1 (4.2 %)	1 (1.8 %)	1 (1.9 %)
Curved fifth finger			
1 = Small curvature	0	2 (3.6 %)	1 (1.9 %)
2 = Greater curvature	0	0	0
Single transverse palmar crease			
1 = Creased	0	0	0
Third toe			
1 = Equal to second toe	0	1 (1.8 %)	0
2 = Longer than second toe	0	0	0
Web toe			
1 = Webbing present	1 (4.2 %)	1 (1.8 %)	3 (5.8 %)
Gap between first and second toes			
1 = Gap exactly or greater than half the width of the second toe	7 (29.2 %)	13 (23.6 %)	19 (36.5 %)

Craniofacial Anomaly Index and the Peripheral Anomaly Index were not entered alongside the other MPA indices because the nature of their relationship was expressed as a sum in the Total Anomaly Score and as a ratio in the ADI. The analysis yielded a statistically significant multivariate association, Rao's $F(6, 232) = 2.55, p = .021$.

The follow-up analyses revealed that the Phallometric Pedophilia Index was significantly related to ADI, $r(123) = .19$, $p = .019$; that is, higher craniofacial-to-peripheral ratio corresponded to greater pedophilic interest (see Table 2). This association appeared attributable to a combination of an increased Craniofacial Anomaly Index, $r(123) = .13, p = .084$, and a decreased Peripheral Anomaly Index, $r_{pb}(123) = -.14, p = .064$. When arithmetically summed to form the Total Anomaly Score, however, the positive and the negative effects of the craniofacial versus peripheral anomalies appeared to cancel, $r(123) = .073$, $p = .21$.

Similarly, the number of victims age 14 and younger was significantly positively related to ADI, $r_s(137) = .24, p = .002$, and negatively related to the Peripheral Anomaly Index, $r_s(137) = -.26, p = .001$. Neither the association of the Craniofacial Anomaly Index, $r_s(137) = .012, p = .45$, nor the Total Anomaly Score, $r_s(137) = -.071, p = .20$, with the number of child victims, reached statistical significance. The number of adult victims (age 17 and older) was not significantly related to any MPA measure: ADI, $r_s(137) < .01, p = .49$, Craniofacial Anomaly Index, $r_s(137) = -.053, p = .27$, Peripheral Anomaly Index, $r_s(137) = .011, p = .45$, and Total Anomaly Score, $r_s(137) = -.061, p = .24$.

As with phallometric scores and child victim counts, admissions to child pornography possession, $r_s(137) = .26, p = .001$, and charges of possession of child pornography, $r_s(137) = .24$, $p = .003$, both related to higher ADI scores. Admissions to child pornography possession, $\phi(137) = -.22, p = .005$, and charges of child pornography possession, $\phi(137) = -.20, p = .008$, both related significantly negatively to the Peripheral Anomaly Index. There were also positive associations between the Craniofacial Anomaly Index and both child pornography possession, $r_s(137) = .12, p = .089$, and child pornography charges, $r_s(137) = .12$, $p = .074$. The relationships between the Total Anomaly Score, and child pornography possession, $r_s(137) = .015, p = .43$, or child pornography charges, $r_s(137) = .025 p = .39$, were not significant.

Ancillary Analysis: Are MPA Scores Related to Non-right-handedness?

Although not statistically significant, an elevated ADI corresponded to lower rates of right-handedness (i.e., lower Laterality Quotient), $r_s(119) = -.076, p = .21$. Further, a higher Craniofacial Anomaly Index was significantly related to lower rates of right-handedness, $r_s(119) = -.17, p = .032$. There was also an association between an elevated Total Anomaly Score and lower rates of right-handedness, $r_s(119) = -.13, p = .085$. The relationship between the Peripheral Anomaly Index and the Laterality Quotient did not reach statistical significance, however, a higher Peripheral Anomaly Index appeared related to higher rates of right-handedness, $r_{pb}(119) = .055, p = .302$.

Discussion

The current investigation examined the prevalence and distribution of MPAs within a clinical sample of men referred for sexological assessment. Cross-study comparisons regarding MPA rates are complicated by the heterogeneity of test items and scoring methods used (e.g., Extended 41-item Waldrop in Ismail et al., 1998; Modified 19-item Waldrop in Sivkov & Akabaliev, 2003; 15-item Waldrop in Hata, Iida, Iwasaka, Negoro, & Kishimoto, 2003; dichotomous scoring versus weighting; total score versus mean score etc.). Green et al. (1989), one of the few studies whose use of the Waldrop Scale was comparable to the present investigation, reported a mean MPA score of 1.81 (SD = 1.63) in the male schizophrenia group and a mean of .74 (SD = .82) in the male control group. By comparison, the mean

Table 2 Intercorrelations between indicators of pedophilia and MPA indices

Variables	ADI	CAI	PAI	Total anomaly
Phallometric Pedophilia Index	0.19[a]*	0.13[a]	−0.14[b]	0.073[a]
Number of victims ages 14 and under	0.24**	0.012	−0.26**	−0.071
Number of victims ages 17 and older	0.001	−0.053	0.011	−0.061
Child pornography possession	0.26**	0.12	−0.22[c]**	0.015
Child pornography charges	0.24**	0.12	−0.20[c]**	0.025
Laterality quotient	−0.076	−0.17*	0.055[b]	−0.13

ADI Anomaly Distribution Index, *CAI* Craniofacial Anomaly Index, *PAI* Peripheral Anomaly Index

[a] Pearson *r* correlation, [b] Point-biserial correlation, [c] Phi coefficient. All the other correlations are Spearman's *rho* values

* $p < .05$ (one-tailed), ** $p < .01$ (one-tailed)

MPA score obtained by the pedophiles in the current sample suggested they possess relatively more MPAs than are found in both schizophrenic and non-clinical samples. Unlike the Green et al. (1989) study, which used a group of healthy participants as controls, the present investigation could not produce a direct comparison of MPA rates between pedophiles and healthy controls because the teleiophilic group was primarily composed of males who had sexually offended against adults. Moreover, although the mean score of the pedophilic group was comparatively elevated, so were the mean scores of the hebephilic and teleiophilic groups. Subsequent research should include both pedophiles and healthy controls in order to ascertain the extent to which pedophiles manifest more MPAs than healthy controls.

MPA indices were associated with multiple indicators of pedophilia, including phallometric responses, number of child but not adult victims, and admission or charges of child pornography possession. Specifically, greater pedophilic interest corresponded to an elevated craniofacial-to-peripheral ratio. Along those lines, manifesting greater pedophilic interest was to a lesser extent related to more craniofacial anomalies and fewer peripheral anomalies. This pattern of results is understandable given that the craniofacial-to-peripheral ratio was composed of an increased number of craniofacial anomalies and a fewer than typical number of peripheral anomalies. The craniofacial and peripheral anomalies canceled each other out when the Total Anomaly Score was used, but were even more observable when expressed as a contrast ratio. Although this field of research is still in its infancy, there is some indication that several neurodevelopmental disorders (e.g., schizophrenia [Compton et al., 2011], Fetal Alcohol Syndrome [Jones, 1997], etc.) that are accompanied by craniofacial anomalies do not appear to show the craniofacial-peripheral distinction evident in pedophilia.

The craniofacial-peripheral distinction emerged regardless of how pedophilia was assessed. Namely, sexually offending against children was related to a higher craniofacial-to-peripheral anomalies ratio. Further, offending sexually against children was associated with fewer peripheral anomalies. Finally, participants charged with possession of child pornography had an elevated ratio of craniofacial-to-peripheral anomalies and showed a trend towards having more craniofacial anomalies, but they generally manifested fewer peripheral malformations. An identical pattern was observed among participants who self-disclosed (but were not charged with) child pornography possession. Given the very strong association between child pornography possession and pedophilia (Seto, Cantor, & Blanchard, 2006), the cumulative effect of these findings implies that more craniofacial anomalies and fewer peripheral anomalies were substantially more frequent among males erotically attracted to children.

Given the current findings regarding the prevalence of craniofacial anomalies among pedophiles, the relationship between MPAs and non-right-handedness was explored, the latter marker having been previously linked to pedophilia (Cantor et al., 2004,

2005b; Fazio, Lykins, & Cantor, 2014). Consistent with the pattern of results described thus far, more craniofacial anomalies corresponded to higher rates of non-right-handedness.

A guiding motive for examining MPAs was their prenatal origin. In particular, the parallel development of brain tissue and morphologic abnormalities (Compton et al., 2007; Green et al., 1989; Lane et al., 1997) appears indicative of a neurodevelopmental contribution to pedophilia, with the stage of craniofacial development emerging as particularly crucial. That craniofacial malformations are also present in other neurodevelopmental disorders, such as schizophrenia (Compton et al., 2011; Gourion et al., 2004; Lane et al., 1997; Waddington, Lane, Larkin, & O'Callaghan, 1999), Down syndrome, and Fetal Alcohol Syndrome (Jones, 1997), further suggests a neurodevelopmental basis of pedophilia. Relatedly, it is conceivable that these neurodevelopmental disorders and pedophilia may be different manifestations of a common underlying (and as yet unidentified) process.

A growing body of evidence regarding the prenatal antecedents of pedophilia has been steadily accumulating over the past few years. Prior work examining rates of non-right-handedness among pedophiles has similarly suggested a prenatal component based on the premise that handedness is a result of mostly prenatal development and therefore rarely results from postnatal life events (Cantor et al., 2004, 2005b).

Aside from serving as a prenatal correlate of pedophilia, handedness can also isolate a critical period during embryogenesis that may be especially sensitive to the prenatal development of pedophilia. Specifically, studies examining the earliest development of lateralized behavior, and in particular handedness (Hepper et al., 1998; Hepper, Wells, & Lynch, 2005; McCartney & Hepper, 1999), found that isolated arm movements were observable at 10 weeks of gestation (corresponding to the first trimester). This in utero hand preference persists into adulthood; Hepper et al. (2005) concluded that, despite minor shifts in hand preference among left-handed children, prenatal thumb sucking at 15 weeks predicted postnatal handedness (measured by the modified EHI) at 10–12-years-old. Given its relationship to handedness, it is reasonable to hypothesize that pedophilia may be developing prenatally and concurrently with handedness.

Whereas handedness anchors the differences between pedophiles and non-pedophiles as existing by week 10 of gestation, MPAs suggest that these differences may occur at an even earlier period during fetal development. Ear malformations occur as early as weeks 3–5 of embryogenesis (Miller et al., 2005). Therefore, the elevation of craniofacial malformations among pedophiles suggests that pedophiles may differ from teleiophiles by the 5th week of gestation.

A related question here is how MPA development may relate to pedophilia. Although the exact mechanism remains elusive, there is some indication from clinical case studies that hypoxic events (e.g., ischemia, edema from hemorrhage, cocaine exposure, etc.) during the early embryonic period may determine the extent

and nature of malformations (Miller et al., 2005). In particular, CHARGE syndrome (typically involving colobomas [missing pieces of tissue from the eye], heart defects, choanal atresia [blockage of the nasal airway], retarded growth and/or development, genital anomalies, and ear anomalies and/or hearing loss), and early (but not later) thalidomide embryopathy are both characterized by ear anomalies (craniofacial) in the absence of limb defects (peripheral), therefore resembling the pattern of anomalies in pedophilia, and have been hypothesized to be related to hypoxic/vascular events (Miller et al., 2005).

Limitations and Future Directions

The marginally significant but consistently negative association between peripheral anomalies and indicators of pedophilia suggests two potential interpretations that should be targets of future research. One interpretation is that pedophiles are less susceptible to peripheral anomalies, perhaps because of some overcompensation that happens during development. Another interpretation is that there is something atypical in the control sample (i.e., teleiophiles), perhaps because the comparison group employed here possessed more antisocial features and/or is more prone to peripheral anomalies. Subsequent studies would need to compare pedophiles simultaneously with multiple control groups, including a healthy control group.

A final interpretive concern is whether MPAs can be specific to a particular disorder or condition. Despite the consistently elevated MPA rates found among individuals diagnosed with schizophrenia, Compton and Walker (2009) argue that, relative to developmental disorders, MPAs are not unique to schizophrenia. Compared with other complex mental health conditions, however, the prevalence of elevated MPA rates in schizophrenia, especially craniofacial insults (Compton et al., 2011; Gourion et al., 2004; Lane et al., 1997; Waddington et al., 1999), is, to some degree, specific to this disorder (Compton & Walker, 2009; Compton et al., 2011; Green et al., 1994). That elevated MPA rates, particularly craniofacial anomalies, were also found among pedophiles in the current investigation suggests a non-negligible neurodevelopmental contribution.

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