

Tanner's Puberty Scale: exploring the historical entanglements of children, scientific photography and sex

Abstract

Globally, increasing numbers of children are thought to be going through early onset puberty. This much debated fact leads to significant concerns about young people's sexualities, as early developers are thought to be more likely to engage in early sexual activity. Underpinning historical, national and subpopulation (including 'racial') comparisons is a standard measurement tool: the Tanner Scale of sexual development. The scale is based on James M. Tanner and R.H. Whitehouse's groundbreaking longitudinal study of children's growth undertaken in London between 1949 and 1971. This article explores the largely over-looked and under-theorised significance of the scale's history, arguing that the study's focus on children living in an English care institution and its material practices of documenting their growth, including photography, has important ethical and scientific implications for understanding sexual development as a bio-psycho-social process.

Keywords: puberty, Tanner Scale, norms, sexual development, child growth, scientific photography, Harpenden

Recent population-level changes in pubertal timing constitute an area of significant scientific controversy (Roberts, 2010). Across the globe many girls are beginning sexual development earlier, spending more time in the initial stages of puberty (breast and/or pubic hair growth). A key American study, for example, reports that

whilst in the 1960s only 1% of girls started pubertal development before they turned 8, in the 1990s 48% of girls in some sub-populations had this experience (Hermann-Giddens et al, 1997). Similar changes have since been reported in Europe and Asia (Aksglaede et al, 2009; Rubin et al, 2009; Ma et al, 2009). Related changes are also documented in boys, with one well-cited study reporting that male puberty in America now occurs 6 months to 2 years earlier than in the 1960s depending on ethnicity (Hermann-Giddens et al, 2012). Widely agreed to be of a different ilk to earlier historical shifts in pubertal timing thought to result from improved nutrition, these changes provoke professional and public concern about long term health, environmental toxins, obesity and young people's sexualities. Early developing girls in particular are said to be more likely to be involved in early sexual encounters, to be exposed to unwanted sexual approaches and to engage in other risk-taking behaviours (Downing and Bellis, 2009; Grabner, Brooks-Gunn and Warren, 1999).

Epidemiological and clinical claims about changes in pubertal timing rely on internationally shared norms and standards of child growth and sexual development. The most significant of these is the Tanner Scale, based on British auxologist James M. Tanner and R.H. Whitehouse's longitudinal study of English children (1949-1971). This paper explores the history of this scale, asking who was involved in this study, uncovering what kinds of 'cuts' (Barad, 2007) were made in establishing this international standard and articulating the associated costs both to young people and to the scientific study of puberty. The history of the Tanner Scale – it's troubling entangling of children, photography and sex – raises both important conceptual questions about the nature of sexual development and ethical concerns about how it

should be studied. Rather than a neutral scientific tool, the Tanner Scale is a significant actor in the making of modern sexed bodies.

Measuring children: the early science of growth

Auxology, the interdisciplinary scientific study of growth, has its roots in mid-18th century attention to measurement and recording. The first textbook on growth, written in 1729 by Prussian physician Johann Stöller, was entirely theoretical, containing no measurements of children. In 1754, however, physician Christian Jampert presented a thesis based on measurements of children in a Berlin orphanage. In 1777 the first longitudinal study of growth was reported in George LeClerc Comte de Buffon's *Natural History*. Based on measurement of his assistant Phillip Gueneau de Montbeillard's son from birth to adulthood (1759-77), this study confirmed the concept of a 'pubertal growth spurt' and seasonal changes in growth rate. Some sixty years later Belgian mathematician Adolphe Quetelet combined a mathematical approach with empirical data on children's growth, using data from measurements of his own children.

Across the nineteenth century a new style of growth research involving a more systematic study of groups of children developed in Europe and the United States. That century's sentimentalisation of childhood saw rising interest in *some* children's health, campaigns to promote their interests and the establishment both of pediatrics as a speciality and institutions to care for destitute children (Lederer, 1992: 96; Lesko, 2012: 72-4). Interest in children's wellbeing was strongly articulated with discourses of race, class and sex: American black children in the first part of the

century, for example, were most often measured in attempts to protect them from post-slavery child smuggling (Tanner, 1981: 165). In the second half of the century, new measures to protect and care for young people on both sides of the Atlantic rendered particular groups of children – those living in newly-formed care institutions due to disability, neglect and/or poverty – readily accessible research subjects. ‘Orphans’ (children living in orphanages who may or may not have living parents) frequently served as research materials for American and European scientists from the late 19th century and into the next century. Consent to perform experimental interventions, which were sometimes dangerous and often unpleasant, needed only be obtained from the institution (Lederer, 1995; 1992; Lederer and Grodin, 1994), whilst regimentation of life in such institutions facilitated a kind of technical scientific control.

In the early to mid- twentieth century, researchers such as anthropologist Franz Boas, psychologists Bird T. Baldwin, Nancy Bayley and Frank Shuttleworth, and auxologist Howard Meredith argued the growth curves obtained from cross-sectional samples were quite different to those obtained by following individuals over time. In the 1920s and 30s, several large scale American longitudinal studies, including Baldwin’s pioneering study based at the Iowa Child Welfare Research Station (results published by Meredith in the 1930s), the Harvard Growth Study, and the Ohio-based Fels Longitudinal Study, tracked the growth of children recruited from schools and local families. Initiated during the Great Depression, these studies had a strong focus on the impact of poverty on child growth. Both this focus and their methods inspired the subsequent English research: in the late 1940s Tanner

visited various US studies and learnt Meredith's measuring techniques (Tanner, 1981b).

Building the Tanner Scale: engaging the children of Harpenden

In 1948, Tanner was approached by E.R. Bransby, a nutritionalist at the Ministry of Health who had researched children's nutritional requirements at the Highfield Branch of the National Children's Home, Harpenden, just outside of London. Bransby had money from the Ministry for a long-term study of children's growth (Tanner, 1981a: 349). Later that year Tanner travelled to Harpenden with his military-trained assistant, Reginald H. Whitehouse, to begin the study of children's growth that was ultimately to form the basis of international clinical norms around growth and puberty.

Children living at Harpenden were studied from 1949-1971. Overall, 450 boys and 260 participated in the research; of these 85 boys and 48 girls were studied for ten years or more (Tanner, 1981a: 353). Tanner and Whitehouse visited the institution every 3 months, measuring each child every 6 months from the age of 3 or 4, and then every 3 months during puberty. These measurements were meticulously taken and recorded, forming the basis for several ground-breaking papers (e.g. Tanner, 1962; Marshall and Tanner, 1969; Marshall and Tanner, 1970), the development of the Tanner Scale of pubertal changes (1955) and the 1982 publication of the *Atlas of Children's Growth: Normal Variation and Growth Disorders*. Building on the accumulated knowledge of the two centuries of research described above, this study

today underpins most clinical and research-based measurements of child growth and pubertal development.

Tanner and Whitehouse's study was exemplary in its elaboration of modern scientific methods and approaches, including the systematic employment of disadvantaged children as research subjects. Institutions like the British National Children's Home provided exciting possibilities for researchers wanting to understand more about children's bodies. Accessing such children in the 1940s-1970s was relatively straight forward in the United Kingdom. It was not until the 1960s, following the Nuremberg Code of informed consent (1947) precluding research on children because they could not consent and the 1964 Helsinki Declaration of the World Medical Associations allowing adults to give proxy consent for children, that clinical experimentation on children became a matter of international concern (Epstein, 2007: 42; Brierley and Larcher, 2010). Although in the UK, the Committee of the Safety of Medicines (1964) and the Medicinal Act of 1968 controlled the use of medicines in clinical trials, there was no specific legislation on the use of children in non-therapeutic research during the period of Tanner's study. It was not until the mid-1990s that British researchers became legally obliged to consult and follow the advice of clinical research ethical committees (Brierley and Larcher, 2010; Larcher, 2009). In publications from the Harpenden study, consequently, Tanner does not describe a process of obtaining either participants' or their parents' consent to involvement.

During visits to Harpenden, Whitehouse made 15 measurements of each child according to standardised protocols. Over the study period this amounted to 15

measurements on 9000 child occasions. Children were required to hold their bodies in particular ways during each test: for height measurements they had to stretch up, 'assisted by the measurer applying upward pressure under the ears' (Tanner, 1981a: 352). The anthropometrist used verbal encouragement and held down the child's heels if they came off the floor (Tanner and Whitehouse, 1982: 2). For seated measurements children 'stretched up as much as possible, aided by gentle pressure under the chin', whilst for supine measurements, children lay on their backs with knees bent up to a right angle. The unique anthropometric instruments devised by Whitehouse to make these measurements are now standard internationally.

Scientific photography and the measuring of children's bodies

During measurement sessions, Tanner took individual photogrammetric pictures: 'pictures so made that enlargements remain dimensionally accurate to the extent that measurements can be taken off them' (Tanner, 1981: 352). This involved strenuous control from both children and scientists: the child stood motionless on a turntable placed 10 metres from the camera and was posed in the standard position recommended for somatotyping... The turntable was then turned (electronically, in later models) to give side and back views' (Tanner, 1981a: 352).

A selection of these images is reproduced in the *Atlas of Child Development*, which contains two oversize pages per child: one displaying growth charts and giving a short written history and description, and the other a set of photographs following the child from early childhood to adulthood. These black and white images are unnerving: the children are naked, their eyes covered with black triangles. Bodies,

shown in frontal, side-on and back profiles, are positioned on a set of grid lines. The eye covering does little to hide the children's identities: their bodies are otherwise profoundly exposed. Although in the *Atlas* the children's facial expressions and bodily deportment are usually highly controlled and 'neutral', several of the younger children (aged between 3 and 5) appear distressed and/or unable to follow the strict instructions (they are turning away, leaning or slumping).

Tanner's images follow a tradition of medical photography stemming from the mid-nineteenth century in which photographs, in contrast to illustrations, represented accuracy and scientific dispassion (O'Connor, 1995; Jackson, 1995; Maehle, 1993). Building on earlier studies of criminals, this tradition developed in the later decades of that century alongside an increasing emphasis on the collection of statistical data about children's bodies and the detailed analysis of physical differences of pathologised groups (Jackson, 1995: 323). Sometimes such individuals were photographed naked in order demonstrate the effectiveness of particular treatments. Tanner's images, in contrast, are intended as objects for measurement and the construction of statistics. In the *Atlas*, they are also visual 'examples' of an individual's change over time. Photography was also widely used in the nineteenth and twentieth centuries in scientific work on 'race'. The sciences of anthropometry and anthropology used standardised photographic techniques to document different bodily 'types' and the 'differences' between 'races'. Intended for measurement and analysis, like Tanner's, such images were often taken in front of a grid with the subject standing next to a measuring device. Subjects were immobilised by metal

stands and other devices. These images were widely used as part of British colonial projects into the early 20th century (Cooper, 1990: 60).

The historical literature on scientific photography illuminates the ways in which cultural understandings of bodies are articulated through visualising practices intended to ensure objectivity. Tanner and Whitehouse's precise techniques constitute a highly elaborated version of the attempt to represent bodies as physiological entities. Such precision does not successfully reduce bodies to mere objects. The practices with which Tanner and Whitehouse engaged the children of Harpenden articulate a wide range of social relations: of class, dis/advantage, health, race and sex/gender. Situating these practices and the resulting images in a history of scientific photography illuminates the material-semiotic relations that make possible this particular rendering of 'objective facts.' Most notably, perhaps, it underlines the significance of the disadvantaged social position of these children: living in a Children's Home made it difficult to resist Tanner and Whitehouse's scientific figurations of development.

What to measure? Accuracy, choice and expertise

The Harpenden Growth Study focussed on physiological measurements of subjects' bodies and of the photogrammetric images. Tanner and Whitehouse also used callipers to measure fat in children's skin and X-rays to record bone growth. Some clinical and orthodontic examinations were also completed. In subsequent writing, Tanner describes his decisions about which data to collect: 'No psychological work was undertaken, nor any physiological research, after an early disappointment over

the accuracy of 24-hour urine collections (bottle-sharing and beer-substitution being excessive)' (Tanner, 1981a: 353). Here, I suggest, we can see the effective resistance of some Harpenden children.

Introducing himself to a 1953 meeting of experts in Geneva, Tanner described this lack of physiological and biological data as 'a very grave gap in our investigation', stating that 'it is a matter of money and space as usual' (Tanner, in Tanner and Inhelder, 1956: 19). He also affirmed that 'we do not have at the present time any psychiatric or psychological studies in progress, and this is a field about which I ... know, practically speaking, nothing' (Tanner, in Tanner and Inhelder, 1956: 19). This failure to take account of the psychological aspects of the children's development was, I suggest, underpinned by the historically situated figuration of institutionalised children as convenient – albeit sometimes resistant – research materials. Itself a legacy of the history outlined earlier, this figuration's central role in the Harpenden research has important ethical and scientific implications for the study of puberty today.

So who were the participants in this study? Some were parentless children who had lived in the home since they were babies. Others – in increasing numbers as the study went on – were taken into the Home 'as the result of family breakdown' (Tanner, 1981a: 353). They were all from working class families and all had experienced (potentially traumatic) separation from familiar carers and surroundings. Some may have experienced abuse and/or neglect. Although noting these specificities, Tanner describes study participants as 'healthy,' 'well nourished,'

and 'ordinary.' Any difficulties the children involved in living at the National Children's Home are effaced. The participants' atypicality is constrained to their backgrounds which might, Tanner argues, affect the timing of their development (and hence the numerical values of their growth curves) but not its overall shape:

The Harpenden Growth Study data were used to determine the shape of the individual height and weight curves at adolescence, but they are not suitable as figures on which to base standards. For one thing, they are obviously too limited in number, and for another they come from boys and girls living in a children's home. The home is an extraordinarily good one, in which the children live in 'family units' consisting of a dozen boys and girls of all ages supervised by a housemother and her younger assistant. The home is well situated in extensive grounds, the food is excellent, and the children attend the schools in the town in the ordinary way. We think it very unlikely that the shapes of these children's adolescent growth curves are in any way unusual, but menarche does occur slightly later than in the London County Council children. For this reason in making the standards we have moved the age of peak velocity of height and weight earlier by 0.2 yr. in both sexes..... These figures are probably closely representative of urban children of average economic status in Southern England in the early 1960s (Tanner, Whitehouse & Takaishi, 1966: 465).

Although keen to represent the majority of children in their study as typical (if 0.2 years slower than their peers), Tanner and Whitehouse sometimes stressed the

developmental effects of deprivation and neglect: indeed, Tanner is today highly regarded for his emphasis on the social aspects of growth. In the *Atlas*, Tanner and Whitehouse briefly broach the question of the interrelationship of the physiological and psychological, presenting three cases of 'short stature... due to psychosocial stress' (Tanner and Whitehouse, 1982: 1). Subject 99 demonstrates 'short stature due to psychosocial stress with catch-up on change of environment' (1982: 179). His history is described as follows:

Subject 99, a boy, was the third child out of four in a fireman's family. His mother brought him to the clinic with the complaint of short stature.... his mother admitted that his behaviour was different from that of her other children.... His feeding pattern was grossly disturbed. At times he ate little and at others he ate voraciously..... He was anxious and slept badly... Mother readily agreed that the child was probably "delicate" In consequence, the boy was sent to a special boarding school for delicate children where this growth showed a marked and sustained catch-up. Height reached the 15th centile after 3 years of this "treatment". No drugs were given at any time.... We presume he had reversible growth hormone deficiency with a disturbance of the nearby appetite centre, **both for psychosocial reasons** (Tanner and Whitehouse, 1982: 178, emphasis added).

Similar narratives are composed about Subjects 100 and 101. Subject 100 'had a very disturbed home background and was sent to boarding school immediately after the first measurement' (Tanner and Whitehouse, 1982: 178). Subject 101's 'home was very disorganized and attendance at doctors' clinics or hospitals very unreliable'

(Tanner and Whitehouse, 1982: 178). The pictures of this child, as Tanner and Whitehouse write, 'show an initially obviously unhappy girl, [aged 4.8 years] growing into the smiling subject of the last occasion [aged 8.4 years]' (Tanner and Whitehouse, 1982: 178). In each case Tanner and Whitehouse figure the 'change of environment' of moving into institutional life away from 'difficult' family as promoting health and happiness as well as growth.

In using the children at Harpenden as research subjects, Tanner was in a difficult position; caught between a tradition in which 'orphans' functioned as convenient research materials and a developing scientific understanding (found in the work of John Bowlby and Donald Winnecott for example) of the long-term impact of childhood trauma. This historically specific dilemma is evident in Tanner's writings: although acknowledging that the background of his sample might be physiologically consequential, Tanner underplays the possibly enduring effects of early separation and ignores the difficulties of institutional life for children. He also, as I argue below, remains oblivious to the possibility that his own engagements with Harpenden residents may have been harmful.

Scaling up puberty: counting and accounting for differences

Tanner and Whitehouse were particularly interested in growth at puberty. During the Harpenden study, 228 boys and 192 girls were measured every 3 months as they went through puberty, using manual palpation and tools such as the orchidometer to measure testicular development (Marshall and Tanner, 1969, 1970). Tanner and Whitehouse's laborious approach foregrounded the significant differences in

children's growth patterns and the importance of recognising wide variation in 'normal' development. Through the careful accumulation of detail, Tanner and Whitehouse produced data that multiplied bodies and biological processes, allowing them to 'define the range of variation seen in the development of pubic hair, genitalia and breasts' (Tanner, 1981a: 354). Their findings thus highlight both sequence *and* variation. In the *Atlas*, they conclude:

There are very large variations in the ages at which the various manifestations of puberty occur in girls and boys. These variations take three forms.

1. Early or late occurrence of puberty as a whole.
2. Differences in timing between different sequences, i.e. say, pubic hair early in relation to breasts...
3. Differences in the rapidity with which each individual sequence progresses; that is, between the time taken by one girl to pass from the earliest breast bud to an adult breast compared with the time taken by another who starts breast development at the same time (Tanner and Whitehouse, 1982: 122).

Statistical analysis of the Harpenden measurements, including the radiological data on bone, muscle and fat and the photographs, resulted in the Tanner Scale (1962): a simple graphic tool used to measure and describe children's breast, or testicle and penis, and pubic hair development (see Figures One and Two). (Sometimes close-up photographs from the Harpenden study are used instead of the drawings). These 'pictorial standards' are organised in five stages, and separate the growth of

breasts/testicles/penises and pubic hair to allow clinicians and researchers to distinguish different sequences and speeds of growth. The relation of these to the pubertal growth spurt and to the onset of menarche varies: Tanner also produced 'individual-type standards for distance and velocity of height and weight' using his longitudinal data to form the shape of standardised growth curves (Tanner, 1981b: 354).

[insert images here]

Through developing these standards, Tanner and Whitehouse figured puberty and growth both as measurable and delineated sequences that can be represented in simple graphical form *and* as processes displaying important individual variation. Although usually predictable, growth and development (as Subjects 99, 100 and 101 highlight) can, according to Tanner and Whitehouse, at least in unusual cases be determined by 'psychosocial' factors.

The Tanner Scale and charts travel; and are criticised

Since publication in 1962, the Tanner Scale has become an immensely mobile tool for measuring children's development. Used widely in both research and clinical practice, it has become the standard against which children are measured globally: research papers describe children's breast/testicle and penis or pubic hair growth as 'Tanner Stage X' or simply 'B1- B5' or 'PH1- PH5'. In more recent years the Scale has also developed a less clinical life. It is available on a wide range of websites: one encouraging young Christian men to understand and control their sexual urges

(lavistachurchofchrist.org/LVstudies/GrowingUpInTheLord/Boys/TannerStage.htm); another reassuring young women about their small breasts (www.living-with-small-a-cup-breasts.com/breast-development-stages.html). Members of online teen forums discuss their Tanner results, asking anxiously if they are at the 'right' stage for their age (www.virtualteen.org/forums/showthread.php?t=31701). Although usually depicted in graphical form, Tanner's original photographs also appear in non-clinical spaces. On the *American Academy of Family Physicians'* webpage on 'Disorders of Puberty', for example, the authors use Tanner's photographic scale of breasts, testicles, penises and pubic hair to educate worried parents (www.aafp.org/afp/990700ap/209.html).

Alongside the flourishing of the Tanner Scale comes some recognition of the cost to young people of having their pubertal stages assessed by adults. Although such practices remain routine in clinical work, research studies now tend to ask young people to assess their own development by making comparisons with Scale images (Cameron, 2002). In early onset puberty this is not possible due to the children's young age, so the standard technique for assessing pubertal stages remains direct human observation.

Tanner's height and weight curves have also been widely used in clinical and research literatures and in public health initiatives. Although the longitudinal 'style' of Tanner's charts remains gold-standard in the UK, the original curves' numerical values are no longer seen as appropriate standards (Wright et al, 2002). Over the later decades of the twentieth century, as politics around treating children's atypical

growth intensified in the US, the UK and Australia (Hall, 2006; Morrison, 2008; Rayner et al, 2010), pharmaceutical companies began promoting charts based on different data. In a 2005 interview, Tanner suggested that such charts promote over-diagnosis and consequent prescription of hormonal treatments. Hall writes,

The Tanner-inspired longitudinal charts are still sold and used in England, but he said their use had been overshadowed by cross-sectional charts distributed by drug companies or growth foundations that receive financing from companies that make human growth hormone, the use of which has exploded in recent years (Hall, 2005: 2).

Tanner's acknowledgement of the specificities of the Harpenden sample is sometimes mentioned in recent epidemiological research on pubertal timing. In their paper on British girls' development, for example, Carol Rubin and colleagues write,

As stated by Marshall and Tanner, participants came mainly from the lower socio-economic sectors of the population. A poor nutritional status and overall well-being in early childhood may well lead to a later pubertal development in these girls compared with what would have been expected in the British population at the time (Rubin et al, 1992: 502).

In his 2004 parental guide to early puberty, similarly, leading US clinician Paul Kaplowitz (2004: 76) describes the Harpenden sample as 'extremely non-random', arguing that its results should not be seen as constituting a norm for today's children.

In their 2008 review of the epidemiological literature on early puberty, Euling et al make another criticism; that the participants in the study were all white and so should not be taken as typical for non-white children, who are today seen as notably 'different' in their patterns of sexual development. Although this criticism seems somewhat misplaced – Tanner's papers and the *Atlas* do include some black participants – Tanner and Whitehouse did not make distinctions according to 'race.' Although intensely problematic, such distinctions sometimes have highly serious implications: discourses around 'racial' and ethnic differences in child growth are central to contested age determination techniques used in assessing child asylum-seekers' cases (Hopkins and Hill, 2010: 141-44).

In these criticisms, contemporary researchers point to the limitations of Tanner and Whitehouse's sample in terms of the *timing* of 'normal' puberty and consequent assessment of contemporary changes in pubertal development. Importantly, these concerns have *not* reduced reliance on the Tanner scale as the standard articulation of the *stages* of puberty: although sequentially ordered, these can be disarticulated from age-related norms. The children of Harpenden still literally represent 'normal' puberty: photographs of their genitals and breasts (and line drawings based on them) circulate globally as tools with which clinicians, scientists, parents and children measure bodies to make judgements about growth. But what does it mean for a particular group of children living in an English care institution to function in this way? What ethical and scientific questions does their position raise?

Revisiting Harpenden: the costs of children's participation in research

The post-war encounters between Tanner, Whitehouse and the children at Harpenden took place at a time in which English children were expected to stoically manage psychologically challenging separations from birth families and immersion in moral regimes of institutional care that attempted to replicate family life (Lesko, 2012). Being part of the Harpenden Study exposed children to additional regimes of measurement and exposure (to cameras, instruments and X-rays) requiring them to stand still, tall and quiet. Although reported in some of Tanner's writing, the children's labour as research subjects is largely absent in the published papers. Their detailed contributions are obscured in the simple graphic and photographic representations of the Tanner Scale widely used since in pediatric endocrinology.

In a self-published memoir about life at Harpenden, former resident Phillip Howard describes memories of participating in Tanner and Whitehouse's study (www.theirhistory.co.uk). Using text and archival photographs, this memoir is also a call to others to share memories and get back in touch. Howard's generally positive account of his participation in the Harpenden growth study, which meant welcomed time off school, is rather poignantly undercut by his reference to 'ordinary children' who 'might have been a little scared' of having to do the things he and his friends did. Howard writes,

Our regular visits for the Growth Study Tests every few months were welcomed by most of us. An entire morning off school was something of a treat. The tests took about two hours. There were not that many of us in the group, but as we were all seen individually... much of the time was waiting to be seen.... **Ordinary children might have been a little scared of having to strip**

down to their underwear and have parts of their bodies measured in size and density; we took it as fun..... As well as our measurements, photographs of our body stature and growth were taken from our front, back and side. These were done naked, and as there were no girls present, we did not find any reluctance at having such photographs taken (emphasis added).

Later, Howard describes the embarrassment he and others felt when experiencing a sexual response during the measurement sessions. Here he reveals some of the more difficult elements of life at Harpenden, noting the reaction to sexual arousal boys would have expected from their carers:

If a few of us were embarrassed at times, it was when the staff might have touched certain parts of our body during the tests. When it came to standing up for the photographs, on occasions a few of us experienced erections. With the others occupied with their own part of the test, it was generally only the staff that witnessed our embarrassment. At our young age, we did not understand why things like this should happen. **If this had been in front of the Sisters or a Houseparent we could have expected some form of punishment; the medical staff took little notice of us** (emphasis added).

The fear hinted at here is evident in Howard's discussion of the protective pants children wore during the X-rays. In two places, he describes urinating in these pants: sometimes as prank and sometimes as a fear response:

For a young child on their first session, the plastic pants hid any accident that happened during the x-rays, strong elastic in the leg area, kept this matter secret from the doctor, allowing your return to the dressing area to put your clothes back on and to try and hide the event. In future sessions you would know not to be afraid, when it came to putting the plastic pants on ready for your x-ray session, you might find they were already slightly damp.

Howard describes the x-rays as the most 'boring' part of participating in the study: not only did children have to wait a long time they were also left alone during the test. Wearing the thick plastic pants becomes intertwined in his narrative with this boredom and with the fear of x-rays. At the Home, Howard notes, children were sometimes required to wear rubber shorts because they wet their pants. This connection caused confusion:

To children in our Home at the age six or seven, the only reason in our minds why you would be provided with such a garment was that you might wet yourself. At this age we could understand little about the complexes of x-rays, and even if we were older learning that x-rays could be dangerous to certain parts of the body, might have introduced even more fear.

Howard's memoir details the historical specificities of the Harpenden study, which was made possible by the fact that he and his friends were not 'ordinary' but rather brave or stoical children living in the care system who could be expected to cope with such challenges and even to 'take them as fun'. His account demonstrates that the production of twentieth century clinical 'norms' of puberty was dependent upon

children living in an atypical situation that was sometimes violent and frightening: Howard describes being repeatedly hit by a slipper for wetting his bed and includes a photograph of a group of children in which one boy is wearing the shaming rubber shorts. Tanner, in contrast, assumes in his writings that children's experiences of participating in the Harpenden study were neutral and is, as noted above, very positive about the lives of the children at the National Children's Home.

Scientific and clinical assumptions about the effects of studying and particularly photographing children have recently come under scrutiny, in large part because of the effective activism and scholarship around people born of indeterminate sex (Holmes, 2009; Hughes et al, 2006). Although stating that 'there are no data on the impact that being photographed may have on the patient or their family,' for example, Creighton et al (2002: 67) argue that being photographed, particularly naked and as a child, is likely to have negative effects on at least some patients. 'Medical photography is not a "neutral" act,' they assert (Creighton et al, 2002: 67). Children with atypical sexual morphology were often, and are still today, photographed naked, with particular attention paid to their genitals. Such photography is sometimes justified clinically (to record a pre-surgical state of the body, for example) but other times is 'simply' a snapshot taken for no clear purpose. Although the Harpenden children were not photographed for clinical purposes, their experiences of being photographed naked may be similar. Indeed, Creighton et al (2002: 69) show that even images taken of visually 'normal' bodies can cause later distress. They suggest that 'it is reasonable to assume that taking pictures of intimate areas such as breasts or genitals, or a naked full body, would be more likely to cause

psychological distress' (2002: 68) and conclude that full naked body images are intrinsically unethical and potentially so damaging that they should never be taken (see also Hughes et al, 2006).

Such photographs also travel in relatively uncontrolled ways: people diagnosed with intersex conditions report unexpectedly coming across images of themselves as children whilst seeking information on their conditions (Creighton et al, 2002: 68). The images used in the Tanner study, as mentioned above, have a similar ongoing life: not only were participants photographed over many years, the images of their naked bodies are repeatedly reprinted in scientific and clinical texts (for example, the *Cambridge Encyclopedia of Human Growth*) and are available on the internet.

My aim here is not to represent the Harpenden participants as victims but to acknowledge their contribution to Tanner's research and to take seriously the ethical implications of their involvement. My thinking has been strongly influenced by Howard's website. As well as his detailed descriptions, the site contains a set of 'souvenir photographs' that were offered as a treat for participants for good behaviour during the tests. Such images, Howard writes, recognised that they 'had done all everything the people in the white coats had asked.' The photographs show fully clothed children laughing or smiling at the camera, their arms around their friends' necks and waists, seemingly enjoying the experience of posing. Here the gridlines of the photogrammetric equipment and the turntable fade into irrelevance and the young people's liveliness takes centre stage.

Conclusion

Tanner and Whitehouse's study constitutes a typically twentieth century approach to bodies, both attempting produce standards through measurement and analysis and in so doing recognising and documenting variation and differences. Recent scientific work on rising rates of early puberty builds on this tradition: scientists count bodies, plot graphs, make international comparisons and build health policies and treatment protocols around such statistics, whilst at the same time acknowledging that very little is understood about the causes of such trends or indeed the processes initiating puberty in any particular child's body. Contemporary research from a wide range of disciplines also describes children travelling on diverse paths into early puberty: they are adopted internationally, they experience racism, they are overweight, their fathers do not take care of them. Such children do not form coherent populations and their physiological experiences constitute compelling 'mysteries' for contemporary biomedicine and technoscience (Roberts, 2010).

In my analysis, Tanner and Whitehouse's fastidious documentation of sexual development highlights a significant conceptual and ethical point: that it is impossible to clearly distinguish between the physiological, psychological and social aspects of bodies. These elements are always entangled, moving in and out of focus but remaining constantly in productive play. Tanner and Whitehouse's Subject 99 exemplifies this most directly: his short stature, they argue, is 'due to psychosocial stress.' But the same could be said about the development of all the children involved in the Harpenden study *and* of the children described in the contemporary scientific literatures on puberty. In each case, growth and sexual development is a

result of an entangled mix of psychological, social and physiological factors.

Contemporary discussions of changes to pubertal timing, in my view, need to take account of this entanglement and understand where, how and why particular conceptual cuts are made to distinguish the physical, psychological and the social in stories of early developing bodies. Tanner's decision not to include psychological testing, as he himself admitted, skewed the story of child development towards physical explanations, sidelining the psychosocial situation of the Harpenden participants as institutionalised children.

Coming to terms with the historical production of norms and standards like the Tanner Scale rings a salutary note for analysts of contemporary claims about changes to pubertal timing. Tanner's own cautions and recent scientific criticism notwithstanding, the Tanner Scale has functioned effectively for many decades as an international measurement tool and standard depiction of 'normal' developmental stages. Exploring the Scale's history, I conclude that Tanner and Whitehouse's research should not, either ethically or scientifically, be relied upon to provide ahistorical physiological 'norms' or standards. In contrast, however, I suggest that the great and consistently overlooked value of Tanner and Whitehouse's research is its illumination of the bio-psycho-social entanglements constituting both growth and sexual development. Paying detailed attention to Tanner and Whitehouse's complex encounters with the Harpenden children encourages us to honour and explore this entanglement rather than bury it inside standards. Such exploration will produce richer accounts of pubertal development that both recognise the contribution of the Harpenden children to international research on puberty and move Tanner's

contention that growth is a complex mix of biological and psychosocial factors onto new political and empirical ground.

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