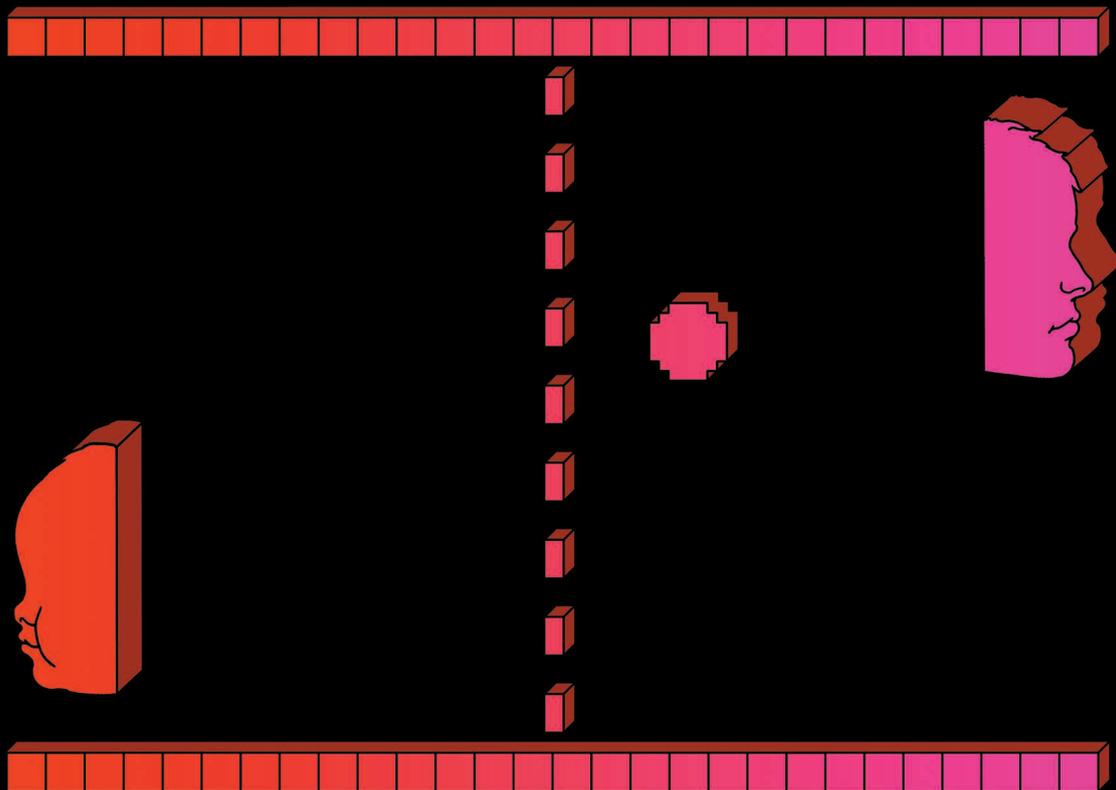
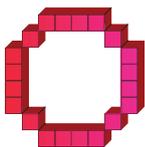


THE SHIFTING BOUNDARIES OF ADOLESCENCE



RESEARCHERS STRUGGLE TO DEFINE THE SPAN OF TIME BETWEEN CHILD AND ADULT.



In the days when Roy Laver was summoned to be measured, he knew to expect two things. “You were going to be cold,” he says. “And you were going to be starkers — in the nude — with lots of adult people looking at you.”

Every few months from 1949 to 1971, dozens of youths, Laver included, were marched to a specially outfitted (but poorly heated) wing of the Harpenden branch of the National Children’s Home, near London, UK. The

BY HEIDI LEDFORD

home was a charity-run institution that took in neglected youngsters. Laver, now 80, put up with periodic testing there as part of a ground-breaking study to define adolescence.

Each battery of tests took about 3 hours. There were calipers to assess body fat, photographs and X-rays to record growth, and a physical and dental exam. The boys and girls were pleased to miss an afternoon of school, says Laver, but they came to dread the calipers’ pinch on their scrawny frames. “If you didn’t have a lot of fat, it bloody



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ILLUSTRATION BY ERIC NYQUIST

hurt,” he says. “It took six or seven tries to find some.”

The data from that study are still used today to track a child’s progression through growth spurts and puberty towards sexual maturity — a journey that the study’s lead investigator, paediatrician James Tanner, used to define a firm, physical beginning and end for adolescence.

But few researchers feel that same certainty today. Adolescence is nestled between two transitions — the end of childhood and the beginning of adulthood — with malleable borders. Epidemiological data suggest a trend towards earlier puberty in some countries, including the United States and China; at the other end of the spectrum, societal changes and a growing awareness of the timeline of brain development are pushing the accepted threshold for adulthood well into the twenties.

Scientists, clinicians and policy-makers now find themselves wrestling with these shifting frontiers and asking anew: when does childhood end, when does adulthood begin, and what exactly happens in the middle?

Without a good definition of what adolescence is, it’s difficult to nail down what protections and responsibilities adolescents should have. The debate is taking on more urgency as researchers have realized that adolescence helps to set the trajectory for adult life, and as judges and doctors try to fix boundaries on when a person is competent to make adult decisions. “Clarity regarding our conceptualization of adolescence is not just semantic nit-picking,” says Jay Giedd, a neuroscientist at the University of California, San Diego. “It has profound implications for clinical, educational and judicial systems.”

The lack of a clear definition could also be choking off funding for research on adolescence, which tends to take a back seat to research on early childhood. “One of the reasons adolescence has suffered in terms of financial support and has generally been put at the back of the queue is because the definition is quite difficult,” says Anne-Lise Goddings, a developmental neuroscientist at University College London. “It’s hard to give money to something when you can’t say what it is.”

TURNING POINTS

Generations of researchers have painted adolescence as a span of unremitting hazards on the road to adulthood (see page 426). In 1904, US psychologist G. Stanley Hall wrote an influential two-volume opus on adolescence, which he concluded was between the ages of 14 and 24. Hall, who focused his analysis largely on white boys, promoted the idea that adolescence is a time of upheaval. He blamed the mass media — in the form of cheap fictional pamphlets called ‘penny dreadfuls’ — as well as ‘immoral’ activities such as drinking and dancing for leading youths astray.

That narrative of fear still prevails, says Nancy Lesko, a sociologist of education at Columbia University in New York City. Lesko worries that the widespread perception of adolescents as irrational risk-takers could bias everyone from policy-makers to researchers. “My guess is that there are lots of changes going on in adolescence that we’re missing because adults, including researchers, are still clinging to these dominant narratives,” she says.

Half a century after Hall, Tanner embarked on his Harpenden growth study. It began as an effort to track the effects of improved, post-war nutrition on child development, but would become the most influential quantitative picture of adolescence. Tanner’s team meticulously detailed changes in height, weight, fat, breast and testicle sizes, the thickness of pubic hair, and a host of other physiological characteristics.

Tanner broke down his data into a sequence that has been simplified into the ‘Tanner stages’. Stage I describes the body before the onset of puberty. In Tanner’s study, this occurred at about 11 years old, on average, in girls, with boys following six months later. During Stages

II, III and IV, the breasts and testes enlarge. Menarche, a woman’s first menstruation, is a relatively late event and typically begins at Stage IV. Stage V marks puberty’s completion: for the adolescents in the children’s home, this happened at about age 15. The value of the study was in defining the progression of events associated with adolescence; Tanner himself noted that the ages at which they occurred varied too much to be of wide use.

There are questions about how relevant Tanner’s data are to today’s children, says Celia Roberts, a sociologist at Lancaster University, UK. Some of the participants had arrived at the children’s home after enduring years of neglect. During Laver’s time at the home, nutritious food was in short supply: most meals leant heavily on potatoes, whereas meat, in the form of Spam, was served about twice a week. Laver took to scraping the cooking pots to scrounge a few extra bites, earning him the nickname ‘fatty’ — although he says he would have been considered slender by today’s standards.

Despite its shortcomings, Tanner’s catalogue of puberty has become entrenched. Researchers have suggested other scales, some based on different definitions of maturity, others based on hormone levels or voice changes. None has had Tanner’s staying power, says Frank Biro, a paediatrician specializing in adolescent medicine at Cincinnati Children’s Hospital in Ohio. Even if the growth curves are a little off, the stages provide a useful point of reference, he says. Biro keeps a signed copy of one of Tanner’s books on his shelf and still uses the scale in his research.

In today’s adolescents, Tanner’s stages may be shifting because the onset of puberty — Stage II — is starting earlier in many populations. Tanner already saw signs of this in his studies. Although food was scarce at the children’s home, the residents there were better fed than many children living a century before. He thought that this improved nutrition could account for a reduction in the average age at menarche since the mid-nineteenth century¹.

That trend towards earlier puberty has continued, and is most notable in girls. A study² of Danish children found that the age of onset of breast development dropped by a full year between 1991 and 2006, to just younger than 10 years. In China, between 1985 and 2010, the age at which a girl gets her first period also dropped by a year³.

Biro’s studies have shown differences between ethnic groups: since the late 1990s, the age at which breast development begins has decreased more among white girls in the United States than among African American girls, who were already developing breasts at a younger age.

The evidence strongly suggests that in many parts of the world, this change is at least partly due to the rise in overweight and obese children, Biro says. Several mechanisms might link obesity to the time of onset of puberty. One is that excess body fat increases oestrogen production, which in turn stimulates the growth spurt and breast development associated with puberty. (For boys, the trends are more complex: one study⁴ of US boys found that overweight white and African American boys enter puberty earlier than boys who are underweight, but obese boys tend to enter puberty a little later.)

Researchers are trying to decipher what impact this earlier entry into puberty has on the normal progression of adolescence. “You have some of these girls who at age seven and eight are clearly into puberty,” says Biro. “But are they adolescents yet?”

In some ways, they might be. Studies have found that earlier-maturing girls exhibit risk-taking behaviours that are typically associated with adolescence⁵. And in a survey of more than 700 magnetic resonance imaging scans from 275 people, Goddings and her colleagues found some changes in the brain that correlated with the Tanner stage of their subjects. For

“THERE IS NO SUCH THING AS AN AVERAGE ADOLESCENT.”

example, the growth of the amygdala, a brain region involved in processing emotions, was influenced by chronological age and by the onset of puberty⁶.

Goddings urges caution when interpreting the results: she does not yet know whether the growth patterns trigger behavioural changes common to adolescence or whether they are a response to such changes. A 9-year-old girl, for example, whose breasts have begun to develop might be treated differently by the people around her. This shift could prompt her to behave differently from a prepubescent girl of the same age, with corresponding changes in brain activation. “If a 9-year-old goes through puberty that probably does change something about the brain,” says Goddings. “And yet in many ways they are still a 9-year-old.”

ON THE THRESHOLD

The definition of the end of adolescence — the emergence into adulthood — is even more nebulous. Although Tanner equated this with the end of puberty, many today use a different definition of adolescence that extends well beyond that point. This could have implications for everything from determining when a criminal can be tried as an adult to when a youth becomes responsible enough to make their own medical decisions.

There is no physical measurement that can capture the beginning of adulthood, say researchers. Often they set the end of adolescence on the basis of social roles. “We don’t have an equivalent physical definition of the end of adolescence,” says John Coleman, a psychologist at the University of Oxford, UK. “It’s lacking a clear definition because it combines social and physical developmental factors.”

Those social roles vary widely by culture and era, opening up the definition to a range of interpretations. Tanner tethered the end of puberty to the onset of adulthood, which coincided with social forces in post-war Britain: Laver, for example, left the children’s home at 16 to take a job as a clerk in a police station while living with relatives.

But in many societies today, the conventional markers of adulthood are slipping to later in life. Young people spend more years at school, live with their parents for longer, and delay marriage and parenthood. Marriage, in particular, has historically been a key marker for adulthood in many cultures, says anthropologist Alice Schlegel at the University of Arizona in Tucson. The average age of women at first marriage has risen by two years globally over the past two decades, according to the United Nations. In some countries, that increase is more dramatic: in Brazil the average age has increased by 6 years to 27, and in several European countries the age is creeping over 30.

And whereas Tanner could only speculate about changes in the brains of his young subjects, studies by today’s neuroscientists have bolstered the idea that adolescence does not stop in the teenage years. The prefrontal cortex, considered the seat of executive functioning and responsible for the ability to plan ahead and to resist impulses, typically does not come fully online until the early twenties — or later⁷. “The brain doesn’t suddenly become adult at age 18,” says Sarah-Jayne Blakemore, a neuroscientist at University College London.

But if not then, when? The hotchpotch of definitions in research articles, social policies and laws around the globe reveals a wide range of opinion about the end of adolescence (see ‘Sliding scales’). The World Health Organization set its boundaries at ages 10 and 19, but Susan

Sawyer, chair of adolescent health at the University of Melbourne in Australia, and her colleagues have argued⁸ that this upper boundary should be raised to 24. In 2017, New Zealand revised its regulations regarding children in protective care: rather than sending them out on their own at the age of 18, the government continues to provide support into their twenties. The change came in response to reports that the adolescents

were not coping well with independence at younger ages.

As helpful as it would be to have a fixed, biological end point to adolescence, neuroscientists are unlikely to derive one, says Blakemore. Ultimately, the end point of adolescence is a social construct, she says, with large differences between cultures. And there is so much variation in brain function and structure from person to person that it may not be possible to nail down a suitable biological end point. “There is no such thing as an average adolescent,” Blakemore says.

That can confound research by making it difficult to compare and interpret results across studies. And it complicates social policies by yielding a patchwork of inconsistent guidelines. But Beatriz Luna, who studies neurocognitive development at the

University of Pittsburgh in Pennsylvania, sees the differing definitions as a reminder of the complicated and gradual changes that occur in the brain as it specializes for adult modes of action — a process that continues into adulthood. “I don’t believe the brain has an abrupt change that will determine the end of adolescence,” she says.

At the National Children’s Home in the 1950s, however, there was no discussion of when adulthood began, says Laver. At 16, Laver simply left to take a job, later attending a technical college before embarking on a career in the Royal Air Force. During Tanner’s study, Laver says he was told that no one would see the pictures that had been taken of him, starkers and shivering, at the National Children’s Home. But twice, some of the older students stumbled across them in a nursing magazine. Black bars obscured much of the faces in the photos, but Laver easily recognized some of his classmates.

Many physicians are unaware of the full history of the Tanner scale, says Roberts, who has written about the growth study. “When clinicians have heard me talk, they are quite shocked,” she says. “We just wouldn’t do that to kids anymore.”

But Laver looks back on his days in Harpenden with affection, and with respect for the charity’s efforts. The standards of child care were different back then, he says. And participation in the study was voluntary — sort of. “We were told to put your hand up if you would like to have half a day off school,” Laver says. “And up went young Roy’s hand.” ■

Heidi Ledford reports for Nature from London.

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