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News, Views and Comments

Kin recognition by olfactory cues: What can twins tell us?

In 1875, Sir Francis Galton alleged that 'It would be an interesting experiment for twins who were closely alike, to try how far dogs could distinguish between them by scent'.[1] Galton never tried this experiment, but later investigators have pursued this line of inquiry in fascinating and informative ways. Unfortunately 80 years passed before H Kalmus, of the Galton Laboratory in London, picked up where Galton left off. Kalmus began with an intriguing anecdote.[2] A nearly blind, not very friendly great dane named Silvia was especially fond of a particular prospector in the camp where she resided. When a newcomer arrived, Silvia displayed unusual affection toward this individual. It turned out that he was the identical twin of the favoured prospector, raising the possibility that the dog had reacted to the MZ twins' similar body odours, products of the chemical similarities in their sweat.

Kalmus was the first to undertake a series of retrieval and tracking studies testing canine recognition of MZ twins by means of olfactory cues. His work is well worth a second look, not only because it led to further studies, but because it may encourage additional innovative efforts by current investigators.

Kalmus first established that dogs could match the odour of a given individual by selecting the correct handkerchief, from an array, when its scent corresponded to that of a target handkerchief (retrieval studies). He also determined that dogs could follow the path of an individual after encountering his or her handkerchief in a field, and avoid the path of a different individual (tracking studies). Participants included three MZ female pairs and one MZ male pair. Zygosity was determined by blood group analysis. In the first retrieval study a dog, Chloe, correctly matched a twin's hand scent to this individual's handkerchief. However, when the co-twin's handkerchief was substituted in the array (which included the twin's non-twin sister, her father and unrelated participants), the dog chose it. Most interesting, when both twins' handkerchiefs were available, the dog retrieved whichever one was encountered first, after which the co-twin's handkerchief was selected. In this second context, the dog showed no apparent preference for either twin.

Kalmus' second set of studies yielded different results: dogs could distinguish between the odours of co-twins from two MZ twin pairs, one male and one female, in a tracking task. Specifically, when the odours of both twins were present simultaneously, the dog followed the one matching that of the garment presented initially. Despite these interesting findings, 33 years passed before the question of whether odour differences arising from environmental sources may have affected the dogs' discrimination of co-twins in the tracking task.

In 1998, Peter G Hepper, of the Psychology Department of Queen's University, Belfast, brought together infant twins and dogs in a trio of studies aimed to disentangle genetic and environmental effects on body odours.[3] In experiment 1, participants were 10 DZ male twin pairs aged 2–3 months. All twins were living together and were fed identical diets. Each infant wore a white t-shirt for a 24-hour period that was then stored in a sealed plastic bag for later use. Four dogs could distinguish between co-twins, implicating genetic factors in body odour. In experiment 2, participants were 10 male MZ twin pairs between 34 and 50 years of age. All twins were living apart, were married, and ate different diets. Dogs correctly discriminated between co-twins, based on the odors of their garments, but experienced greater difficulty in making these discriminations than those in the first experiment. Thus, despite the genetic identity of the individuals, environmental differences allowed the twins to be differentiated by olfactory cues. The possibility that transient household odours facilitated these discriminations was, however, not substantiated. In experiment 3, participants were 10 sets of identical male twins aged 2–3 months. Again, all twins were living together and were fed identical diets. Dogs were unable to distinguish between co-twins, showing that both genes and environments affect body odour, and that when both are held constant, individual twins' body odours are not identifiable.

Can humans discriminate between MZ and DZ co-twins using similar methods? A twin-based approach to kin recognition by olfactory cues has emerged only recently. This may be explained by increased interest in evolutionary perspectives on human behaviour, mounting evidence that both human and non-human relatives can discriminate kin from non-kin by olfactory means, and greater appreciation for what twin studies reveal about behavioural processes.

In 1987, Richard H Porter, currently of the Laboratoire de Comportment Animal, in Nouzilly, France, proposed that 'humans actually have genetically-determined biochemical "fingerprints" that serve as a basis for individual odours ... one would expect a correlation between genetic similarity and odour similarity' (p 195).[4] For example, researchers showed that adults distinguished between the odours of garments worn by siblings from whom they had been separated for 1–30 months, and age and sex matched stranger.[5] A twin-based approach to this issue would seem informative, but only a single study had been conducted prior to 1980. In 1977, Patricia Wallace, of the Psychology Department at Clarion State College in Clarion, Pennsylvania, subjected 16 female observers to the palm odours of a pair of MZ female co-twins on the same diet, a pair of MZ female co-twins on different diets and a pair of unrelated females, all adults.[6] Observers could more effectively distinguish between the unrelated females than between the twins. They could, however, more easily differentiate between the co-twins on different diets than between the co-twins on similar diets. These results are consistent with those of Hepper showing that both genes and environments affect body odour, and that judges can perceive olfactory differences among people.

I searched the psychological and medical literature for additional

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human twin studies along these lines, but none had been conducted. (Human kin recognition studies using non-twin relatives have been performed and an extensive review is available.[7]) I was curious to know if the odours of T-shirts worn by MZ twins were less easily distinguishable than those of DZ twins. My former students, Michelle Grimes-Hillman and Tari D Topolski contributed to this effort.[8] T-shirts were worn for three consecutive nights by members of 21 MZ twin pairs and 16 DZ twin pairs. Participants ranged in age from 10.6 to 25.8 years, and zygosity was determined by blood-typing or by physical resemblance questionnaire. Eleven judges sniffed T-shirts to identify the garment worn by a 'relative' from among a group of three T-shirts, which included the co-twin's T-shirt and the T-shirts of two unrelated twins, matched for sex. Contrary to prediction, the proportion of correct identifications for MZ twins did not significantly exceed that for DZ twins. The lack of both genetic relatedness and social familiarity between twins and judges may explain the findings – most human studies in this area have used genetically related subjects and assessors.

There is yet another crucial twin study waiting to be conducted: olfactory identification of MZ and DZ twins by their co-twins. Recall that interest in the bases of human kin recognition is traceable, in part, to Hamilton's (1964) theory of kin selection.[9] Hamilton asserted that natural selection favours behaviour that reduces the reproductive fitness of organisms if the behaviour enhances the fitness of organisms who are genetically related. This reasoning implies that mechanisms exist that assist recognition of closely related kin, as well as discrimination between kin and non-kin. Animal research includes an extensive series of studies showing recognition of conspecifics, and communication of characteristics such as sex, and social and reproductive status.[10] The possibility that humans may possess such capabilities has excited researchers for some time because it suggests that attraction and recognition may be partly influenced by olfactory cues, even if less effectively than by auditory or visual means.[6]

A study of olfactory recognition of twins by their co-twins could organise twins according to similarity in diet and living status (apart vs together). Twin-family arrangements, involving married MZ and DZ twins, their spouses and children, would allow additional tests of genetic and environmental effects. In this design, it could be determined if twin parents were more sensitive to the odours of their own children (with whom they share both genes and environments) than to their co-twin's children (with whom they share only genes). The addition of twins reared apart from birth would be especially revealing in this regard: More successful identification of co-twins' odours by recently reunited MZ than DZ twins would furnish compelling evidence of human ability to recognise relatives by olfactory means. James A Gall and Dr Glenn Weisfeld, of Wayne State University in Detroit, have suggested adding half-siblings and step-siblings to these research studies for informative contrasts with twins and full siblings.[11]

Medical reports and more

Conjoined twins: differential energy metabolism

There is a common expectation that conjoined twins (believed to result from delayed zygotic division) should be unusually similar, given their physical connectedness as well as their genetic identity. Medical and psychological profiles of these unusual cases, which occur in approximately 1/200 MZ twin births, indicate otherwise. In fact, as is true of ordinary MZ twins, the behavioural and physical variations within these pairs are compelling examples of how early environmental events can induce divergent development. A new study by Dr Mark Powis and colleagues in Great Britain is an informative addition to knowledge in this area.[12]

The twins under study were thoracopagus females, aged 2 months. Thoracopagus twins share part of the chest wall and usually experience chest and upper abdominal abnormalities. They represent the most common form of conjoined twinning, occurring in about 40% of cases. The larger, heavier twin of the pair in this study appeared to grow at a faster rate than her smaller co-twin even though the smaller twin fed better. For example, the smaller twin (3.40 kg) consumed 610 ml of formula, as compared with her co-twin (4.74 kg) who consumed 410 ml. It was suspected that the smaller twin was supplying nutrients to her co-twin through their shared liver. This idea led the investigators to compare energy expenditure in the twins prior to surgical separation (at 73 days) and following separation (at 97 days); separation took place at 85 days.[17]

In both twins, resting energy, whole-body oxygen consumption and carbon dioxide production increased following separation, but co-twin differences narrowed. Resting energy expenditure (and substrate utilisation) did not differ significantly for the smaller twin between study periods, although the larger twin showed a substantial increase. Post-separation weights were 3.71 kg for the smaller twin and 4.08 kg for the larger twin. This study is the first to demonstrate conjoined co-twin differences in rates of energy metabolism prior to separation. This work may help to explain previously observed differences in size and appetite between twins who fail to separate fully.

Improving pregnancy outcome when one twin foetus is malformed

Multifoetal pregnancy reduction (MPR) is sometimes performed to enhance the survival chances of two or three remaining foetuses. This procedure, which involves injecting potassium chloride into the chest cavity to disrupt cardiac function, typically takes place at 9–11 weeks' gestation. Of course, MPR poses difficult emotional hardships for expectant parents. It can also pose serious physical risks for surviving foetuses, including premature delivery or damage. Given ethical issues surrounding MPR during later stages of pregnancy, only a handful of reports concerning delayed (24–34 weeks) selective foeticide of a malformed twin have appeared. These studies, conducted at various medical facilities, have reported favorable prenatal outcomes for healthy surviving co-twins. A more recent study in this series presented findings from 23 consecutive foeticide procedures involving twins discordant for a major malformation. This work, conducted by Dr Josef Shelev and colleagues in Israel, was undertaken by request of

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the families and with consent from the institutional approval committee.[13]

Foetal genetic or structural abnormalities were detected in 23 pregnancies at 18–24 weeks' gestation, and MPR was undertaken at 28–33 weeks. Pregnancies were uneventful following the procedure. Delivery occurred 4–11 weeks later; in 13 cases delivery took place at 35–37 weeks and in 10 cases delivery took place at term. All newborn twins received betamethasone at 26–29 weeks to enhance their lung development. The birth weights of surviving twins exceeded 2000 g, and their survival chances were considered excellent. The investigators concluded that postponing MPR until the beginning of the third trimester can improve survival outcomes of healthy twins. They urge its application at about 30 weeks, given the possibility of preterm labour, as well as ethical issues surrounding delayed foetal reduction.

Co-bedding twins: need for further research

Co-bedding refers to the placement of infant twins in a common incubator or crib. It is a concept that is being increasingly explored in an effort to provide optimal care for newborn twins. Potential benefits include a more stimulating environment for each twin that will foster their growth and development. It is thought that parents acquire a greater sense of control if allowed to decide on this aspect of their twins' care. Possible hazards to co-bedded twins include administering medications or interventions to one twin that were intended for the co-twin. Risks of infection or disturbed sleep are also elevated when twins are placed together. Issues surrounding the co-bedding of twins and proposed guidelines are further described by Kathy DellaPorta, RNC and colleagues.[14]

Until systematic research on co-bedding twins is undertaken, it seems that decisions should be taken on a case-by-case basis.[15] Judgments will, of course, rest partly on whether hospitals have sufficient staff and other resources to permit this particular arrangement. Interestingly, surgical separation of conjoined twins prior to their awareness of being twins is recommended for fostering their psychological well-being. (The age and manner in which twins first acquire knowledge of their twinship is, however, uncertain.) Following surgery, formerly conjoined twins are often kept in close proximity, sometimes assisted by mirrors.[16] The benefits of such procedures are assumed, but are untested, probably due to the variable medical circumstances of each surgically separated pair.

Environmental influence on H. pylori infection

Co-twin control designs can be effective ways of investigating environmental influences on behavioural and medical traits. Helicobacter pylori infection is a bacterium found in the stomach within the mucous layer. It is the most common bacterial infection found in humans – it is pervasive in the Third World and present in approximately one-third of the United States population.[17] It is also present in 90% of individuals affected with duodenal ulcers and 70% of individuals affected with gastric ulcers. (The infection can be eliminated by various antibiotics, such as tetracycline and metronidazole, thus healing the ulcers.) An association between H. pylori infection and stomach cancer has also been reported. Prevalence of H. pylori infection is also known to be higher among members of lower income, lower education and lower social class groups.

Using a natural co-twin control design, Hoda M Malaty of Houston's Veterans Affairs Medical Center and colleagues at the Karolinksa Institute in Sweden, assessed environmental and dietary effects on H. pylori infection.[18] Research participants were monozygotic (MZ) twins reared together and apart who were registered in the Swedish Adoption/Twin Study of Aging (SATSA). First, it was established that various environmental measures (crowded living conditions in childhood, parental educational/occupational status and childhood economic status) were associated with infection. Next, paired comparisons of infection discordant twins revealed significant associations in twins reared apart, but not in twins reared together. Specifically, childhood living conditions and economic status were less favourable for infected reared-apart twins, compared with their non-infected co-twins. This finding thus identifies childhood as a risk period for acquiring H. pylori infection. Person-to-person transmission is suggested in view of the infection's association with crowded living conditions. Contrary to previous research findings, ascorbic acid consumption was higher among infected reared-apart twins than their non-infected co-twins.

Triplet pandas born in captivity

A trio of giant pandas was born in captivity on 18 August 1999 at the Chengdu Giant Panda Breeding Center, in southwest China.[19] This was the first time such an unusual birth had taken place. Each triplet was in good condition, weighing 140 g (4.9 oz) – panda cubs typically weigh 3.0 to 4.5 oz. This conception resulted from artificial insemination in the previous May.

Twin births are not unusual in the Giant Panda. Following fertilisation, the zygote undergoes delayed implantation and division, floating freely within the uterus, for several months. Following attachment of embryos to the uterine wall, gestation lasts for 8 months until delivery of one or two cubs.[20] The zygosity of the new triplets was not reported.

Twins born apart and together

Born apart: are they really twins?

We are hearing more about twins born on different dates. In August 1999 an Italian mother delivered her second twin daughter 18 days after the birth of the infant' twin sister at 23 weeks.[21] This was the first time that Italian obstetricians had succeeded in keeping one twin in the uterus following the premature birth of the first. This was accomplished by administering large doses of drugs to prevent infection after the first placenta and part of the umbilical cord were left in place following the first delivery.

Other deliveries featuring separate births challenge traditional notions and definitions of twinship. A 38-year-old Californian woman experienced three unsuccessful attempts at pregnancy via in vitro fertilisation.[22] It was determined that her endometrium (uterine lining) was too thin to sustain a pregnancy. An unexpected solution

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came in the form of an offer from her younger sister to carry the baby in her place. Eighteen eggs were extracted from the patient and fertilised with her husband's sperm. In addition to implanting three embryos in the sister's uterus, the physician decided to implant several embryos in the infertile woman's uterus, as well – two weeks earlier he had prescribed aspirin, a treatment that elevates blood flow and possibly the chances for pregnancy. Both women became pregnant, delivering healthy male infants 16 days apart. The children have been called 'twins' in the popular press and will be raised as such. However, some details of their earliest beginnings depart from the strictest definitions of twinship.

In my recent book, Entwined Lives, I developed criteria for twinship: simultaneous conception, common parents, shared intrauterine environment and concurrent birth.[7] I did point out that some natural twinning events, eg superfoetation (in which fraternal twins are conceived at different times, occasionally by different fathers) and premature birth of one twin (as happened in Italy, see above) would not deny twinship status to the individuals involved. The infants in the present case did not share intrauterine environments, nor dates of birth, because of the reproductive techniques that created them. Furthermore, a range of maternal factors, including diet, exercise, medications and stress can affect foetal development, so (unlike twins) children born to different women would be exposed to different prenatal factors. (Of course, prenatal factors are not equivalent for twins, but for other reasons, such as foetal crowding or twin–to–twin transfusion. These are events to which separately gestated siblings would not be subject.) I would argue that the children in this case are 'twin-like', but not twins. In view of the many new sibships created by assisted reproductive technologies it may be worth developing new terms to appropriately refer to such births. Researchers also need to consider whether they would pool such cases together with ordinary fraternal twin samples.

In Entwined Lives, I cite the example of identical twins married to identical twins whose children were born within one hour of each other. The intrauterine environments of these women were surely more similar than those of the women who delivered the California infants. In fact, in addition to being cousins, the unique circumstances of these children's births rendered them genetically equivalent to fraternal twins. However, such children, would not be considered twins because they were conceived by different couples and gestated in separate wombs.

Twin Falls Idaho: conjoined twins revisited

A recently released film, Twin Falls Idaho, features identical twins, Mark and Michael Polish, who were also the writers and producers.[23] It is a captivating story of conjoined twins (played by the Polish brothers) whose behavioural differences and interdependencies are accentuated when a young woman enters their lives. The most rewarding aspect of this film is that the twins' humanity is revealed throughout, touching upon themes of psychological connectedness and separation that are universal.

The embryological bases of conjoined twinning are not well understood, but delayed zygotic splitting (fission hypothesis) is the most widely accepted model. The partial joining of separate embryos (19th century fusion hypothesis) is no longer a widely acknowledged explanation.[7] As early as 1923, Professor Horatio Newman observed that the body symmetry of many conjoined twins rendered the fusion hypothesis unlikely.[24] Dr Rowena Spencer, former Professor of Surgery at Tulane University School of Medicine, in New Orleans, has revisited this controversy.[25] Based on a review of over 1200 cases, she argues for the existence of rachipagus conjoined twins, in which partners are attached dorsally in the vertebral column. She proposes that they originated from two embryonic disks situated on opposite sides of a single amniotic cavity. Her interpretation will undoubtedly revive interest in events underlying conjoined twinning.

Tribute to Chang and Eng

Conjoined twins, Chang and Eng Bunker, joined at the chest, were born on 11 March 1811 in Siam (now Thailand).[26] They left their home at age 17, heading for the United States with two British businessmen who involved them in circus exhibitions and other performances. The twins eventually left the circus and moved to North Carolina where they bought farms, married sisters and raised 21 children between them. They died only two hours apart on 17 January 1874.

On 13 August 1999, the twins' hometown of Samut Songkhram unveiled a commemorative statue in their honour. The twins, who have been so famous around the world, have been relatively unfamiliar to residents of their native land. A museum dedicated to Chang and Eng may soon follow.

Parallel lives

Events in the lives of 67-year-old identical twins, Richard and Robert Tenniswood, reveal the scientific side of some identical twins' striking medical similarities. One twin experienced severe chest pains, later diagnosed as a heart attack. While recovering in the hospital, his twin brother appeared for treatment of the same symptoms.[27] Identical twins' genetically-based, coordinated expression of behavioural and physical traits is often misinterpreted as a parapsychological phenomenon or 'uncanny coincidence'. There is considerable scientific evidence to refute this notion.

Sir Francis Galton (1875) was among the first to recognise that identical twins often show synchrony in the timing and expression of behavioral and medical characteristics, associated with their shared heredity.[1] 'We are too apt to look upon illness and death as capricious events, and there are some who ascribe them to the direct effect of supernatural interference, whereas the fact of the maladies of two twins being continually alike, shows that illness and death are necessary incidents in a regular sequence of constitutional changes at birth, upon which external circumstances have, on the whole, very small effect… When the hands approach the hour mark, there are sudden clicks, followed by a whirring of wheels; the moment that they touch it, the strokes fall…' (p. 403). This body of observations is now a subject for serious study, defining the discipline of chronogenetics.

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I recently encountered another compelling example involving twins' coordinated expression of physical symptoms. The twins in question were 32-year-old MZ females, L and J. (L is a student at my university and shared her informative medical history with me.) I determined that the twins were MZ based on L's responses to a standard physical resemblance questionnaire[28] and inspection of photographs taken of the twins at different ages.) In the early 1990s, both twins experienced severe headaches, blurred vision and physical imbalance while living hundreds of miles apart from one another. L attributed these events to a sports accident in which she had been hit in the back of a head with a baseball. However, J experienced similar symptoms one year later, casting doubt on L's sports accident as a cause of her complaints. (J had suffered from headaches in her teenage years, but they were not serious.) Both twins were examined by different physicians who both prescribed antidepressant medication for their patients.

Finally, in 1993, J received a new diagnosis: Arnold-Chiari malformation (ACM). L then consulted several neurologists who concurred. ACM involves distortion at the base of the skull with protrusion of the lower brainstem and portions of the cerebellum protruding through the opening for the spinal column at the base of the skull.[29] The adult form, known as Type I, typically occurs in women during early adulthood, but may be asymptomatic until middle or late adulthood. Type II is present at birth and occurs more commonly, in approximately 1/1000 births. Life-threatening symptoms appear in childhood.[30] ACM was first described in infants by Cleland in 1883.[31] His report was followed by accounts of Type I and Type II by Chiari in 1891 who seemed unaware of Cleland's work. Three years later, Arnold described the malformation in a newborn infant. Two of Arnold's students furthered his efforts, revising the defining features of the different types. Inconsistencies in current terminology exist today.

L and J have successfully undergone the same surgical correction, which involved a craniotomy (removal of part of the skull) and insertion of a dura patch to accommodate any build-up of fluid. L's symptoms have virtually disappeared, but her twin experiences continued pain and limb numbness. The presence of this rare disorder in MZ twins suggests a genetic component; the twins' mother also suffers from migraine. Additional information about the Arnold-Chiari malformation can be found at the ACM website: www.pressenter.com/~wacma/.

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Aging and memory decline

Is the speed of memory decline during life, and especially in old age, a genetic fate or are there environmental and life style conditions that affect the pace of deterioration of this important intellectual faculty? This question was addressed by a group of Californian investigators[1] in a sample of 94 MZ and 89 DZ male World War II veteran twins, aged about 72 years on average. The so-called California Verbal Learning Test (CVLT) was administered to all twins. This multiple trial recall and recognition word-list learning test measures four mnemistic characteristics: verbal learning and memory, response discrimination, learning strategy, and recognition memory. The intraclass correlation was significantly larger in MZ twins than in DZ twins for verbal learning and memory but not for the three other components of memory. Using a best-fitting maximum likelihood model, the investigators could estimate the contribution of additive genetic factors to verbal learning and memory to be about 56% and that of non-shared environmental influences 44%, implicitly indicating the absence of shared environmental effects. Recognition memory is completely or predominantly determined by non-shared environmental influences, whereas response discrimination and learning strategy seem to be under non-shared and same shared environmental control. These outcomes suggest important interventional possibilities for recognition memory, learning strategy and response discrimination in particular.

Authors hypothesise that the genetic variance for learning and memory could be linked to the APO E_4 gene on chromosome 19q13.2, the E_4-allele being a substantial risk-enhancer for Alzheimer's disease.

Foetal origins of pathology risk factors

There is substantial, though not uncontradicted,[2] evidence that conditions in the womb may be at the base of the development of disease in adult life. A major part of the research life of UK epidemiologist David Barker has been devoted to that association.[3,4] Low birth weight, for example, is a predisposing condition for higher blood pressure in children and adults, supposedly caused by relatively poor nutritional circumstances during pregnancy.

When this is true, say Sheila Williams and Richie Poulton from the University of Otago in New Zealand,[5] then one may expect that children with low birth weight in general, twins (weighing about 1000 grams less than singletons) and children from smoking mothers (being about 200 grams less than those of non-smoking mothers) have higher blood pressure in later life compared with children of normal birth weight, non-twins, and children of non-smoking mothers. These hypotheses were tested in a cohort of 1037 children born between April 1972 and April 1973 in two cities (Dunedin and Otago, New Zealand).

The investigators found that, contrary to expectation, systolic blood pressure in singletons was significantly elevated with about 4 mm Hg (both at age 9 and age 18 years) compared with that of twins. Blood pressure in children whose mothers had smoked during pregnancy was 1.54 mg Hg higher than that in children from non-smoking mothers. The total effect of birth weight appeared to be rather small but in the predicted direction (–0.78 mm Hg). There were no effects on diastolic blood pressure.

The twin–singleton difference is at odds with the foetal origin hypothesis but the maternal smoking effect confirmed the theory. These outcomes could be an indication that growth retardation that is caused by poor nutrition (such as may be the case when the mother smokes) should be distinguished from growth retardation that emerges from shorter gestation. Since birth weight discordancy in MZ twin pairs can only be ascribed to differences in access to nutritional resources and not to gestational age (which is per definition equal), one has an instrument to test this speculation.

Why do people differ in what and how much they eat?

What is the relative influence of genetic and environmental factors on habitual eating patterns? The answer to that question is important for both clinicians and researchers. Investigators from Richmond and Boston (USA)[6] have tried to give the answer by having 4640 male and female middle aged and elderly MZ and DZ twins fill out the so called National Cancer Institute food-frequency questionnaire. The researchers could distinguish two different eating patterns: 1. high in fat, salt and sugar, and 2. healthful eating habits. An average 16 to 17% of the variance in pattern 1 could be ascribed to genetic factors, whereas 36% of the variance in pattern 2 had a genetic basis. More than 60% of the individual differences in eating habits had to be ascribed to environmental conditions, most likely several types of social circumstances. This implies that there are considerable interventional possibilities.

Loss of bone because of immobilisation

One interesting methodological use of twins is comparing one MZ twin (being treated or being in a specific condition) with his or her co-twin as a control. This method was used by US investigators[7] who were interested in the effects of forced immobilisation on the speed of bone loss. They studied eight pairs of adult MZ twins, one of each pair having chronic spinal cord injury (SCI) which forced them to immobilisation. Bone mineral content (BMC) and bone mineral density (BMD) were measured in all twins. As expected, both BMC and BMD were significantly reduced in SCI twins. The duration of SCI was linearly associated with BMC and BMD. There is thus a continuous decrease in bone mass as long as immobilisation lasts. Age as such did not modulate this fall in bone mass (although one may be sceptical about the power of statistics that test this latter effect, JFO). The effects were strongest for pelvic and leg bone mass.

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