

New Sources of Reared Apart Twins; Research Reviews: Female Fitness in Male-Female Twin Pairs, Heritability of Olfactory Thresholds and the Twelfth International Twin Congress; Multiple Birth Conceptions: Rethinking Things; Double Donations

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Adoption agencies are expending greater efforts toward placing adoptive twins and siblings together in the same home. However, new sources of reared apart twins continue to be identified. Some of these sources are described, with suggestions for how individual cases can be used more fruitfully by interested researchers. Next, recent findings on the fitness of female twins from male-female pairs and the heritability of olfactory thresholds are summarized. Finally, new thoughts about some artificially conceived infants and artificial reproductive methods are considered. A generous donation to the Twins Days Festival, in Twinsburg, Ohio is also described.

New Sources of Reared Apart Twins

Separating twins at birth and placing them into different homes is the exception, rather than the rule. However, seven scientific studies and a number of case reports concerning reared apart twins include 881 pairs and 45 pairs, respectively; see Table 1. Note that other reared apart pairs have been identified, but may not have participated in ongoing research. (For example, some additional younger Swedish twin pairs completed in-person testing in studies by Pedersen and colleagues, Pedersen, personal communication, 31 July, 2007.) Understanding why twins are separated in the first place may help adoption facilitators develop means for keeping them together.

Illegitimate births, maternal health and financial concerns were the primary explanations for why participants in the

Table 1

Participant Samples of Reared Apart Twins: Published Reports and Case Studies

Study	N (pairs)
Newman, Freeman & Holzinger (1937)	19
Shields (1962)	38
Juel-Nielsen (1965)	12
Bouchard et al. (1990); Segal (2000)	135
Pedersen et al. (1991) ¹	351
Langinvainio, Koskenvuo, Kaprio, & Sistonen (1984)	165
Hayakawa et al. (2006) ²	161
Case study	N (pairs)
Farber (1981) ³	44
Sudarsky, Myers & Walse (1983)	1

Note: ¹Sixty-two MZ twin pairs and 141 DZA twin pairs completed in-person testing; 110 MZA twin pairs and 173 DZA twin pairs completed questionnaires (Personal communication, Deborah Finkel, 18 July, 2007).

²The Osaka University Aged Twin Registry consists of 12,000 twin pairs born before 1935. It is estimated that 10% of the Japanese twins born before World War II were reared apart (personal communication, Kazuo Hayakawa, 18 July, 2007).

³Farber's summary yielded 44 pairs, accounting for overlap among some studies and reports.

Minnesota Study of Twins Reared Apart were reared in separate homes. Even when twins might have been adopted together, some prospective parents were only able to afford one child, thereby sending the twins to different homes. Other ordinary events (e.g., parental divorce), as well as extraordinary circumstances (e.g., accidental switching at birth) also caused some twins to be brought apart.

The Minnesota study attracted approximately 10 pairs per year, a rate that seemed likely to decrease as adoption agencies became increasingly aware of the importance of twinship, and as single motherhood became more

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accepted. However, new sources of reared apart twins have emerged. In 1988, a surrogate mother delivered male–female twins for a woman who had sought her assistance due to reproductive difficulties (*Minneapolis Star & Tribune*, 1988). However, once the twins were born, the male child was given to the surrogate when a doctor suggested that raising two children might be difficult. The lawyer managing this case believed it was the first rejection of a surrogate-born infant due to its sex. It seems ironic that assisted reproductive technologies (ART), designed to help infertile families have children, could also be responsible for giving children away. The rates of twins and higher order multiples have escalated in recent years, largely due to the availability of ART. It is, therefore, likely that other multiples are being reared separately, but are attracting less attention than did the 1988 case. However, new sources of separated twins are emerging.

The Twelfth International Twin Congress was held in Gent, Belgium in July 2007 (see the review below). The congress included a symposium entitled, ‘It’s Always Better With Twins: Remembering the Life and Research of David T. Lykken’. As part of the symposium, I presented a brief overview of the early phases of a developmental study of young Chinese twins separated at birth. China’s One-Child Policy, enacted in the late 1970s, restricted child-bearing to one child for urban couples and two children for rural couples. This policy eventuated in the abandonment and later adoption of thousands of infants, mostly female; Chinese society favors male children. The abandoned children included sets of reunited twins who are participating in the first prospective developmental study of separately raised twins, at California State

University, Fullerton. This source of twins came to my attention in December 2001 following a contact from a mother who had adopted one member of an identical female set.

China recently revised its foreign adoption policies, denying adoptive children to individuals who are single, obese, older than 50 years of age and in poor physical health (Belluck & Yardley, 2007). However, international adoption is on the rise. Ethiopia is currently supplying the fifth largest number of adopted children to the United States. The number of American adoption agencies able to operate there increased from 1 to 22 since 2000. A recent newspaper article showed an American family surrounded by several adopted Ethiopian children (Gross & Connors, 2007). Two of the female children appeared to be exactly the same height and, in fact, were identified as twins. I wondered if other Ethiopian twin sets had been separated, and how many.

Twins are sometimes separated because of dishonesty and greed on the part of people with power. An alleged baby-selling scheme in Greece involved hundred of infants, some twins (Bonner, 1996). The following recent case in Ecuador is also disturbing.

A chance event in May 2007 led to the reunion of 15-year-old identical twin girls, Andrea Penaherrera and Marielisa Remo, in Milagros; milagros means ‘miracles’ (CBS News, 2007). The Penaherrera family entered a steakhouse and were surprised to see another family with a daughter who looked exactly like their own. It turned out that Marielisa’s father, Dr Roberto Remo, was the twins’ delivering physician who had performed a cesarean section on their mother. Mrs Penaherrera claims that she was never told that she had delivered twins. The Remos claim that she was told

about the multiple birth and decided she was unable to raise two daughters. A lawsuit against the physician is now pending. The upside to this story is that the twins were delighted to meet one another. However, Marielisa wishes to remain with her adoptive family, despite the fact that her biological mother would like her to return.

This story, and the events that separated the young Chinese twins described above, remind us that twins are still being reared apart due to extraordinary circumstances. Twins who meet early in life have a chance to recapture some of the special elements of twin relationships — close companionship, mutual trust and striking similarity. The parents of the Chinese twins with whom I am working should be commended for doing their best to bring their twin children together as often as possible.

The geographically diverse membership of the International Society for Twin Studies (ISTS) is well poised to study cases of separated twins as they appear. Administering a common set of tests (e.g., general intelligence, special mental abilities), questionnaires (e.g., personality and attitudes), interviews (e.g., life history, medical life history) and physical examinations (e.g., height, weight) would allow some pooling of cases. For example, I have gathered data on a set of separated Korean twins (one raised in the United States and the other raised in South Korea), in conjunction with Dr. Yoon-Mi Hur. These twins have completed many of the same tests and activities as participants in the Minnesota study, allowing informative comparisons.

A review of the ISTS membership list does not include researchers or physicians from Ecuador, but some might be interested in pursuing this case. It is hard to imagine that they would not be.

Research Reviews: Female Fitness in Male–Female Twin Pairs, Heritability of Olfactory Thresholds and the Twelfth International Twin Congress

Female Fitness in Male–Female Twin Pairs

The possibility that female twins with male co-twins show differences in reproduction-related characteristics and other traits, relative to female twins with female co-twins, has been of interest (see Segal, 2005, this journal). Evidence has, however, been mixed on this question. Cole-Harding et al. (1988) observed that female twins from opposite-sex pairs scored as high as their twin brothers on spatial ability tasks, and better than females from same-sex pairs. Resnick et al. (1993) found that female twins from opposite-sex pairs scored higher on sensation-seeking measures than females from same-sex pairs. McFadden (2002) reported that the emission of SPOEs (spontaneous otoacoustic emissions) by female twins with male co-twins appears to be masculinized. In contrast, Loehlin & Martin (1998) found that age at menarche, age at first pregnancy, menstrual cycle length and body height were only slightly higher for female twins from male-female pairs, compared with female twins from same-sex pairs. Christensen et al. (1998) and Rose et al. (2002) did not find differences in fertility, age at first birth and feminine interests between females with twin brothers and twin sisters.

A recent Finnish study has reported provocative new evidence of reduced female fitness in females with male co-twins, compared with females with female co-twins (Lummaa et al., 2007). Some specific findings were that: (1) adult female twins from opposite-sex pairs have a 25% lower rate of having children than do adult female twins with female co-twins, (2) production of children by males was unaffected

if they had a female co-twin, rather than a male co-twin, (3) females who had a male co-twin had a reduced probability of marrying, compared to females with a female co-twin, (4) females with a male co-twin did not have a reduced probability of surviving until adulthood, relative to females with a female co-twin, (5) males with a female co-twin were as likely to marry as males with a male co-twin and (6) mothers of male-female twins had fewer grandchildren than mothers of same-sex twins.

Luummaa et al. explained their results with reference to the possible exposure of female fetuses to male hormones in utero. They ruled out postnatal explanations by finding that females whose twin brothers died after birth did not differ in their reproductive histories from females whose twin brothers survived. The authors attributed the absence of significant effects in some studies to the fact they included participants from post-industrialized populations who might have benefited from advanced medical care and reproductive technologies. In contrast, the Finnish twin sample was drawn from a preindustrialized population that lacked these modern interventions. It will be of interest to see replications of this work in other societies and cultures.

Heritability of Olfactory Thresholds

A recent twin study of olfactory recognition thresholds has provided evidence of genetic influence on sourness, but not on saltiness (Wise et al., 2007). Participants included 74 MZ twin pairs and 35 DZ twin pairs, identified at the 2003 and 2004 Annual Twins Days Festival,

in Twinsburg, Ohio. This venue is becoming increasingly popular with twin researchers, given that it attracts up to several thousand twin pairs each year. (I attended the 2000 festival and administered family relationship questionnaires to a number of sets; see Segal et al., 2007.)

The twins completed a series of tasks: initial psychophysical testing (to ensure that they had a functioning sense of taste and could follow instructions), recognition threshold tests for sourness and saltiness (to determine the lowest concentration at which they could identify the different tastes) and a sorting task comprised of three samples of the concentration at which they identified the given tastes and three blanks (to identify and confirm the olfactory thresholds for each individual). A heritable effect was found for sourness, accounting for 55% of the variation. In contrast, saltiness was best explained by a shared environmental component of 22%. Various environmental events that might explain the results for saltiness (e.g., sodium depletion, time of day) were considered.

The authors noted that a more balanced representation of MZ and DZ twins in their sample would be desirable; two thirds of the twin pairs were MZ, which is typical of volunteer twin samples. The number of male–female pairs among the DZ twins was not provided, but it is likely that some were included, given that the numbers of males ($n = 57$) and females ($n = 161$) were uneven. It is also worth noting that the zygosity of the twins was assessed by three methods: self-report, experimenter ratings of physical similarity based on facial photographs, and DNA testing of a

subsample of slightly over one-third of the twins (43 pairs). The DNA findings agreed with the self-reported data in all cases. However, it is unclear why a standard physical resemblance questionnaire was not used to assess zygosity. It is also unclear if the photographs were taken under standardized conditions; even if they were, facial photographs would not provide information on height and weight which are important in assessing zygosity in the absence of DNA analysis.

The Twelfth International Twin Congress

The Twelfth International Twin Congress, held in Gent, Belgium, July 7–10, 2007, brought together an extraordinary group of researchers, physicians, twins club leaders and interested individuals. Over 200 registrants from around the world gathered in one of Belgium's most beautiful and historic cities for this special event that takes place only once every three years. The local hosts were Dr Robert Derom and his daughter, Dr Catherine Derom, who head the East Flanders Prospective Twin Study.

Limited journal space does not allow mention of all the many con-

ference highlights, so only a selected sampling can be presented. The first session opened with an appearance by Prince Laurent and his wife, Princess Claire. They have a daughter, Princess Louise, who was born February 6, 2004, and twin boys, Prince Nicolas and Prince Aymeric, born December 13, 2005. Introduction of the royal couple was followed by a fascinating account of the lives of conjoined twins, Chang and Eng, by Dr Roger Short of Australia. The twins had, apparently, undergone extensive physical examination, reported in a little-known paper published in the *British Medical Journal* in 1869, by Professor John Young Simpson. This talk was followed by a stunning presidential address by Dr Jaakko Kaprio, from Finland, who spoke about twin studies in the 21st century. There was mention of how twin studies inform the biological bases of aging, and how multiple birth rates are changing, areas likely to attract attention in the future.

Other major addresses included 'The Genomewin Project' (Dr Leena Peltonen) and 'Twinning After Infertility Treatment' (Dr Jan Gerris). A session on 'Twin Relationships' (E. Thiery, Chair) was extremely informative, and an educational workshop, 'Meeting the Educational Needs of Multiple Birth

Children' (P. Preedy and D. Hay, Co-Chairs), was important and timely, given the current focus on United States state legislation to grant parents a meaningful voice in the classroom placement (together or apart) of their twin children (see Segal, 2006, this journal).

There were paper sessions devoted to a wide variety of twin-related topics. They included freemartins and chimeras, epigenetics and twinning, statistical issues, linkage and association, multiple pregnancy, fetal programming, the East Flanders Prospective Twin Study, childhood and adolescent behavior, mental health, artificial reproductive technology, twin research designs and twin registries. The wide array of topics reminds us that we are fortunate to work in such a rich and exciting field. Abstracts from the congress are available in the society's journal, *Twin Research and Human Genetics*, 10 (Supplement) 2007, pp. 23–59.

The congress banquet, held at the Castle of the Counts of Flanders, is an event that no one will forget. The venue and entertainment were truly unique. We look forward to the next International Congress of Twin Studies, to be held in South Korea.

Multiple Birth Conceptions: Rethinking Things

'Twins [?] With 2 Mums.' The birth of 'twins' Lauren and Hannah Bernaba, to two different women on the same day, only 1½ hours apart, was announced in June 2007 (Dolan, 2007). A couple had undergone in vitro fertilization (IVF) hoping to conceive a younger sibling for their teenage son. However, the pregnancy was considered high risk because the mother suffered from immune system problems. It was, therefore, decided to implant embryos (created from eggs extracted from the mother and fertilized with her husband's sperm) into her womb and the womb of an unrelated sur-

rogate. Against all odds, both women became pregnant and carried the female fetuses to term.

I would argue that the two children resulting from this procedure are unusual siblings, but not twins, despite their shared conception times and delivery dates. This is because they did not share their intrauterine environment, and did not experience twins' potentially hazardous prenatal and perinatal circumstances.

Multiple Birth Risks

The birth of higher order multiples is not considered to be a reproductive success, despite the birth of several

celebrated sets (Roan, 2007; also see Segal, 2000). This is explained by the increased frequencies of gestational diabetes, high blood pressure and bleeding among the mothers, and the elevated levels of prematurity, cerebral palsy and birth defects among the infants. The birth rates of higher order multiples (triplets and more) are currently declining in western nations, but the birth rates of twins are on the rise. Experts believe that while the births of twins are less complicated than the births of triplets and more, they still pose serious risks. Consequently, physicians are being advised to assist infertile couples conceive with vitro

fertilization (IVF), rather than fertility drugs, because IVF allows better control over how many embryos are implanted. Given that IVF techniques have improved, it is becoming increasingly possible to implant only one or two embryos to achieve a successful outcome, rather than three, four or more as in the past. In fact, the percentage of clinics transferring just two embryos increased from 3.3% in 1996 to 49.9% in 2003.

Control over reproductive outcomes is more difficult with fertility drugs because they can lead to the production and fertilization of multiple eggs. However, many physicians continue to endorse the usefulness of fertility drugs. They point out that clomiphene, which stimulates egg production, rarely leads to the production of more than two eggs. Egg production can also be monitored prior to conception, allowing the cycle to be terminated if too many eggs are produced.

Double Donations

The identical Reiff twins, John and William, were once listed in the *Guinness Books of Records* for being the most identical twins in the world. These twin farmers from Pennsylvania recently donated most of their estate to the annual Twins Days Festival (Los Angeles Times, 2007). Plans for developing their farmland are nearly complete, and the festival will benefit from getting an estimated four to five million dollars. It will be interesting to see how the festival and other twin-related activities held in Twinsburg are affected by this generous gift.

References

- Belluck, P., & Yardley, J. (2007, December 20). China Tightens Adoption Rules for Foreigners. *New York Times*.
- Bonner, R. (1996, April 13). Tales of Stolen Babies and Lost Identities. *New York Times*.
- Bouchard, T. J., Jr., Lykken, D. T., McGue, M., Segal, N. L., & Tellegen, A. (1990). Sources of human psychological differences: The Minnesota Study of Twins Reared Apart. *Science*, 250, 223–228.
- CBS News (2007). Ecuadorian Twins Reunited After 15 Years. Retrieved from www.cbsnews.com/stories/07/14/world/main3057614.shtml.
- Christensen, K., Basso, O., Kyvik, K. O., Juul, S., Boldsen, J., Vaupel, J. W., & Olsen, J. (1998). Fecundability of female twins. *Epidemiology*, 9, 189–192.
- Cole-Harding, S., Morstad, A. L., & Wilson, J. R. (1988). Spatial ability in members of opposite-sex twin pairs. *Behavior Genetics*, 18, 710.
- Dolan, A. (2007, June 11). How Twins Were Born to Two Different Women. Daily Mail (http://www.dailymail.co.uk/pages/live/articles/news/news.html?in_articleid=460860&in_page_id=1770).
- Farber, S. L. (1981). *Identical twins reared apart: A reanalysis*. New York: Basic Books.
- Gross, J., & Connors, W. (2007). Surge in Adoption Raises Concern in Ethiopia. *New York Times*, pp. A1, A16.
- Hayakawa, K., Kato, K., Onoi, M., Hayashi, C., Yan-Ping, C., Kanamori, M., Doi, S., Kikuchi, H., Nishihara, R., & Kodota, K. (2006). The Japanese study of adult twins reared apart and growing old separately. *Twin Research and Human Genetics*, 9, 806–807.
- Juel-Nielsen, N. (1965). *Individual and environment: Monozygotic twins reared apart*. New York: International Universities Press.
- Langinvario, H., Koskenvuo, M., Kaprio, J., & Sistonen, P. (1984). Finnish twins reared apart II. Validation of zygosity, environmental dissimilarity and weight and height. *Acta Geneticae Medicae et Gemellologiae*, 33, 251–258.
- Loehlin, J. C., & Martin, N. G. (1998). A comparison of adult female twins from opposite-sex and same-sex pairs on variables related to reproduction. *Behavior Genetics*, 28, 21–27.
- Los Angeles Times* (2007, July 16). Ohio: Twins Leave Most of Estate to Festival. *Los Angeles Times*, pp. A11.
- Lummaa, V., Pettay, J. E., & Russell, A. F. (2007). Male twins reduce fitness of female co-twins. *Proceedings of the National Academy of Sciences*, 104, 10915–10920.
- McFadden, D. (2002). Masculinization effects in the auditory system. *Archives of Sexual Behavior*, 31, 99–111.
- Minneapolis Star & Tribune* (1988, April 23). Surrogate Mom Has Twins; Girl Taken, Boy Rejected.
- Newman H. N., Freeman, F. N., & Holzinger, K. J. (1937). *Twins: A study of heredity and environment*. Chicago: University of Chicago Press.
- Pedersen, N. L., McClearn, G. E., Plomin, R., Nesselroade, J. R., Berg, S., & DeFaire, U. (1991). The Swedish Adoption Twin Study of Aging: An update. *Acta Geneticae Medicae et Gemellologiae*, 40, 7–20.
- Resnick, S. M., Gottesman, I. I., & McGue, M. (1993). Sensation seeking in opposite-sex twins: An effect of prenatal hormones? *Behavior Genetics*, 23, 323–329.
- Roan, S. (2007, June 25). Multiple births, multiple risks. *Los Angeles Times*, pp. F–1, 10.
- Rose, R. J., Kaprio, J., Winter, T., Dick, D. M., Viken, R. J., Pulkkinen, L., & Koskenvuo, M. (2002). Femininity and fertility in sisters of twin brothers: Prenatal androgenization? Cross-sex socialization? *Psychological Science*, 13, 263–267.
- Segal, N. L. (2000). *Entwined lives: Twins and what they tell us about human behavior*. New York: Plume.
- Segal, N. L. (2005). Auditory systems of opposite-sex twins. *Twin Research and Human Genetics*, 8, 80–84.
- Segal, N. L. (2006). Same or separate classrooms: A twin bill. *Twin Research and Human Genetics*, 9, 473–478.
- Segal, N. L., Seghers, J. P., Marelich, W. D., Mechanic, M., & Castillo, R. (2007). Social closeness of monozygotic and dizygotic twin parents toward their nieces and nephews. *European Journal of Personality*, 21, 487–506.
- Shields, J. (1962). *Monozygotic twins: Brought up apart and together*. London: Oxford.
- Sudarsky, L., Myers, R. H., & Walse, T. M. (1983). Huntington's disease in monozygotic twins. *Journal of Medical Genetics*, 20, 408–411.
- Wise, P. M., Hansen, J. L., Reed, D. R., & Breslin, P. A. S. (2007). Twin study of the heritability of recognition thresholds for sour and salty taste. *Chemical Senses* (July 10, 2007, Epub).