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**NEWS, VIEWS AND COMMENTS**

# Classic, Provocative and/or Influential: A Twin Study Sampler/Twin Research Reviews: Twin Pregnancies With and Without Polycystic Ovary Syndrome; Ectopic Twin Pregnancy; Sex Differences in Cognition; Maternal Cardiac Hemodynamics/Newsworthy: President Obama's Portrait Artist; Winkelvoss Twins Update; Triplet Models; 'Meet Your Twin'

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Selected twin research papers that are classic, provocative, and/or influential are surveyed. Many papers meet these criteria, so those chosen reflect the opinion of the author. Reviews of recent research on twin pregnancies with and without polycystic ovary syndrome, ectopic pregnancy, sex differences in cognition and maternal cardiac hemodynamics follow. Newsworthy twin-based items, including President Obama's portrait artist, the financial activities of the Winkelvoss twins, a set of triplet fashion models and the experience of seeing oneself in a painting, are summarized.

## Classic, Provocative and/or Influential: A Twin Study Sampler

Everyone has unique academic experiences as college students, doctoral candidates, medical students, professionals, and/or practitioners. There are certain research papers that stand out among others, based on our interests, but also because of their impact on a particular area of specialization. Such papers are variously classic, provocative and/or influential. Briefly summarized below is a selective sampling of articles that span over a century and which are those that I turn to often.

- Galton, F. (1876). The history of twins as a criterion of the relative powers of nature and nurture. *Journal of the Anthropological Institute, 5,* 391–406.

Galton eloquently set forth the logic of the classic twin design in a report of his findings from 35 twin pairs showing close similarity (presumably MZ twins) and 20 pairs showing marked dissimilarity (presumably DZ twins). These 55 pairs were drawn from a larger respondent pool of 80 sets, but these pairs provided the most detail. Note that the biological bases of twinning had not been worked out at

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that time. Also, note that Galton's recognition as 'Father of the Twin Method' has been a matter of some debate (Segal, 2017). It is in this 1876 paper that Galton stated that there is 'no escape from the conclusion that nature prevails enormously over nurture' (p. 404).

- 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.

IQ findings from MZA twin pairs in the Minnesota Study of Twins Reared Apart (MISTRA) were contrasted with those from three previous reared-apart twin studies on primary and secondary mental ability tests, respectively. The intraclass correlations proved exceedingly robust within and across studies: MISTRA (1990): ($n$ pairs = 48, $r_i$ = 0.69; $n$ pairs = 42, $r_i$ = 0.78), Newman et al. (1937): ($n$ pairs = 19, $r_i$ = 0.68, $n$ pairs = 19, $r_i$ = 0.74), Juel-Nielsen (1965): ($n$ pairs = 12, $r_i$ = 0.64, $n$ pairs = 12, $r_i$ = 0.73), and Shields (1962): ($n$ pairs = 38, $r_i$ = 0.74, $n$ pairs = 37, $r_i$ = 0.76). The MISTRA also reported results for a tertiary measure ($n$ pairs = 43, $r_i$ = 0.78). Overall, approximately 70% of the IQ variance was attributable to genetic sources. Parental socioeconomic status, physical facilities in the home, and relevant family environment scales made negligible contributions to the MISTRA twins' IQ scores and IQ resemblance.

- Gottesman, I. I., & Bertelsen, A. (1989). Confirming unexpressed genotypes for schizophrenia: Risks in the offspring of Fischer's Danish identical and fraternal discordant twins. *Archives of General Psychiatry*, *46*, 867–872.

Gottesman and Bertelsen (1989) presented an elegant application of the twin-family study, also known as the MZ Half-Sibling Design, Nuclear Family Twin Design, Children-of-Twins Approach, and Twin-Pedigree Study. Using data gathered on MZ and DZ adult twins who were discordant for schizophrenia, the authors showed that the disease risk for children of affected and unaffected MZ co-twins was the same (16.8% and 17.1%, respectively). In contrast, the disease risk was elevated only among children born to affected DZ twins, in comparison with their unaffected co-twins (17.4% and 2.1% respectively). It was concluded that unexpressed disease liability may be transmitted to offspring.

- Tellegen, A., Lykken, D. T., Bouchard, T. J., Jr., Wilcox, K. J., Segal, N. L., & Rich, S. (1988). Personality similarity in twins reared apart and together. *Journal of Personality and Social Psychology, 54,* 1031–1039.

This paper presented the first four-group study of personality, including MZ and DZ twins reared-apart and together (MZA, DZA, MZT, DZT). MZA and DZA twin pairs came from the MISTRA, while MZT and DZT twins were enrolled in the Minnesota Twin Registry. The most provocative finding was that the MZA twins were as similar in personality as the MZT twins, as reflected by the median correlations across the 11 scales of the Multidimensional Personality Questionnaire (MPQ) ($r_i$s = 0.49 and 0.52, respectively). This result was wrongly interpreted by some as suggesting that parental rearing practices are inconsequential (Segal, 2012).

- Martin, N. G., Eaves, L. J., Heath, A. C., Jardine, R., Feingold, L. M., & Eysenck, H. J. (1986). Transmission of social attitudes. *Proceedings of the National Academy of Sciences of the United States of America, 83*, 4364–4368.

This paper reported the counterintuitive finding that individual differences in social attitudes can be partly explained by genetic factors. Twin participants included pairs from Australia and Great Britain. Social explanations, such as degree of contact between twins, could not account for the findings. This paper led to a number of replications by other research teams, among them the MISTRA, many of whom found comparable results.

- Merrill, J. P., Murray, J. E., Harrison, J. H., & Guild, W. R. (1956). Successful homotransplantation of the human kidney between identical twins. *Journal of the American Medical Association*, *160*, 277–282.

This landmark case report documented the first successful kidney transplant between MZ twins. Given their genetic identity, MZ co-twins are ideal donors and recipients for one another, although infection and other factors may intervene (Segal, 2017). This procedure was, however, performed without immunosuppressive medication. The donor twin, Ronald Herrick, whose kidney was given to his twin brother at age 23, died 56 years later at age 79, from heart surgery complications. The recipient twin, Richard Herrick, lived for 8 years following the operation (Associated Press, 2010).

- Plomin, R., & Daniels, D. (1987). Why are children in the same family so different from one another? *Behavioral and Brain Sciences*, *10*, 1–16.

This provocative and ground-breaking article underlined the finding that siblings growing up together in the same family differ considerably from one another, not just because of their different genes, but because of non-shared environmental influences. These influences appear to be the most important source of environmental effects on behavior, including cognitive skills. Such effects are shown most dramatically by adoptive siblings raised in the same home, whose correlations capture direct estimates of environmental influence. One might argue that the different ages and time of arrival in the home explain these siblings' dissimilarity in general intelligence, but the same results have been reported for virtual twins, that is, same-age unrelated children raised together since early infancy (Segal et al., 2012).



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- Lykken, D. T., & Tellegen, A. (1996). Happiness is a stochastic phenomenon. *Psychological Science, 7*, 186–189.

This paper used a complete four-group twin design (MZA, DZA, MZT, DZT) in an analysis of the subjective well-being scale of the Multidimensional Personality Questionnaire (MPQ). The MPQ had been completed twice by 79 MZT pairs and 48 DZT twin pairs, yielding a correlation of 0.50 for scores at the two different ages. More significantly, the MZT cross-twin, cross-time correlation of 0.40 was equal to 80% of the 0.50 retest correlation, whereas the same correlation for the DZT twin pairs was close to zero. This finding was replicated using the reared-part twins. It was concluded that genetic factors underlie each individual's characteristic happiness set point, that is, the general level of happiness that he or she experiences. Additionally, the well-being correlations did not differ between MZA ($n = 75$ pairs, $r_i = 0.52$) and MZT twins ($n = 647$ pairs, $r_i = 0.44$), demonstrating that shared environmental factors do not affect how happy we are or can become.

- Lykken, D. T., & Tellegen, T. (1993). Is human mating adventitious or the result of lawful choice? A twin study of mate selection. *Journal of Personality and Social Psychology, 65*, 56–68.

This thought-provoking piece challenged the view that our choice of mates follows lawful orderly processes. Instead, in a series of separate twin studies on assortative mating (twins and their spouses), spouse similarity (twins' spouses), twins' views of their co-twins' choices and spouse evaluations of twins support the positions that mate selection reflects romantic infatuation, and that individuals' characteristics have weak effects on partner choice. It is surprising that MZ twins do not choose similar mates, given their similarities in so many other areas of social behavior. Note that some recent research has found that MZ twins' spouses and best friends are somewhat more similar to their co-twins' friends and spouses than those of DZ twins in political orientation (Kandler et al., 2012), personality and attitudes (Rushton & Bons, 2005).

A personal anecdote may be informative. A number of years ago, I was on a British television program in which the members of four MZ twin pairs were individually introduced to four potential mating partners, themselves part of an MZ twin pair. Co-twins' preferences were quite similar, suggesting that when the 'same' partner is available their choices coincide.

- McNamara, H. C., Kane, S. C., Craig, J. M., Short, R. V., & Umstad, M. P. (2016). A review of the mechanisms and evidence for typical and atypical twinning. *American Journal of Obstetrics and Gynecology, 214*, 172–191.

This article provides an excellent and timely overview of the many varieties of both typical MZ and DZ twin pairs. Variations with respect to placentation and chorionicity are described and supplemented by detailed diagrams created by the gifted medical illustrator Levent Efe. This combination of science and illustration informs even the most knowledgeable of twin research scientists, as does the debate surrounding traditional and new models of twinning. Other twinning varieties such as polar body twinning, fetus-in-fetu and fetus papyraceus are also covered. Appendices listing published reports of the rare monchorionic DZ twins, so called "mirror-image" twins, vanishing twins, superfetated twins and superfecundated twins are helpful to individuals interested in further researching these fascinating topics.

- Martin, N., Boomsma, D., & Machin, G. (1997). A twin-pronged attack on complex traits. *Nature Genetics*, *17*, 387–392.

This paper critically examined twin studies in light of advances in molecular genetic techniques used for identifying quantitative trait loci. It was written over 20 years ago, but remains relevant today, given the rapidly accumulating analyses of twin data via molecular genetic procedures. Key themes are that classic twin studies must show genetic influence on traits of interest prior to undertaking more sophisticated examination; correct classification of twins as MZ or DZ is mandatory and easy to accomplish; and carefully conducted twin studies provide useful and valid data. A chart depicting various genetic and environmental factors associated with MZ co-twin differences is an especially informative feature of this publication.

- Turkheimer, E., Haley, A., Waldron, M., D'Onofrio, B., & Gottesman, I. I. (2003). Socioeconomic status modifies heritability of IQ in young children. *Psychological Science, 14*, 623–628.

Most twin studies include participants from middle-class families, but there is considerable interest in the extent to which findings vary across socioeconomic groups. This study compared IQ resemblance between 7-year-old MZ and DZ twin pairs from neighborhoods near or below the poverty level. In contrast with most extant findings, shared environmental effects explained 60% of the variance in general intelligence, with a negligible contribution from genetic factors. It appears that extreme settings can overwhelm individual differences in ability.

There are of course, many other studies I could have chosen, and not all readers of *TRHG* will agree with these choices. I look forward to learning the favorite papers of others working with twins and will consider listing them in a subsequent *News, Views and Comments* column.



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# Twin Research Reviews

## Twin Pregnancies Without and Without Polycystic Ovary Syndrome

Polycystic ovary syndrome (PCOS) is marked by cysts on the ovaries that are associated with elevated levels of male hormones (medical.dictionary.com, 2018). Women with PCOS are at increased risk for gestational diabetes, early delivery, and pre-eclampsia. (Pre-eclampsia, which affects about 5% of pregnancies in the third trimester, involves high blood pressure, protein in the urine, and swelling of the hands, face and feet; medicine.net, 2018). It has been noted that women without PCOS carrying twins are more likely to experience similar adverse factors than women carrying singletons. Researchers in Denmark compared pregnancy outcomes in both PCOS women ($n = 72$) and non-PCOS women ($n = 288$) pregnant with dichorionic twins (Jonsdottir et al., 2017). Data for the first group were extracted from a fertility clinic and data from the second group were obtained from a hospital cohort.

The main finding was that pregnancy risks in the two participant groups did not differ. Outcomes were also comparable when the women were organized according to whether they were hyperandrogenic or normoandrogenic. Interestingly, the body mass index of the PCOS women was lower than that of the unaffected women, possibly reflecting their higher socioeconomic status and more favorable lifestyle. It was suggested that these characteristics may have masked the impact of PCOS on the pregnancy.

## Ectopic Twin Pregnancy

An ectopic pregnancy occurs when the fertilized egg implants outside the uterus (Mayo Clinic, 2018). The overall incidence of this condition is 6.4 cases/1,000 pregnancies (Hoover et al., 2010). Ectopic pregnancies involving twins are rare, with an estimated 100 cases documented in the medical literature, and only 10 reported cases of unilateral live twin ectopic pregnancies. A paper describing another occurrence of ectopic multiple pregnancy is, therefore, of interest (Samardzic et al., 2014).

This case involved a 30-year-old woman who had experienced abdominal pain and nausea for three weeks. She had had an elective abortion approximately 10 years prior to this pregnancy, as well as endometriosis. A pelvic ultrasound was performed, followed by surgical removal of her right fallopian tube and adnexal mass; an adnexal mass occurs in the area connecting to the uterus, such as the fallopian tubes and ovaries (Advanced Gynecologic Surgery Institute, 2018). Pathological examination confirmed an ectopic pregnancy. It was also noted that an intertwin membrane did not appear to be present, indicative of monoamniotic twinning.

## Sex Differences in Cognition

The twin testosterone transfer hypothesis posits that prenatal exposure to male hormones among female co-twins from opposite-sex pairs may masculinize various physical and behavioral traits in these females. In the area of cognition, enhanced non-verbal skill would be one such example. This hypothesis, which has been the focus of a number of twin studies, has produced mixed findings. A new, longitudinal twin study has examined sex differences in verbal and non-verbal abilities in twins at ages 2, 3, 4, 7, 9, 10, 12, and 14 years of age (Toivainen et al., 2017). Participants were from the Twins Early Development Study that has enrolled more than 16,000 twin pairs from England and Wales in the years 1994–1996. Different measures of verbal and non-verbal ability were variously administered at each assessment; for example at ages 2 and 3 non-verbal abilities were measured by the Parent Report of Children's Abilities, and at ages 10 and 12 these skills were measured with both the Picture Completion subtest from the WISC-III-UK and Raven's Progressive Matrices.

Interestingly, no evidence of the TTTS was detected at any age. It was suggested that prenatal hormonal effects may be relevant only to specific abilities, such as 3-D mental rotation. It was reasoned that better male performance in this particular skill would reflect evolutionary pressures on males with respect to navigating and recalling spatial locations.

## Maternal Cardiac Hemodynamics

Comparing birth parameters between twin and non-twin pregnancies allows greater understanding of the unique aspects of multiple births. It is known that women carrying twins experience greater cardiovascular changes than women carrying non-twins.

A study of maternal cardiac hemodynamics in cesarean section (CS) twin and singleton deliveries was undertaken by researchers in Israel (Lavie et al., 2017). Cardiac functioning was assessed among 62 women at five-time points: before elective CS, after spinal analgesia, 3 and 10 min after delivery of the fetus and placenta, and within 24 and 48 h after delivery. Perhaps somewhat surprisingly, hemodynamic parameters were found to be equivalent in the two groups of women. It was suspected that cardiac parameters in twin pregnancies reach a low point at about 4.5 months, and then stabilize before reaching singleton pregnancy levels during the final trimester.



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# Newsworthy

## President Obama's Portrait Artist

Former United States President Barack Obama unveiled his presidential portrait at the Smithsonian Institution's National Portrait Gallery on February 12, 2018 (Rhodan, 2018). The artist he chose was Kehinde Wiley, of Nigerian descent, who is well-known for depicting individuals from various minority groups in casual clothing. In addition to being an artist, Wiley has a twin brother, Taiwo. Taiwo's name signifies that he is the firstborn brother (by 5 min); Wiley's name, Kenhinde, indicates that he is the younger twin. The twins appear to be identical, based on one of Kehinde's quotes about his experience: 'I grew up half of my life with someone who looks and sounds like me' (AZQuotes, n.d.).

At age 11 years, the brothers traveled together on weekends to attend classes at an art conservatory on the California State University, Los Angeles campus (Mason, 2017). I was curious to discover whether Taiwo was also a painter, but he is not. According to Kehinde, his twin eventually studied writing, medicine, and then business before shifting to other areas. However, Kehinde claims that Taiwo was the more highly skilled artist when they were young, 'the star of the family', but that it takes 'stick-to-it-ness' to do well in that profession (AZQuotes, 2018; Nance, 2014). These types of differences between identical twins are fascinating and could be linked to any number of non-shared environmental factors. Interestingly, twinship themes appear in some of Kehinde's art.

## Winkelvoss Twins Update

The identical 36-year-old twins Tyler and Cameron Winkelvoss are well-known for many things (Popper, 2017). Among them is rowing in the 2008 Olympic Games in Beijing, China, and fighting a legal battle with Mark Zuckerberg over the ownership of Facebook. It turned out that the twins failed to capture an Olympic medal in Bejing, and settled their legal battle with Zuckerberg for $65 million dollars. Now they hold currencies of $1.3 billion dollars in Bitcoin and have formed a company called Gemini (twin in Latin), a virtual currency exchange. Many people in the investment world mocked their financial decisions, but the twins claim to be very much at ease in environments that pose considerable risk with little promise of success. This trait, no doubt, explains the long, punishing hours they invested in rowing, as well as their connection to Bitcoin and other virtual currencies.

## Triplet Models

I have written about identical twin models in earlier issues of *Twin Research and Human Genetics,* but never about identical triplets (Krueger, 2018). The three Levesque sisters are all fashion models, but each has an additional-related profession, such as photography (Andrea), designing (Arianna), and acting (Athena). Originally from Hyannis, Massachusetts, the triplets now live in Astoria, Queens in New York City. One of their future plans is to introduce their own line of clothing.

It is important for the triplets to all be alike or to all be different—they dislike it when two are the same and one differs in some way. A concern on the part of modeling executive Sara Ziff is that identical triplet models may reinforce the idea that models all look alike. At the same time, the identical looks of Andrea, Arianna, and Athena attract considerable attention.

## 'Meet Your Twin'

Finding a likeness of yourself in a work of art has become a popular pastime (Hauser, 2018). The Google museums app allows people to post a photo of themselves and to learn the names and locations of paintings of people to whom they show a strong physical resemblance. People visiting their look-alikes use selfies to capture the artwork and themselves.

It is interesting to speculate on the basis of the intense interest of this undertaking that has engaged millions of people. At one level it may relate to our universal fascination with identical twins—we all grow up learning to expect individual differences in appearance and behavior, so when we encounter identical twins who look and act so much alike it challenges our beliefs in the ways that the world works. These challenges may intrigue us as we attempt to make sense of what we see (Segal, 2017). In addition, Hamilton's (1964) evolutionary-based concept of kin selection may be relevant, namely that we are predisposed to be altruistic toward individuals with whom we share common genes. How we determine who are relatives is a matter of debate, but assessing our similarity to others may be one such mechanism. Of course, art lovers are not going to develop social relationships with their painted likenesses, but what drives the attraction may be somewhat the same.

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