Article

Unusual Behavioral Similarities in Twins Reared Apart: Genetic Effects, Random Chance or Both?

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Abstract

A wealth of twin research shows that monozygotic (MZ) twins are more alike in virtually all measured behavioral traits, relative to dizygotic (DZ) twins. These results apply to twins both reared apart (MZA, DZA) and reared together (MZT, DZT). This recurring pattern of findings is consistent with contributions from genetic effects on intelligence, personality, height and weight, to name a few. However, the lack of perfect MZ twin resemblance indicates that environmental influences before and/or after birth also shape behavioral outcomes. A related and continually posed question remains unresolved: Are MZA twin similarities in unusual behaviors and atypical characteristics best explained with reference to genetic factors, random chance, or a combination of the two? Some insights into this complex question were provided by a psychology graduate student class project undertaken in spring 2021 at California State University, Fullerton. Prior to describing the methods, early outcomes, and future directions of this project area an overview of relevant research in selected domains of human behavioral and physical development. These summaries are needed for the purpose of providing a meaningful context to the issue under consideration.

Keywords:
monozygotic twins, dizygotic twins, rare behaviors, genetics, environment, coincidence, random chance

(Received 30 January 2022; accepted 30 January 2022; First Published online 31 December 2022)

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A *New York Times* article titled, "Journal: Separated at Birth, charts some striking resemblances between former United States President Bill Clinton (Democrat) and former United States House Speaker Newt Gingrich (Republican), born three years apart (Rich, 1995). "Whatever clues you find most compelling, the evidence keeps mounting that Bill Clinton and Newt Gingrich were separated at birth. Rich labels some biographical details "trivial; for example, both men were Baptists, drove 1967 Mustangs, participated in student protests, smoked marijuana and avoided the Vietnam war draft. Other resemblances are taken more seriously—both men were self-invented, at odds with their upbringing, favored eldest children, raised by demanding mothers, never knew their biological fathers, and experienced difficult relations with their adoptive fathers and spouses. Both men were also described as narcissistic. Differences between the two included Clinton's preference for Elvis Presley and Gingrich's impersonation of Red Skelton. Both men represented different political parties, but both recognized the benefits of reconciliation.

Of course, Rich wrote his essay with a light touch, most likely using separated twinship as a convenient metaphor for revealing the resemblances between these two political figures. Nevertheless, these kinds of similarities, as well as more atypical behavioral similarities, have been observed in reared-apart monozygotic (MZA) twins. Unusual behaviors differ from standard behavioral phenotypes, such as general intelligence, spatial reasoning and information-processing speed, that have been studied by many researchers, and whose heritability estimates apply to the general populace. Unusual behaviors, such as favoring Vademecum toothpaste from Sweden, wearing rubberbands around one's wrist and fondness for sneezing loudly in elevators (behaviors displayed by some participating pairs in the Minnesota Study of Twins Reared Apart), are rare and idiosyncratic. They do not lend themselves well to systematic study across cases (Segal, 2012).

Accumulating descriptions of MZA twins concordant for traits that are atypical and rare raise debate over whether their development is a greater reflection of genetic propensities or random chance. This is a curious question, given that the same atypical traits have appeared in relatives who have never known one another, as described below.

Studying MZA Twins' Rare Behaviors

In October 2020 I received the following email message from psychologist Steven Pinker: We've spoken about this before, but I'll be curious to learn the scientific status of the startlingly specific MZA quirks--sneezing in elevators and all that. We know that heritability of measured traits is rigorous and massively replicable, and I believe the reports of the quirks, but it would be nice if some rigor could be added. I agreed and organized a psychology graduate student project to examine and compare the nature and frequency of MZA and DZA (dizygotic reared-apart) twins' unusual similarities. Fewer DZA than MZA twin pairs have been studied scientifically, despite their higher representation among multiple births. That is most likely because DZA twins rarely reunite due to confusion by others; I am aware of only one such case involving a set of look-alike DZA female twins (Segal, 2012). DZA twins who are aware of their twinship must search for their cotwin, possibly through adoption records or the Internet. In contrast, many MZA twins have reunited due to being mistaken for one another by someone unaware of their twinship (Segal, 2012, Segal & Montoya, 2018).

Prior to describing the class project, it is important to summarize the standard, replicated findings from reared-apart twin studies as a meaningful framework for evaluating the behavioral "quirks. A selective research review focusing on MZA twin findings from studies of intelligence, personality and physical characteristics, mostly from the Minnesota Study of Twins Reared Apart (MISTRA), is presented below.

Research Review

General Intelligence.

A table summarizing IQ intraclass correlations for 117 MZA twin pairs from four separate studies shows remarkable consistency with reference to the magnitude of these values (Bouchard, Lykken, McGue, M., Segal, N. L., & Tellegen, 1990). The intraclass correlations range between r_i = .64 and .78, indicating that approximately 70-75% of the variation in general intelligence (individual differ-

ences) is associated with genetic differences among the population members represented by the different samples. The consistency of these values is remarkable, given that the investigators drew their participants from different countries (Denmark, England, and the United States), used different sample sizes (N = 12 - 48), conducted their research at different times (1937 – 1990) and administered different test protocols (Stanford-Binet, Mill-Hill Vocabulary Test, Wechsler-Bellevue and Wechsler Adult Intelligence Scale). An updated chart that also includes findings from a Swedish study (N = 45, r_i = .78, Pedersen, Plomin, Nesselroade, & McClearn, 1992) yielded a weighted average IQ correlation of .73 (McGue, Bouchard, Iacono, & Lykken, 1993).

Findings from the first four studies were further evaluated with reference to a second ability test administered to the MZA twins by each investigator (Bouchard et al., 1990). The sample sizes varied slightly from those of the primary measure (N = 19 – 42). Secondary tests included the Otis IQ Test, Raven Progressive Matrices, Dominoes IQ Test and Raven/Mill-Hill. Intraclass correlations ranged between .73 - .78, confirming the results from the primary mental ability test. A third measure was computed for 43 participating MZA pairs in the Minnesota Study of Twins Reared Apart, namely the first principal component of two multiple ability batteries (verbal and non-verbal tests from the Hawaii Family Study of Cognition and Comprehensive Ability Battery). The intraclass correlation for the MISTRA's tertiary measure was r_i = .78, in line with the findings summarized thus far.

A comprehensive analysis of intelligence test data from the MISTRA replicated evidence of "just one *g* (i.e., a general mental ability factor) and replicated the Visual-Perceptual-Image Rotation model of mental ability structure (Johnson, te Nijenhuis, & Bouchard Jr., 2008). The sample included 74 MZA twin pairs and 52 DZA twin pairs. The proportion of genetic variance shown *by g* was .771. Interestingly, this was the correlation reported by the British psychologist Sir Cyril Burt whose reared-apart twin research became suspect in the 1980s (see Segal, 2012 and references therein).

A prospective, real-time study of the mental ability resemblance of young MZA twins was undertaken for the first time by Segal, Niculae, Becker and Shih (2021). The twins, 3 to 24 years of age, were mostly Chinese and separated indirectly due to China's One Child Policy that was in place from 1979 – 2015. Two pairs from Vietnam and one pair from Taiwan were variously separated due to their mothers being young and single, differences in cotwins' early health and/or inadequate family resources. The similarity of the separated twin pairs (N = 15) was compared with young Chinese twins reared together (N = 43) and with virtual twins *(*N = 169) who are same-age unrelated individuals reared together from infancy. The IQ intraclass correlations were r_is = .51, .75 and .28, respectively. Genetic influences were indicated based on the greater resemblance of both MZ twin groups, relative to the virtual twins. However, the shared environment of the reared-together twins most likely explains their greater resemblance, relative to the MZA twins. Given that IQ heritability increases with age, it will be of interest to assess the MZA twins' similarity as they approach adolescence and adulthood. Most participating pairs have completed a second IQ test, so it will be possible to address this issue in the future.

It is worth noting that a highly controversial developmental study of separated twins took place in New York City in the 1960s-1970s. An adoption agency purposely separated twins who became research subjects in a longitudinal investigation until they turned twelve. The twins' adoptive families were never told that they were raising a "singleton twin. The twins were mostly adults when their twinship was revealed to them, often when they met by chance. The news continues to be devastating to them and to their families (Segal, 2021). Unusual similarities among them include preference for spicy food at age three years (e.g., ketchup), distaste for condiments (e.g., ketchup and mustard) and former marriages to German engineers (Segal, 2021).

Personality.

In 1988 the MISTRA published the first twin analysis of personality similarity using a four-group design (MZ and DZ twins both reared apart and together: MZA, MZT, DZA, DZT) (Tellegen, Lykken, Bouchard, Wilcox, Segal, & Rich, 1988). Key findings were that (1) MZA twins are as similar as MZT twins, (2) family members living to-

gether are alike in personality because they share genes, not because they share environments and (3) genetic factors explain approximately 50% of the personality variance, while nonshared, idiosyncratic events explain the remainder. Other twin studies of personality have reported comparable findings, with genetic influence varying from 30-50 percent and shared environments making small contributions (Knopik, Neiderhiser, DeFries, & Plomin, 2016).

These personality findings have been controversial and misinterpreted as implying that parenting does not matter. However, parenting matters considerably—parents have the challenging responsibility of staying attuned to children's interests and inclinations, and nurturing them to the fullest.

Over the years I have also assessed the personality similarity of unrelated look-alikes (U-LAs, Segal, 2013; Segal, Graham, & Ettinger, 2013; Segal, Hernandez, Graham, & Ettinger, 2018). The reason for doing so has been challenges to the view that genetic factors influence personality development. In particular, twin study critics have asserted that MZ twins' matched behaviors reflect similar treatment by others, based on their matched appearance, not their shared genes (Billings, Beckwith, & Alper, 1992; Segal, Hernandez, Graham, & Ettinger, 2018). The rationale behind this series of ongoing studies is that if U-LAs are as similar in personality as MZA twins (who are also reared apart, but who share 100 percent of their genes), then the critics are correct. However, if the U-LAs show reduced resemblance relative to MZA twins, then the critics have erred.

The mean intraclass correlations across the Big Five personality traits from the most recent replication were r_i = -.02 and .53 for the U-LAs and MZA twins, respectively, using the Personality for Professionals Inventory (PfPI) for the URLs. The same pattern emerged for the NEO/NEO-FFI-3 (Costa & McCrae, 2010) using the same unrelated pairs plus some additional sets, that is r_i = -.04 and .53, respectively. The U-LAs also showed little resemblance in self-esteem, based on their responses to the Rosenberg Self-Esteem Scale (r_i = -.18), relative to MZ twins reared together (r_i = -.30, males; r_i = .38, females).

Collectively, these findings suggest that MZ twins' personality similarity resides in their shared genes, not in their matched faces and physiques. To the extent that the treatment of MZ twins by others is similar, it most likely reflects the effects of evocative gene-environment correlation. In other words, it appears that MZ twins' similar behaviors elicit similar responses from those around them.

Medical Conditions and Physical Traits.

MZ twin concordance for rare physical conditions, e.g., craniosynostosis, involving early closure of one or more joints connecting the bones of an infant's skull (Segal, 2021a), Kleine-Levin Syndrome, involving recurrent episodes of hypersomnia variously associated with behavioral symptoms such as compulsive eating, sexual disinhibition, and odd behaviors, as well as atypical cognitive, mental and physical complaints (Peraita-Adrados, Vicario, Tafti, García, & Billiard (2012), and Peters Anomaly involving abnormal development o the anterior segment of the eye, culminating in amblyopia or congenital blindness (Almarzouki, Tayyib, Khayat et al., 2016) arouse considerable professional interest. Such similarities are generally--and I would assert legitimately--attributed to genetic influence.

The same conclusions have been applied to unusual physical traits. Among the various reared-apart twins from the different studies have been reports of the same crooked little fingers, eye-rolling ability, absent teeth, elongated tongues, receding hairlines and foot ailments. In addition, various MZA twins have both presented with mixed headache syndrome, similar weight gain, allergic reactions and ocular disorders (Segal, 2012, 2021; Segal & Montoya, 2018). Again, assigning genetic commonality as the primary cause is typically offered and accepted.

A review of twin studies of well-researched medical conditions and physical traits also shows substantial genetic influence. Twin studies have found greater resemblance for autism in MZ than DZ twins, although recent work has indicated more of an environmental effect than has been previously reported (Hegarty, Pegoraro, Lazzeroni et al., 2020). A recent heritability estimate for autism spectrum disorder was 60.9 percent (Deng, Zou, Deng et al., 2015). A meta-analysis of twin studies reported a heritability estimate of 72.0 percent for diabetes (Willemsen, Ward, Bell at al.,

2015), and a recent twin study found 82.0 percent heritability for childhood asthma (Ullemar, Magnusson, Lundholm et al., 2016).

In the area of physical traits, there have been scores of twin studies assessing genetic and environmental effects on height and weight. Heritability estimates are 80-90 percent for height, with intraclass correlations being approximately the same for MZA ($r_{i=}$ .96) and MZT $r_{i=}$ .94) twin pairs, indicating strong genetic effects (Segal, 2012 and references therein). In contrast, body weight correlations are somewhat reduced for MZA twins (r_i = .69), relative to MZT twins (r_i = .87). The MZA correlation was, however, based on a largely female twin sample that tends to show lower weight resemblance (Shields, 1962; Elder, Roberts, McCrory et al., 2012). Factors differentially affecting MZ female cotwins variously include exercise, diet, pregnancy, and hormonal fluctuations. However, a meta-analysis of twin studies conducted over fifty years did not show correlational differences in weight between adult MZ male pairs ($r_{i=}$ .70) and MZ female pairs ($r_{i=}$ .73); see Polderman, Benyamin, De Leeuw et al. (2015). This result might reflect different participant characteristics and/or methodological features across studies.

Most importantly, the Polderman meta-analysis found that heritability estimates cluster within functional domains and noted a heritability estimate of 49 percent across all domains. This information provides an informative backdrop for theorizing about recurrent observations of MZA twins' behavioral oddities. Specifically, there is reluctance to acknowledge genetic effects when it comes to unique behavioral habits, rituals and/or practices that cannot be assessed using large twin samples. In such cases, coincidence and random chance often become favored explanations. Perhaps reluctance to consider genetic explanations for unusual behaviors is explained by the fact that medical conditions and physical traits, such as those mentioned above, are often present at birth or develop over time without effort on the part of the affected individual. It may also be incorrectly assumed that odd habits and quirks are partly intentional or under personal control. However, such suppositions cannot be substituted for systematic study. In fact, the idea that wearing big belt buckles, selecting the same unusual bedspread, or drinking lukewarm coffee do not reflect genetic effects is inconsistent with scientific conclusions surrounding rare medical conditions and physical traits.

My students launched a class project to assess the nature and origins of MZA twins' unusual behaviors. We did so by comparing the frequency of such behaviors with those of DZA twins and the frequency of these behaviors in the general population.

Class Project

The class project described below was an attempt to bring clarity to debates about the origins of the perplexing, yet intriguing "quirks displayed by many MZA twins. The present paper provides a preliminary sketch of the project with selected findings; more detailed analyses will be the subject of a future paper.

Methods

The participating investigators included the author and eleven psychology graduate students enrolled in a twin studies seminar in spring 2021. A copy of a book-length report of a previous reared-apart twin study was given to two or three students, although each student worked independently. The studies were those by Newman, Freeman, & Holzinger (1937), Shields (1962), Juel-Nielsen (1965/1980) and Bouchard (Segal, 2012). Books about separated twins by Watson (1981) and Farber (1981) were also assigned. Prior to distribution of these materials, photographs of the twins were concealed with post-it strips to avoid biased decisions based on zygosity judgements. Students were also encouraged to seek available case reports and media sources that described reared-apart twins' similarities.

The instructions were to study the life histories of each pair and to note unusual behavioral similarities that cotwins had in common. Students periodically presented their findings to the class for feedback regarding whether, or not, a particular trait seemed truly "rare. For example, if both twins displayed outgoing personalities this was discounted; however, if both twins consumed beer while placing a pinky finger under the can (as did an MZ male pair in the MISTRA), the behavior was considered to be rare. Most importantly, stu-

dents also researched the population frequency of the behaviors and habits as reported during the years the twins would have expressed them. If such data were unavailable, then current statistics were referenced.

Selected Findings: MZA Twins

- Berta and Herta were both were nicknamed "pussy or "kitty in different languages because they "tended to be affectionate in nature and 'purred' like a cat when pleased (Shields, 1962; Farber, 1981). Between 1920 and 1945, the nickname "Kitty was ranked between 786th and 506th out of the 1,000 most popular nicknames in the United States (Campbell, 1996).
- MZA twins Valerie and Joyce were both terrified of pulling the lavatory chain in bathrooms (Shields, 1962).
- Viola and Olga, independently and frequently, complained of feeling a lump stuck in the throat (Shields, 1962). This condition is referred to medically as globus hystericus/pharyngis. Both twins also reported often feeling as though they were choking until they drank water [10]. According to *Medical News Today* (2017), only approximately 4 percent of all new ear, nose, and throat (ENT) referrals are for a globus sensation (Fletcher, 2017).
- British twins, Irene and Jeanette, both crossed out "tolerate and replaced it with

"respect on a questionnaire item concerning other people's religions (Watson, 1981).

- George and Millan both men won boxing championships (Stephens & Thompson, 1943). In 2017, approximately 2% of the U.S. population participated in recreational boxing. While boxing was a more popular pastime during the twins' lifetime in the 1940s ("Boxing, 2017), there are relatively few champions.
- Jack and Oskar both washed their hands before and after using the restroom (See Segal, 2021). It has been reported that 4 out of 5 people, globally, do not wash their hands at all after using the restroom (WaterAid, 2020).
- Jim Lewis & Jim Springer smoked the same brand of cigarettes, i.e., Salem (Leo, 1987; also see Segal, 2012, 2021). Salem is a rare brand in the United States. Twelve years of data collected from the early 2000s show that Salems held only about 2.32% of the market and were unpopular compared to the leading Marlboro brand which held 38% (Sharma & Delnevo et al., 2016).
- Maren & Jensine had the same career paths by first working as maids when they left their homes, then as children's nurses and finally as general nurses (Juel-Nielsen, 1965/1980). Data revealing the number of nurses and midwives in Germany in 2000, where Maren lived, showed that there are only 10.295 nurses per 1,000 people in that population. In Denmark where Jensine lived, this number was lower, at 9.541 per 1,000 people (World Bank, Nurses and Midwives, n.d).
- P and E saved their childhood Alice in Wonderland dolls in scientific decanters, creating "barbies in a bottle (Nussbaum, 2007).
- Dora and Brenda when reunited at twelve years or age, were wearing the same clothes, brought the same presents for each other, and carried the same pocket money (Shields, 1962).
- Odette and Fanny shared fears of fire and water and in cinemas or hotels and would look for the emergency exit (Shields, 1962). Environmental fears (except heights) have a prevalence rate of 0.5%, with fear of water at 0.3% (Becker et al., 2006).

Selected Findings: DZA Twins

The MISTRA was the only reared-apart twin study to systematically assess DZA twins, although only 56 pairs were fully assessed. Eleven DZA twin pairs were briefly studied by Shields (1962) and several case studies/life histories of DZA twin pairs are available (Segal et al, Segal 2012, 2021; Segal, Cortez, Zettel-Watson et al., 2015). According to a MISTRA colleague, "The DZA twins whom we studied have, in contrast [with the MZA twins] seldom produced 'coincidences' . . . (Lykken, 1992). He then referenced the following exceptional pair: DZA male twins, assessed in 1984, had both acquired sixteen tattoos across their bodies. However, tattoos were popular during the 1980s, and encouraged in the media (Inkbox, 2017), possibly lessening the significance of this similarity.

It was also the case that both of these DZA male twins, in their early thirties, had been incarcerated at times and suffered from drug abuse. Males in the United States were more likely than females to be imprisoned between 1974 and 1991 (2.3% and 3.4% vs. 0.02% and 0.3%, respective-

ly). In addition, the percentage of black and Hispanic male inmates in prison in those years (8.7% and 2.3%; 12.0% and 4.9%, respectively) exceeded the percentage of white male inmates (1.4%, 1.9%, respectively) (Bonczar, 2003). The incarcerated population is much lower in percentage than the non-incarcerated population, so incarceration is relatively rare.

Cocaine abuse shows a similar trend. In 1977, the percentage of male and non-white users (2.6% and 3.1%, respectively) exceeded the percentage of female and white users (1.5% and 2.0%, respectively). Prevalence rates for lifetime drug abuse/dependence disorders confirmed these findings across age, sex and ethnicity (Anthony & Helzer, 1991). Projected frequencies for 1985 showed a similar pattern, as did the 1977 statistics for current heroin use (Richards, 1981). Twin research shows substantial heritability in drug abuse, with a higher estimate for females (73%) than for males (55%), Interestingly, shared environmental effects are higher for male than female twins; when twins are living apart, these effects are traceable to circumstances in their common community (Kendler, Maes, Sundquist et al., 2014). Of course, the DZA twins described here did not share their community, so their drug abuse suggests a shared genetic basis and/or shared environmental influences in their respective environments. Drug abuse is a serious medical and societal issue, but its relative rarity in the population and concordance in a pair of reared-apart twins, albeit DZA, is consistent with an inherited tendency toward such behavior.

Discussion

There were fewer DZA than MZA twins from which to sample, so it is possible that DZA twin pairs expressing unusual similarities did not come to attention. At the same time, behavioral similarities in some DZA twin pairs have been noted, e.g., both DZA female cotwins enjoyed art, but lacked artistic ability (Segal, 2021). However, this resemblance is less striking when we consider that 68 percent of people in the United States attended an art event in 2015-2016 and 49 percent engaged in some form of artistic activity (Americans for the Arts, 2016). Another pair of DZA female twins both presented with ectodermal dysplasia (ED; see Segal, 2021), a condition affecting only an estimated 3.5/10,000 people (National Foundation for Ectodermal Dysplasias, 2021). However, while concordance for a rare medical condition in DZA cotwins is of interest, ED is not a behavior. In summary, other than the single DZA male pair referenced above, atypical behavioral displays or habits were not detected among the DZA twin pairs studied thus far. Further examination of the *types* of tattoos chosen by the concordant DZA male twins, e.g., flowers, women, and/or mottos, might be informative. This effort would require determining the varieties of tattoos, and how many people choose common types, prefer unusual types or design tattoos themselves.

Juel-Nielsen, who directed the Danish reared-apart twin study in 1965/1980, was interviewed by Bouchard during a visit to the United States (University of Minnesota Media Center, 1981). He admitted having noted odd habits in the MZA twin pairs he studied, but he chose to not publish this information for fear it would detract from his statistical findings on ability, personality, and other measures. He also suspected that readers would not believe his observations. Bouchard, who directed the MISTRA, wondered if the media had exaggerated the similarities of the "Jim twins, the pair that launched the MISTRA in 1979. However, once these twins had been assessed, Bouchard concluded that the twins' atypical similarities had been accurately described (University of Minnesota, 1981; Segal, 2012).

Theoretical Implications

Understanding the bases for MZA twins' rare similarities requires creative theorizing if coincidence and rare chance are to be challenged or dismissed. The concept of *emergenesis*—the idea that unusual traits reflect a distinct configuration of hundreds of genes--is an attractive and plausible explanation. The concept and term are not new, having been proposed nearly thirty years ago by Lykken (1992); however, emergenesis remains scientifically grounded, far-reaching and timely. It sheds light on why some MZA twins and relatively few DZ twins display behavioral oddities. Emergenesis can also explain why genetically based traits may not repeat in families—particular gene configurations are disassembled in subsequent generations. It helps to recall that MZ twins inherit the same unique genome (gene combina-

tion) from their parents, while DZ twins share half their genes, on average, such that each cotwin's genome is distinct. DZ twins can share an average of 25% of their dominance variance, possibly eventuating in resemblance for certain traits, but DZ twins fall short of showing the same similarity frequency (either in ordinary or extraordinary traits) as do MZ twins.

Regardless, unusual behaviors have been known to run in some families. It is difffcult to explain the recurrence of such behaviors when members of different family branches or generations have not had contact. Perhaps the best example is one reported by Charles Darwin in the *Descent of Man* (Darwin, 1871):

"Some few persons have the power of contracting the superficial muscles on their scalps; and these muscles are in a variable and partially rudimentary condition. M.A. de Candolle has communicated to me a curious instance of the long-continued persistence of inheritance of this power, as well as of its unusual development. He knows a family, in which one member, the present head of a family, could, when a youth, pitch several heavy books from his head by the movement of the scalp alone; and he won wagers by performing this feat. His father, uncle, grandfather, and all his three children possess the same power to the same unusual degree. This family became divided eight generations ago into two branches; so that the head of the above-mentioned branch is a cousin in the seventh degree to the head of the other branch. This distinct cousin resides in France, and on being asked whether he possessed the same faculty, immediately exhibited his power. This case offers a good illustration how persistently an absolutely useless faculty may be transmitted. (vol. 1, p. 20)

A related comment in another source is instructive. In referencing Darwin's observation presented above, Bucher (1882, cited in Thomson, 1908) wrote: . . . it seems no doubt that trivial peculiarities, e.g., playing with a lock of hair and idiosyncrasies of handwriting, may reappear even in cases where imitation was out of the question. (p. 42).

If emergenesis is a possible explanation for the rare and complex behaviors some MZA twins display, what could be the mechanism(s)? What transpires between the gene configurations at the molecular level and the behavioral phenotypes observed in everyday life? The answer is somewhat speculative at this time, but it is generally accepted that genes predispose individuals to gravitate toward certain people, places and events and away from others. Genetically influenced abilities, personality traits, temperaments and sensitivities, in conjunction with environmental factors and circumstances probably help fashion MZA twins' odd habits and quirks. It is difficult to know exactly how such predispositions translate into how beers cans are held, how bedspreads are chosen or why condiments of any kind are eschewed—but the mechanisms may not be too different from those underlying twins' rare matched physical traits and, in the case of elite athletes, concordant performances and achievements.

The section that follows describes the practical applications of research into MZA twins' unusual matched behaviors. Additionally considered is the combined role of genetic factors and random chance that underlie these behaviors in everyone, not just twins.

Practical Applications.

Unusual habits and preferences are typically idiosyncratic, so their appearance in an MZA twin whom one has never met offers a range of fresh explanations. Acknowledging genetic influence on unusual habits and behavioral rituals is a step toward understanding why we behave the way that we do. Some habits may conceivably originate by imitation or by chance, but if they serve a purpose or feel comfortable, they may be maintained. For example, some people add salt to watermelon because their family members do so, but they also find the flavor appealing. However, if garlic was substituted accidentally for salt and tasted good, one's routine for seasoning melon could be modified. Similarly, if an aspiring ballet student could not enroll in a particular class because it was full, he or she might choose a modern dance class as an alternative. With time, the dancer may decide that the second choice was better suited to his or her interests and talents. Being at a certain place at a certain time is often taken for chance, but there is a deliberate choice to be at that place (e.g., dance studio), rather than another. Thus, in this case it would appear that both genetics (e.g., dancer's body build) and chance (e.g., unavailable class)

conspired to alter the career goals of the individual in a positive way.

Future Directions

Understanding the mechanisms giving rise to rare behavioral phenotypes may be broadened by increased documentation of such occurrences in reared-apart MZ and DZ twins, adoptive siblings and other relatives. An important addition would be obtaining parental reports of young children who develop persistent or ritualistic behavioral patterns that seem atypical—perhaps these behaviors were present in former generations. Population frequencies are also important to obtain. The possibility that MZA twins might both enjoy drinking coca cola is not newsworthy, given that coca cola is consumed by many people. Research shows that in 2020, 44.9 percent of Americans consumed that soft drink (Statista, 2021). However, if MZA twins both drank coca cola only when poured into a coffee cup or a test tube, it would be worth examining why.

Sex differences in odd behaviors would be worth exploring, as would public and private displays of these behaviors. It might also be of interest to organize unusual behaviors by age and type, comparing their nature, frequency and modification.

Some might argue that the scientific study of rare behaviors and habits holds little theoretical or practical promise. However, nothing about the human behavioral repertoire is trivial or uninteresting—any path toward greater understanding of who we are and how we got that way is important and exciting. Once again, MZA and DZA twins offer simple, but elegant approaches to virtually every class of questions.

Acknowledgments

A California State University Grant for Instructional Funding to NLS supported the class project.

Contributing investigators

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