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EXPERIMENTING IN THE BIOSOCIAL: THE STRANGE CASE OF TWIN RESEARCH

Twins can be viewed as pivotal instruments in the articulation of modern scientific reason. Twin methodologies – using bodies individual, paired, or aggregated into statistical populations – and their derived datasets constitute a collective asset to twin researchers and others who have claimed an understanding of human development, health and wellbeing through the use of twin-born people.[1] Both historical and contemporary uses of human twins in the life and human sciences provide fascinating instances of a human group instrumentalised in the advancement of competing forms of scientific inquiry, and their cultural identities partly formed through their participation in those competing visions of human life. Especially though not exclusively in the case of monozygotic ('identical') twins, the appeal of twin bodies may simply be optical: higher-order, developmental, and evolutionary processes thought to shape human health and behaviour, can be seen to take phenotypic expression in twin bodies. As 'living laboratories' championed for their capacity to isolate interior 'biological' mechanisms from external 'environmental' influences, twin studies have became synonymous with 'gene-centric' models of human behaviour and wellbeing. But because twins are presented by twin researchers as having an embodied and mediatory capacity within the process of research design and dissemination, twins are now being used as the living proof of new, complex settlements found in postgenomics – such as epigenetic, microbial or metabolomic research – to complicate the partition between nature and nurture or dissolve it altogether (van Dongen et al 2012). It is important to stress, therefore, that twins and twin data in the twentieth and twenty-first centuries have played an important and appropriately duplicitous role in defining, defending, and disrupting the polarities between what is biological and what is social.

This chapter describes the 'biosocial life' of twins as it has emerged in the sciences; the forms of life that emerge for twins through their participation in biomedical research science. In particular, it describes them as flexible figures taken to be the vitally epistemic things of experimental use and evidence, caught in the processes of research design, description, publication, and public dissemination. Twins who participate in and become used in such research are human brokers, elected go-betweens in the emergent assignations of 'the biological' and 'the social'. Though the use of twins in biomedical research has led to atrocity, debate and controversy, the critical position adopted in this chapter seeks to understand why twins have been used and continue to be used despite critical attempts to disavow twin research methods (Davis 2014; de Nooy 2005, 90–93; Joseph 2004). Although the historical and political consequences of twin research cannot be expunged from any discussion of its past, present, or future ambitions, this chapter avoids the binary of advocacy or condemnation to explain the methodological persistence of twin models and the socialites they engender, from early to mid twentieth century transmission genetics to late-twentieth and twenty-first century, transition genomics, small-scale cohort studies to large-scale, computationally complex systems biology (Barnes and Dupré 2008). The remarkable longevity of twin research – used to stress the relative importance of biology or society in human life, to prove and disprove divisions between biology and environment – have repercussions for how we understand how human groups socialised into and through scientific endeavours. It is not simply the case that human twins are made to be the passive bearers of laboratory results formed within the life sciences, neither is it simply a matter of recognising how twins are the active constituents of novel ‘biosocial’ formations; rather, twins actively volunteer for, have their identities transformed by, and seek to adapt and inform the discrete workings of scientific knowledge production because the scientific *and* social basis of their twinship preexists their inclusion in experimental science. Finally, a focus on how the meaning of twins, as informed by their scientific utility, facilitates a reappraisal of social scientific approaches that define modern and contemporary twinning according to its dyadic dynamicism (Hoctor 2015; Davis 2014; Piontelli 2008) and ‘supraindividuality’ (Stewart 2001, 169). While twinning has been linked to the specific uterine quality of their co-development or to generalised patterns of psychological development said to be unique to twins (Joseph 2004; Leonard 1961; Burlingham 1945), what has yet to be fully realised is how these conceptions of twin sociality are enhanced, diminished, or negated by being clinical labourers within scientific enterprise.

BORN INTO EXPERIMENT

To recognise the historical circumstances by which human twins have entered the life sciences is to recognise how the division between ‘biology’ and ‘society’, as well as the subsequent attempts to renegotiate or even dissolve this division in postgenomic laboratory sciences, is marked by its historical attachment to the hereditarian twin research of British polymath, Francis Galton (1822 – 1911) (Meloni 2016). Galton should not only be credited as the first scientist to use twins in the formal, qualitative and quantitative biometric study of human development, aging and disease (Waller 2012), his studies of twins are simultaneously noted for advancing the polar distinction between ‘nature’ and ‘nurture’ into the scientific and popular imaginary.[2] In his ‘The History of Twins, as a Criterion of the Relative Powers of Nature and

Nurture' (1875), Galton observed the phenotypic diversity of twins – 'strongly alike, moderately alike, and extremely dissimilar.' Though Galton lacked an embryological or genetic understanding of twin difference – categories such as monozygotic twins (abbreviated to 'MZ' or colloquially known as 'identical') or dizygotic twins (abbreviated to 'DZ' or colloquially known as 'non-identical') would not become firmly established and incorporated into experimental designs until the 1910s and 1920s – he made them equal in scientific utility. He compiled biographical information for 94 sets of twins by postal correspondence (Galton 1875, 566). Studying these twins offered Galton a means to respond to complaints that earlier measures of heredity overlooked the role of chance, so that 'some new method [was required] by which it would be possible to weigh in just scales the effects of Nature and Nurture, and to ascertain their respective shares in framing the disposition and intellectual ability of men. The life-history of twins supplies what I wanted' (Galton 1875, 566). As a consequence, narratives of twin lives, when reported to a trained researcher, became a methodology that could confirm and also measure the influence of biology or society, nature or nurture.

The wider aims of Galton's early use of twins also shaped the epistemological imperatives and research objectives of subsequent twin research using these people. First, Galton aimed to know whether twins regarded as highly similar at birth could develop physical and behavioural differences. Second, he wanted to know whether twins who were considered to be dissimilar at birth could grow more alike in later life, meaning that the logic of between-pair concordance and discordance determined a scalar approach to trait analysis. Galton concluded that twins 'either grow unlike through the development of natural characteristics which had lain dormant at first, or else they continue their lives, keeping time like two watches, hardly to be thrown out of accord except for some physical jar' (Galton 1875, 574). He had a strong conviction that twins of varying types made legible an interior component that guided physiological development. This interior 'mechanism' was immune and indifferent to external interference, pervious only to the most extreme circumstances, so that any evidence of between-twin concordance or discordance reflected the strength of heritable, biological characteristics.

Twin research has changed dramatically in scale and levels of sophistication since the end of the nineteenth century, yet two further aspects of Galton's use of twins are important to underline for his influence on subsequent research designs and findings. One concerns the exclusivity and significance placed upon twins as the methodological means by which to achieve certain kinds of scientific observation. The other concerns how that methodological importance, next to the evidence Galton drew from twins, extends throughout their 'life–histories.' As a consequence, cases of mistaken identity, attempted and achieved suicide, toothaches, malformed fingers, even the slow movement down a flight of stairs, were all felt by Galton to connect to the 'inner clockwork' whose influence he sought to expose. The twin body had become an abundant source of evidence, a place where traits could be calculated and placed within a scale of difference, not as the testing ground for new hypotheses about human life but as the living, embodied, and unmediated site of experimental observation.

There are now numerous methods of using twins in research, extending across the life and social sciences. Separate, discipline-specific histories can be written about how twin research has helped to form priorities in epidemiology, psychiatry, genetics, behaviour genetics, molecular genetics, and more recent –omics research. I wish to outline the most significant twentieth-century designs and their historic uses before discussing current applications. Each design approaches the ‘nature and nurture’ divide that Galton claimed twins exemplify from a different point of view, but each accepts that a division between the two is either actual or necessary to impose by statistical means.[3] The principal use of twins in biomedical research in the twentieth century was to calculate heritability scores. These measure the quantity of variance in a given trait that can be attributed to either genetics or to the environment. In the 1920s Herman Weiner Siemens is said to have invented the ‘classic twin method’ in order to calculate the trait resemblance between reared-together monozygotic (‘identical’) and same sex-dizygotic (‘fraternal’) twins (Siemens 1924). It is a method of research that already assumes a quantitative genetic resemblance between those two twin types – its effectiveness depends on how monozygotic twins, who are born from the same zygote, share 100 per cent of their genes, while dizygotic twins, born from two separate eggs fertilised by different sperm, are said to share 50 per cent. (Plomin, et al 2008, 79; Barnes and Dupré 2008, 98–99). Based on this creation of two different types of twin based on zygosity, each individual in each zygotic group is measured for a trait and a numeric index of heritability ranging from .0 (no genetic contribution) to 1.0 (complete heritability) can be generated to express a ratio of between-pair variation to total variation for that given trait, otherwise known as an intraclass correlation (Ball and Teo 2008, 473). On this comparative basis, the classical twin method can help to estimate the heritability of a trait: the proportion of the variance in a given population that can be attributed to genetic variance. Following Galton’s recognition that twins could be used to study *any* phenotype studies in the twentieth and twenty-first centuries have focussed on diverse and complex behaviours such as nail-biting (Ooki 2005), loneliness (Boomsma et al 2005), mobile telephone use (Miller et al 2012), intelligence (Haworth 2010), sexual dysfunction (Burri et al 2012), and happiness (Bartels and Boomsma 2009). Twins research has made these diverse behaviours not only more visible but visible through the lens of genetic variation.

After or in conjunction with the classical twin method, the second way of using twins in biomedical research employs twins reared apart. This methodology includes twins of both zygosities who have been separated, through adoption or by other means, at or near the time of their birth, and then studied in later life in order to model how shared genes and different environments have affected them. Early pioneers of this method include Horatio Newman, Frank Freeman, and Karl Holzinger in Chicago in 1937, British psychologist James Shields in 1962, and Danish psychiatrist Niels Juel-Nielsen in 1965, all of whom compiled studies of twins reared apart. None compare in scale (137 reared-apart pairs), longevity (20 years), or number of published outputs (more than 150 papers and chapters) to the Minnesota Study of Twins Reared Apart (MISTRA) (Segal 2012). As a logistically complicated and expensive form of twin research, the size of the MISTRA study almost certainly flourished thanks, in part, to the long-standing and wonder-struck narratives of visually alike twins being reunited; narratives that privilege what are now known as monozygotic twins but which historically intersect modern zygotic categories (Kooper 1994; Viney forthcoming). Harnessing extra-clinical fascination about twinning, as well as the commercial opportunities that may arise in their reunion,television and print media acted as a recruitment tool; through their appearance in the media, twins became an influential part of the study’s methods of research dissemination (Segal 2012, 104). Working in union with classical twin methods using reared-together twin data, and also using dizygotic twins reared apart for added insight, the MISTRA group argued that their data showed how monozygotic reared-apart twins were viewed as broadly sharing intraclass correlations with reared together twins for a range of personality traits, including controversial measures of general ‘intelligence’ (Segal 2012, 100). They took this as proof of the marginal influence of non-shared environmental effects compared to genetics, and used their twin data to conclude ‘about 70% of the variance in IQ was found to be associated with genetic variation’ (Bouchard et al 1990). While certainly not the sole finding from the 15000 questions asked of each twin pair during a week-long assessment process, MISTRA’s emphasis on the genetic component of complex traits left many concerned about the study’s methodological weaknesses and potential policy implications: the relatively small sample size; the amount of time twins had spent together either before or after their separation; the way in which confidential protocols made data inaccessible to other researchers; more deep-seated concerns about how the stress upon ‘genetic’ influence over, say, intelligence, implies the actual or potential irrelevance of policies aiming to improve educational attainment and, by proxy, to tackling social, economic and health inequalities (Lewontin et al 1985; Segal 2012; Ashbury and Plomin 2014).

The final method of using twins in biomedical research is by using monozygotic twins who are discordant for a particular trait or disease. It also assumes that they ‘share’ almost all their genes. Phenotypically discordant monozygotic twins, however, are useful to researchers who want to understand how those deemed genetically alike can develop divergent health experiences. Comparable to the classical twin methods for its development within a context of twentieth century eugenics, the discordant monozygotic technique was pioneered in the 1910s and 1920s by German researchers such as Heinrich Wilhelm Poll (1877–1939), Hermann Werner Siemens (1891–1969) and Otmar Freiherr von Verschuer (1896–1969)

(Joseph 2004; Teo and Ball 2009; Roelcke 2013). Heinrich Wilhelm Poll, an advocate for and victim of scientifically-driven policies of racial hygiene, promoted the importance of discordant twin research: ‘the well-planned and critical investigation of each suspected inherited character for its modification in MZ [monozygotic] twins must be conducted as an essential first step in all human genetics investigations’ (Poll 1914). Such methodological priorities had a direct influence over Horatio Newman (1875–1957) and colleagues at the University of Chicago, who helped to establish twin studies in North America after World War Two and inspired more extensive uses of the design at the University of Minnesota (Newman, Freeman and Holzinger 1937). In the years that followed the purpose of twin research moved away from proving the scientific basis for state-organised eugenics, yet the celebratory attitude towards the experimental possibility of monozygotic twins has scarcely changed in over 100 years of twin research. Robert Plomin, a leading behavioural geneticist and twin researcher, has argued that MZs differ for a given phenotype are ‘a sharp scalpel for dissecting non-shared environmental effects from genetic effects’ (Plomin 2011, 584). This is because the lives of monozygotic twins can be studied in order to disentangle how their behaviour and lifestyle interact with and act upon what is understood as a common genome, the cause of a considerable resurgence of discordant monozygotic twin designs in an era of postgenomic science (Castillo-Fernandez, Spector and Bell 2014; van Dongen et al 2012; Bell and Spector 2011). These are the hopes and expectations, the version of twin research most eagerly reported by popular print, television and film media, since it appears amenable to dyadic narratives of nature vs. nurture, nature-nurture, nature-through-nurture (e.g. Spector 2012; Miller 2012; Mukherjee 2016). What is particularly interesting for the sake of this volume is that monozygotic twins are felt to harbour within them a 'nature' that comes into contact with and dwells within an 'environment'. If postgenomic research has sought the 'molecularization of biography and milieu' (Niewöhner 2011, 279) to understand the malleability of the human body then the severance between, or imagined unification of, nature and nurture is internalized within the vital materiality of experimental twin designs: researchers can use twins to present their experiments and demonstrate the underlying dichotomy guiding human life without then having to translate findings into another kind of living body. The spheres of biology and society, like twins themselves, are then viewed as the component parts acting within a wider ecosystem. Without the burden of analogy or translation, these twin studies promise to isolate genetic regions, life events or behavioral patterns that can account for phenotypic discordance between pairs, leaving twins to operate as rhetorical and experimental vehicles for lived conceptions of the biological and social.

It is not my principal ambition to evaluate, as many others have done, the faults levelled against the methods and assumptions that guide twin studies: criticisms that range from accusations of genetic determinism; reductionism, the simplified genetic comparison between mono- and dizygotic twins, or the confusion over what a 'non-shared' environment means. Perhaps the most frequently citied criticism of classic twin models is the assumption that twins of different zygosities share environments in the same way (the so-called 'equal environments assumption'); studies suggest that monozygotic twins are far more likely to be treated alike and exposed to similar environments than their dizygotic counterparts (Stevens and Richardson 2015; Joseph 2013; Ball and Teo 2008). If we doubt the equal environments assumption then not only do mono- and dizygotic twins fail to operate as a control population for the other, they no longer stand as a representative group for singletons, since they experience an environment that is specific to their twinship. Twin research has caused particular controversy when applied in psychology, psychiatry and allied fields when false equivalences can be implied between complex, time-specific behaviours such as ‘criminality’ or ‘finger-nail biting’. These, once made into heritability scores, can be and are easily mistaken by those not familiar with twin research for universal indices of genetic determination rather than as a measure of trait variation attributed to genes within a specific population, within a particular time and place (Burt and Simons 2014). When misunderstood in this way, measures of heritability for psychosis, schizophrenia and other expressions of mental ill health have led to a focus on the genetic determinants that may underlie these conditions to the relative neglect of other causes (Bentall 2009, 123–127). Elsewhere, more detailed levels of genomic analysis, combined with the hybrid effects of mosacism and chimericism, have led some to argue that the idea of monozygotic twins ‘sharing’ a genome is misleading (Dupré 2015; Barnes and Dupré 2008). Taken together, these doubts about twin research have led its most vociferous opponents to demand it be ‘relegated to its proper place alongside the discarded pseudosciences of bygone eras, such as phrenology, alchemy, and craniometry’ (Joseph 2004, 244).

Critics of classical and other twin methods have either perpetuated distinctions between nature and nurture – focusing on methodological weaknesses and neglecting to engage with the underlying dichotomies guiding this research – or they have sought to reverse the genetic tendencies of twin research by stressing the ways that environments and the independent agency of individuals have a greater affect on the expression of behavioral traits (Davis 2014; Piontelli 2008; Joseph 2003; Stewart 2001). They do this at at the cost of understanding how the biosocial status of twins is at stake when participating in biomedical research. By focusing on the results that twin research produces, and leveling criticism towards the universal descriptions of human health and behaviour resulting from twin data, has meant that the status and position of twins within research science is considered of secondary or derivative importance. With the exception of Davis (2014), whose negative view of twin research stems from an assumption that all research scientists treat all twin participants as ‘zombies or performing monkeys’ (37), simpler questions about the relationship between twins and twin research are not being asked: why should twins continue to volunteer their time, energy, emotions, and bodily matter to the advancement of a publically contested science? In later stages of this chapter the development and transformation of twin research will be shown to depend on the recruitment and retention of a particular variety of clinical labourer, whose participation in research presupposes, informs, and legitimises the social status of twins, even in a postgenomic era that appears set to unravel the Galtonian nature/nurture distinction that brought twins into scientific studies in the first place.

EXPERIMENTAL BODIES

Having outlined some of the multiple ways by which diverse kinds of twins have been drawn into life and human science, largely to assert the division between ‘genes’ and ‘environment,’ it is important to stress the terms by which twins have been promoted by twin researchers as experimentally significant. Doing so means that we can turn to why twin research and its associated controversies have persisted from an era of gene-centric, transition biology to more complex, contingent and entangled models of human life (Stevens and Richardson 2015; Barnes and Dupré 2008). Doing so means we can understand why the use of twins, while instrumental in bringing the division of ‘nature’ and ‘nurture’ into public discourse, remains a favoured method by which to conduct biomedical science even while the desired research findings seek to move beyond polarities of nature, nurture and interactionalist metaphors of their correspondence (Keller 2015).

Natural experiments are prized as a gold standard among health and evolutionary scientists for their scale and variety of time, place, and observed specimen, since they allow for experimental conditions that cannot be generated in field or laboratory conditions and can reveal end results of ecological and evolutionary processes over long durations (Diamond 1983). The language that has validated the use of twins – whether using classical, discordant, reared apart, or combined methods – has been dominated by naturalism; the research achieved through twin bodies is neither confined to the artificial environments of laboratory-reared organisms or to the analogous caesuras that attend the use of model organisms. It also means that twin researchers can present their methods and findings as grounded in 'natural' phenomena. Twin research attains an abundant autonomy for those researchers who have come to depend upon and present twin studies as a 'naturally occurring experiment' (Smith et al 2012, 12), and 'experiment[s] of nature' (Plomin et al 2008, 38). Nancy Segal, researcher for, and historian of MISTRA, claims that twins are 'an experiment of nature' (Segal 2012, 62) – a powerful investigatory community who are capable of generating 'unique insights […] simply by acting naturally' (Segal 2010, 317). The presence of twins continues to energise a powerful experimental license. Thomas Bouchard, leader of MISTRA, whose extensive, costly, and politically contested studies into human intelligence were noted earlier, claims that 'molecular genetics looks at genes, not whole, live human beings,' so for him the advantage of twins studies is that they 'add a very necessary human element to genetics' (quoted in Panofsky 2015, 164). In addition to the sense of wild, standardised abundance the twin models permit its users, the notion that twin research forms a ‘natural experiment’ connects it to John Snow’s epidemiological studies of the 1850s, when Snow observed the randomised effects of differing water quality in two London boroughs. As is well known, his observations allowed him to deduce the source and spread of cholera through contaminated water. The claim that twin research constitutes a form of ‘natural experiment’ emboldens these designs and situates them within a canon of triumphant, life saving and preserving discoveries, rendering the randomised distribution of genetic difference between monozygotic and dizygotic twins akin to the randomised distribution of contaminated water in Victorian London.

Trafficking between the molar and molecular, easing the uncertain ‘coulds’ and ‘mays’ of scientific commentaries and review articles, twins relieve twin researchers of some of the burden of scientific abstraction or the traditional, metaphors of scripts, codes, and copies that accompany efforts to make genetic findings understood by non-scientists (Pickersgill et al 2013, 434, 443 n. 6; Nierlich 2016). By claiming that twin research is based upon a ‘natural’ kind of experiment twin models help to equivocate the technical, computational, social, and historical interventions made by expert analysts such as Bouchard. As if the expertise and technological infrastructures employed to articulate genetic findings can be substituted, or even elided, the presence of twin bodies means that the public understanding of DNA, RNA, single-nucleotide polymorphisms, bacteria and more, can be made known to wider populations through and between twin bodies. The spatial imaginary afforded to twin research through the bodies that they work on and work with is never simply limited to the discrete laboratories which elicit, recruit and analyse the data attributed to them, but, instead, it is energised through the entire ‘life-histories' that Galton claimed were the reason why twins were scientifically significant. When bodies are treated as a method, a global population of research subjects and a gateway to a standardised order of scientific utility, contemporary twin researchers such as Tim Spector can claim he and his colleagues have '11 million natural identical-twins experiments to choose from' (Spector 2012, 21). The experiments are already 'out there', waiting for Spector to capture. Elsewhere, Spector argues that his twin research is 'the closest we can get to doing animal experiments on humans' (quoted in Jolin 2013). Taken together, these statements might seem to appeal to opposed notions of experimental availability, intervention and manipulation, yet it is claimed that twins give all the power of animal research without the temporal and spatial confinement of a laboratory setting nor the problem of translating between model and target organism.

A recent meta-analysis of twin research over the last 50 years has revealed the extent to which twins are being used in health research – over 17,800 traits have been assessed in 2,748 scientific publications, including data drawn from more than 14.5 million twin pairs across 39 different countries (Polderman et al 2015). Currently, researchers estimate that there are 1.5 million twins and their family members currently participating in ongoing cohort studies around the world, gathered into twin registries that contain anything up to 200,000 participants (Hur and Craig 2013). In this respect, twins are not ordinary experimental bodies; in an era of international research collaboration, their experimental capacities are corporeally global. Defined by Ilana Löwy, an experimental body is one 'which can be substituted for patients' bodies in order to investigate diseases and look for treatments' (Löwy 2000, 435). Biomedical modelling stresses translation and substitution, a relation that 'presupposes representation, not identity' between model and target organism (Löwy

2000, 447). In twin studies, however, model and target simultaneously occupy the same experimental location, even while that experiment is distributed not simply *within* a body but also *between* bodies; they can be both representative of their target and presented as ‘identical’ to it. Furthermore, the ways in which twins occupy an intermediate position between model and target makes translating laboratory findings and forging collaborations between different disciplines more likely. Löwy notes that ‘an “experimental body” may allow the bridging of differences through the development of open-ended, “boundary concepts” which may have one meaning in their common use by several professional groups, and another when used by each specific group’ (Löwy 2000, 447). Twins, then, are used to produce forms of evidence such as heritability estimates that translate complex behaviours into manageable data and can be shared across disciplinary communities. For Alison Cool these estimates are ‘compact and comprehensible representations of less tangible social phenomena’ (Cool 2011). The important point is that corporeal standardisation and the numerical representations of complex traits and behaviours have secured the reproductive success of twin research. Heritability estimates may bring mobility and tangibility to less easily perceived social phenomena, but the social phenomena of twin research as a process of standardisation passes into obscurity. Twin bodies become, rhetorically at least, ‘immutable mobile’ (Latour 1987) that are, like the heritability scores that spring from them, presentable, readable and combinable beings that convey information without undergoing transformation.

Human manipulation, emotion, volunteerism or coercion can be written out of the accounts of twin research that stress the spontaneous efficiency of the twin body in generating numerically meaningful, ‘scientific’ evidence. As a consequence, twins serve as an experimental and explanatory resource that redistributes epistemological authority away from the analyst. The overall effect is to go beyond a power that Isabelle Stengers has claimed is typical of modern scientific objectivity, 'the invention of the power to confer on things the power of conferring on the experimenter the power to speak in their name' (Stengers 1997, 88). Twin studies does not confer upon the scientist a power to speak on behalf of mute phenomena, it confers on some scientists the power to indicate how phenomena speak themselves. In this case, the power of scientific discourse renders twin bodies the experimental and explanatory vectors of scientific fact, with the devolution of explanatory powers to twins in general, rather than to twin individuals. Twin research, in its efforts to displace the responsibility of its findings on the bodies that it analyses, fundamentally transforms the ways in which twins are viewed as a community of clinical labourers.

MAKING UP TWINS, FAST AND SLOW

As we have seen, the presentation of twins as experimental bodies, experimentally necessary for the study of basic biology, development, health, disease, and studies of aging, frequently points to the 'natural' availability of twins as a population, bodies who permit an explanatory power to pass from the scientific observer into the minutiae of twin lives. This control can be communicated between twin researchers and other expert practitioners in the life and human sciences through the immutable 'givenness' of twins. And yet that givenness, especially to longitudinal research programmes, capitalises on the pre-existing relationship shared between twin pairs that cannot be considered to be the straightforward product of their embryological, gestational, genetic or even epigenetic relations. The paradox is that though the practice of biomedical research provides twins an arena in which to situate their relations, that practice is extraneous to the experimental lives twins come to contribute to biomedicine.

What remains of this chapter examines the ‘biosocial’ constitution of twin identities in light of how biomedical research can or cannot inform, shape, or even determine how twinship is understood. Such an undertaking demands a more robust understanding of what twin-participants experience in research contexts. I discuss concepts of the biosocial, theorised by Paul Rabinow, Ian Hacking, Carlos Novas, Nikolas Rose, and others and, in separate but related scholarship, I also consider what some call the ‘biomedicalisation’ of human identity – the increasing influence of biomedicine to affect the ‘unprecedented and historically transformative differentiation of human bodies and futures clearly visible in contemporary struggles over pharmacological access, care, legal redemption, and therapeutic sovereignty’ (Moyer and Nguyen 2016). Biomedicalisation, and hence the emergent biosocial identities it may forge, is used here to describe technological and economic processes that express the capture and control by, and imposition of, medical knowledge upon individuals (Clarke et al 2010).

Theories of biosociality acknowledge both a debt to Michel Foucault’s interests in the historical constitution of subjects as they ‘are gradually, progressively, really and materially constituted through a multiplicity of organisms, forces, energies, materials, desires, thoughts, etc,’ (Foucault 1980, 97), while showing that Foucault did not anticipate the medical technologies or the kinds of subjectivity permitted by those technologies in the twenty-first century (Campbell and Sitze 2013). Paul Rabinow’s early efforts to define ‘biosociality’ stressed acts of collective identification that emerge as a result of novel and often genetic findings; while Foucault stresses the multiple agencies that inform who and what different people are and do, Rabinow's intervention argues that technologically-advanced biomedicine should be viewed as a dominant influence (Rabinow 1996). One outcome of the biomedical recreation of identity, claims Rabinow, would be the dissolution of the traditional division between nature and culture: 'nature will be modeled on culture understood as practice. Nature will be known and remade through technique and will finally become artificial, just as culture becomes natural' (Rabinow 1996, 99). The social and biological converge when 'new group and individual identities and practices aris[e] out of these new truths […] there will be groups formed around the chromosome 17, locus 16,256, site 654,376 allele variant with a guanine substitution. These groups will have medical specialists, laboratories, narratives, and traditions and a heavy panoply of pastoral keepers to help them experience, share, intervene in, and "understand" their fate' (Rabinow 1996, 102). Sociological analysis, coupled with and made possible through the emergence of new biomedical truths about individual health conditions, has encouraged subsequent theorists 'to name the kinds of socialities and identities that are forming around new sites of knowledge (genetics, molecular biology, genomics) and power (industrial, academic, medical)' (Gibbon and Novas 2008, 3). Ian Hacking also notes that those collectivities are fundamentally shaped by institutional classifications that are managed by experts, experts whose classifications identify people 'that would not have existed, *as a kind of people*, until they had been so classified, organised and taxed' (Hacking 2007, 288). Following Rabinow, Hacking also gives a special role to the biomedical sciences in galvanising the various numeric, normative, correlative, medicalised, biologicalised and genetic 'engines' that govern attempts to form human groupings: 'There has been making up of people,' concedes Hacking, 'in all times and places, but only in the past two hundred years have the sciences been so central to the human understanding of who we are' (Hacking 2007, 305). The important point to underline here is how these theories of biosociality stress the novel contribution of biomedical science in identifying and grouping individuals around 'disease, disfigurement or disability' (Rose 2007, 137) in order to identify the vital and increasingly molecular components of individual and collective identity.

In the clamour to understand the novel contributions made by emergent information about the structures and contingencies of life, scholars of the biosocial risk overlooking an important and somewhat opaque qualification made by Rabinow in his early theorisation of biosociality: 'older cultural classifications will be joined by a vast array of new ones,' he cautions, 'which will cross-cut, partially supersede and eventually redefine the older categories' (Rabinow 1996, 103). For Rabinow, the precise extent to which older cultural classifications enter into, cross-cut and redefine newer identities is uncertain, nor is it entirely clear whether those older classifications are already 'biosocial' in the enriched biomedicial sense that Rabinow describes. Furthermore, Rabinow assumes that the new will always topple the old and seems not to have considered the potential for established classifications to become resurgent, or to redefine the meanings attributed to biomedical innovations. Twin research may provide an important corrective to how theories of the biosocial explored above can be freighted with subtle yet hierarchical distinctions, ones that privilege the emergent over the established, the richly new over porously old, the dynamically fast before the superfluously old. The biosocial does not affect all subjects of biomedical research at the same speed, intensity or with the same emergent sense of dynamic novelty. This seems especially important when, as in the case of twins used in biomedical research, their status as 'natural experiments' runs contrary to sense of novelty that is being placed over the material that is being discovered within, through, and with them.

Though twins have been used in the life and human sciences since the end of the nineteenth century, they have been recruited on the assumption that they provide methodological immunity from the effects of ‘biologicalisation’. What might first appear to be a divergence between the logic of twin models and concepts of biosociality may, in fact, reveal a more subtle interaction between the clinical and extra-clinical attributes of human groups that serve to ensure the continuation of twin research. To help explore the temporal and historical formation of ‘twinship’ I refer to the United Kingdom’s largest twin studies project, TwinsUK, hosted by the Department of Twin Research, Kings College London.[4] This research group studies the etiology of age-related diseases and the genetic pathways that inform those diseases, but it can only do so by carefully managing the clinical and extra-clinical identities of twin volunteers.[5] The twins in the TwinsUK cohort are not, however, clinical labourers of the kind documented in the work of Melinda Cooper and Catherine Waldby; they do not sell their cell tissue or reproductive services, nor are they financially remunerated for their participation in clinical tests and measurements (Cooper and Waldby 2014). The cohort of 12,000 twins each complete an annual questionnaire that gathers detailed information about birth and health histories, daily and monthly dietary intake, and exercise. The twins also attend a four-yearly clinical assessment that involves an intensive, daylong series of testing, measurement, and tissue sample collection. Clinical examinations can gather multiple samples of blood, saliva, hair, skin, urine and faeces, while a series of tests include blood pressure and glucose, renal function, liver function, cardiogram, bone-mineral density, grip and lung capacity tests, and cognitive and memory examinations. Results for each individual twin are returned to him or her by post and copied to the volunteer’s general practitioner. With the exception of specific discordant monozygotic twin designs, the twins that participate in this research do not receive a clinical diagnosis before participation in twin studies but are used for the ‘randomised control’ that they provide. Nor is TwinsUK providing information that is exclusive to twin health or experience, their findings are frequently extrapolated to the general population. While some twins have outstanding health conditions these are not the determining factor for their participation, these individuals are not grouped by biomedical practice according to a specific ‘disease, disfigurement or disability’. Instead adult twinship is the principle requirement for participation – conceived, gestated, and born in unison.

Twins who enter genomic studies of the kind conducted by TwinsUK experience a different process of biomedicalisation from that which is prevalent in sociological and science studies literature on biosociality. Next to the routine tests, clinical visits mark an occasion for twins to spend time with one another; the tests and trials offer a combination of interpersonal interaction and personal discomfort, as well as occasions for playful, between-pair competition and comparison.[6] What is especially important to bring to light is how biomedical experts work to encourage and validate these extra-clinical benefits, respecting and often affirming ‘older classifications’ dear to twin siblings. Rather than simply making them redundant, twin researchers managing large cohorts utilise far older and in some cases ancient valuations of twin exceptionalism, especially those valuations that, rather than stressing clinical conditions affecting an individual, stress extra-clinical and collective effects of twinship such as the longevity and intimacy of the sibling relation or being the objects of curiosity and wonder of others. Celebrating the birthdays of older cohort members in newsletters and social media posts is one example of how engagement reinforces a set of values about how longevity, simultaneity, and continuity are shared by twins. Another example of how the sociality of twinship interacts with TwinsUK's research imperatives can be found in the following radio advertisement, aired in 2012 to recruit new twin pairs, it may be taken as exemplary for its celebration of a certain kind of prior, extra-clinical twin identity at the precise moment when twins are engaged as research participants:

> [*A male voice; background music*] You've lived your whole life as a twin, it's something that's really special to you and you're always keen to celebrate your uniqueness. We'd like to invite you to join TwinsUK, the biggest registry in the UK especially for twins. Our team of experts carry out innovative and research in the areas of genetics and aging. You'll be able to meet other twins and be part of the latest discoveries in science. For more info simply text 'TWIN' to 8400 […] (DTR, 2012).

To TwinsUK and numerous other research programmes that use data generated from tissue extracted from twin bodies, twin-born people are not simply passive assets: their experiences, beliefs, and behaviours fundamentally inform the particular quality of latent biosociality that initiates contact with medical researchers employed at TwinsUK.

Through social media accounts on outlets such as Facebook and Twitter, TwinsUK offers a wide range of items to engage their twin volunteers. Only a few posts disseminate research findings. Twins have been asked if 'you and your twin share a telepathic connection' (DTR, 2013), shown pictures of twin volunteers on holiday in a regular 'Twin Travels' section, and are linked to stories about unusual or celebrity twin pairs. Perhaps, most striking was the promotion of a study – not conducted by TwinsUK – that 'shows that twins enjoy better health and live longer thanks to their close bond' (DTR 2016) The post, popular among readers, in terms of comments, shared reposts, and 'likes', introduced research that compared the life expectancies of twins from a Danish birth registry to suggest that monozygotic twins live longer than dizygotic twins. The authors of the research paper claimed that this is a ‘consequence of the social bond between twins buffering against risky behaviors, providing emotional or material assistance during times of stress exposure, and promoting health-enhancing behaviors’ (Sparrow and Anderson 2016). It is a striking piece of research to disseminate through TwinsUK media channels, not only because it reinforces a deep-seated, cross-cultural belief that twins enjoy particular forms of intimate relation (Hoctor 2015; Davis 2015; Peek 2011; Pionelli 2008; Joseph 2004), but also for the evidence it gives to the long-standing criticism of twin models employed by TwinsUK. If different twin zygosities can be consistently associated with different biosocial ecologies (contradicting the ‘equal-environment assumption’), then the controls classic twin studies designs provide for non-shared environmental effects are distorted (Joseph 2013). The biosocial identities of twins are neither aligned with nor straightforwardly attuned to the research in which they participate.

CONCLUSIONS

Twin cohorts may celebrate, indulge in or build upon prior, extra-clinical exceptionalism felt for and by twins, forming a community of twin volunteers around their work that both reenacts and performs existing twin identities while co-emerging with novel research findings. Returning to Rabinow, the assumed dominance of biomedical practice and its capacity to create novel biomedicalised identities overlooks how twin researchers interact with the lives of twins, as well as how those lives have been the subject of focused medical discussion for thousands of years, not least because the circumstances of twin birth have grounded philosophical and theological interpretations of twin lives (Aristotle 1991; Dasen 2005; Hippocrates 2012; Viney forthcoming). What is made apparent through the example of twin participation in TwinsUK research is the way that the biosocial expectations of the past facilitate those of the new. Moreover, while promising a renegotiation of nature and nurture, concepts of biosociality have depended upon an asymmetry between what is past and present, working through the assumption that 'traditional' collectivities are either 'non-biomedicalised' or less biosocially sophisticated. Nikolas Rose has argued that what is distinct to twentieth and twenty-first century biosociality is that 'making up biological citizens also involves the creation of persons with a certain kind of relation to themselves' (Rose 2007, 140). Twins enrolled into scientific study, however, repeat at an inter-corporeal scale what has been identified at the historical scale: comparison, relation, and the dispersal of individual conditions across pairs and populations. Their ability to establish relations with themselves continues to be informed and mediated by their prior sibling relations; indeed, the forms of twin bisociality explored here, which produces scientific significance from rich mixture of somatic materialisations, descriptions and communications that circulate both within and far beyond the laboratory, within bodies and between bodies, may also stand in contrast to the individualism and genetic individuation described by sociological of the contemporary life sciences.

While twins have been made to matter in the attempt to identify molecular entities, processes, and locations that have emerged through intense, rapid, technical and financially complex developments in the life sciences, twins also constitute the molar and embodied evidence of such research, recruited as rhetorical devices and narrative protagonists by which to prove that those entities, processes and locations can become publically understood. And yet, as a group of people that have long been distinguished for the gestational circumstances of their birth and attracted debate over their complex biological and social significance, twins are not a modern biosocial grouping in the sense that they, as a human kind, have been discovered through biomedical innovation. Nor do they necessarily participate as biosocial bodies thanks to the genetic identification of a given pathology or disease; even monozygotic twins, discordant for a given trait and included within a cohort of others for a study may recognise the trait analysed as a significant but not a sufficient condition for their twinning. First-person narratives and ethnographic studies of twins who have experienced divergent health experiences tend to stress the transcendence of twin relations over and above the influence of an acquired or congenital condition on one or the other (;Davis 2014; Lewis and Lewis 2013; Stenzel Byrnes and Stenzel 2007; Wagner Spiro and Spiro 2006). There is far more to be discovered about how biomedical advances form and fail to form identities, and why theories of the biosocial are so quick to follow novelties rather than acknowledge classificatory resonance, dissonance, or ambivalence with longstanding patterns of knowing and being. Such an inquiry would not isolate the biological from the social or cultural still further, but provide a more nuanced understanding of how the biological and social are not only compelled by time's arrow but are concepts that are historically entwined.

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Notes

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[1] Here I follow Nancy Segal's definition of 'twin-born people' as those who share 'simultaneous conception, shared prenatal environments, and common birth' (Segal 2000, 225).

[2] Thought to have entered the English language in Shakespeare's *The Tempest* ('a born devil, on whose nature nurture can never stick', (4.1.188–189)), Galton's first use of the phrase 'nature and nurture' occurred in 1874, a year before he published his work on twins in *Fraser's Magazine* in 1875, when expressing interest in the 'energy, intellect, and the like' of other fellows of the Royal Institution (Galton 1875).

[3] For a succinct overview of twin research methods and its various attempts to identify numerical values for 'genes' or 'environment', see Ball and Teo 2008. That twin methods are inextricably tied to efforts to separate, even provisionally, different domains of so-called 'natural' or 'environmental' influence, may be

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observed in how behaviour geneticists such as Nancy Segal now regret using the expression 'nature vs nurture' to evoke an imagined battle between two opposing entities. But, testimony to how models of conflict between genes and environment have given way to more interactionist models, the old protagonists remain distinct entities, Segal now prefers either 'Nature-Nurture or Nature and Nurture, because it is widely appreciated that the two effects work together and are separable only in a statistical sense.' Her studies on twins concede interaction on the basis that their statistical separation is (and should be) achieved through twin research (Segal 2012, 96).

[4] Described as 'the biggest UK adult twin registry of 12,000 twins used to study the genetic and environmental aetiology of age related complex traits and diseases.' See http://www.twinsuk.ac.uk/ Accessed 17 May 2016. Information on the activities of TwinsUK has been gathered by my participation (2012–present) and as a Volunteer Advisory Panel member (2014-15). I conducted clinical visits in March 2012 and March 2016.

[5] The TwinsUK website claims that its 'genome-wide association studies have identified over 400 novel gene loci in over 30 disease areas including osteoporosis, osteoarthritis, melanoma, baldness, and telomere length from TwinsUK data. Current research covers the genetics of metabolic syndrome and cardiovascular disease, musculoskeletal system, ageing and sight.' http://www.twinsuk.ac.uk/about-us/ Accessed 2 May 2016.

[6] For documentary footage of such competition, see Alexander and Christoffer van Tulleken visit to TwinsUK in the BBC documentary, *The Secret Life of Twins* (van Tulleken and van Tulleken 2009).