2

The Photographic View: Observational Record and Symbolic Excess

Photographs are a common visual genre used by popular science magazines and other mass media to communicate genetics to public readers. Their use spans the entire history of modern genetics and continues to evolve as the discipline and its social context change. As a genre familiar to public readers and capable of displaying concrete visual details, photographs, as this chapter argues, can make for relatable and accessible visual evidence. At the same time, photographs' rich (some would say excess) visual details can also mean a lack of semantic determinacy; that is, their meanings are subject to the potentially different interpretations of a viewer (Pozzer-Ardenghi and Roth 2004). Examining photographs' evolving and multiple roles in the popular communication of genetics, this chapter sheds light on how this visual genre partakes in shaping public perceptions of genetics. In particular, the chapter emphasizes two interrelated functions of photographs: as primarily informative, cognition-based evidence and as primarily symbolic, affect-based artifacts.

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Informative Photographs: Evidence from Classical Genetics

It is, by now, a well-known story. Gregor Johann Mendel (1822–1884), posthumously revered the father of modern genetics, was a little-known Austrian monk in his lifetime. While trying to create hybrid pea plants in his monastery garden, he established what is known today as the Mendel's Law of Inheritance. Put somewhat simplistically, Mendel's Law states that alleles (multiple variants of one same gene) are separately and randomly passed from parents to offspring; the combination of the alleles and their dominant or recessive state determines the appearance of the offspring. Mendel published his findings in 1866 in *Versuche über Pflanzen-Hybriden* (*Experiments on Plant Hybridization*); it was, however, not until the early twentieth century when his work became widely known and confirmed by other researchers, which ushered in the roughly 40-year span of classical genetics.

During this era, photographs were used to demonstrate the apparent results of inheritance and mutations in plants, trees, and animals (including humans). In particular, they were used to demonstrate how Mendel's Law can be employed for selective crossbreeding, as shown in Fig. 2.1, in the case of corn. On the left panel of Fig. 2.1 are two different corn strains, separated in two rows. These corns show obvious

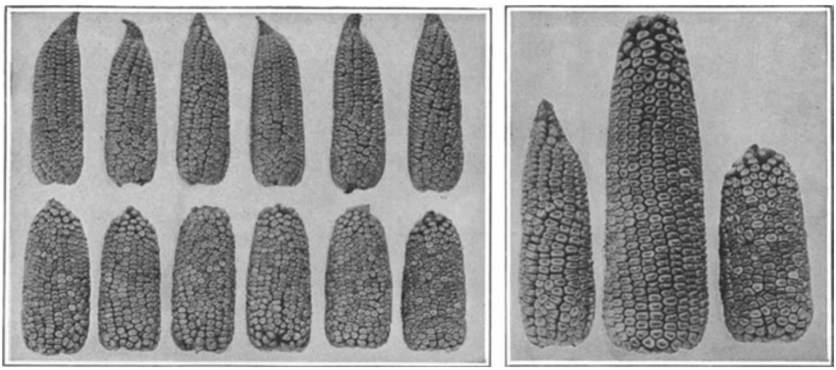

Fig. 2.1 Hybrid corn grows to superior size (Jones 1919, p. 230)

inter-strain consistency and cross-strain difference in their shape and structure. The right panel displays three corns. The smaller ones on the sides are the same two strains shown on the left panel; the larger one in the middle is their crossbred offspring. As the photograph makes clear, the crossbred strain has a larger size unmatched by its parents.

Similar success was gained in the breeding of tobacco. In Fig. 2.2 left, we see the Havana wrapper tobacco grown in the Connecticut River Valley. It features short, wind-resistant stalk and large leaves, but the leaves are moderate in number (averaging 19–21 per plant). Shown in Fig. 2.2 middle is the Cuban tobacco that has tall, non-wind-resistant stalk and medium-sized leaves, but the leaves are superior in number (averaging 26 per plant). By crossing the two breeds and recombining crops with desired features, one can, in the second generation, breed the Halladay shown in Fig. 2.2 right. It combines Havana's strong stalk and large-sized leaves with Cuban's superior number of leaves, leading to significantly higher yields. Photographic evidence similar to that shown in Figs. 2.1 and 2.2 was used to report genetics-based experiments and practice in animal breeding (e.g., Castle 1905) and later forestry development (e.g., Hunter 1951).

Fig. 2.2 Halladay tobacco outperforms its parents in stalk strength, leave size, and leave number (East 1910, pp. 350–352)

These early twentieth-century photographs may seem unsophisticated compared to today's high-tech visual splendor, but their perceived ability to photographically record "reality," especially through comparison, makes them powerfully persuasive (Dobrin and Morey 2009, p. 293). The comparison of different specimens illustrates, simultaneously, the experiment process (crossbreeding two strains), its outcomes (obtaining a hybrid), and its significance (a superior hybrid). As such, not only do the photographs explain scientific experiments, they are arguments for genetics-based agricultural practice and its social benefits.

These arguments were especially significant in the early twentieth-century America—when rapid urbanization and industrialization were taxing the agriculture industry and changing the agriculture paradigm "from widespread subsistence farming to a system of farms providing food for the newly urbanized areas" (Fulton 1998). As rural population migrated to cities and immigrants arrived, significantly fewer farmers were operating on fewer acres to feed more people (Fulton 1998). When America joined World War I in 1917, the food needs of its European allies also added to the demand (Fulton 1998). In this historical context, higher production yields, shorter growth periods, and an overall control over agricultural practice became a social urgency.

Early genetics photographs not only responded to this urgency by presenting scientific solutions but also made the solution a matter of personal pride. Exuding from these photographs is a sense of human triumph over Mother Nature. As an article on tree breeding exclaimed, "MAN IS now making new kinds of trees. The old, established kinds don't suit him any more. They grow too slowly, or they have too many branches, or they succumb too easily to disease or drought. So man has started to create trees which will not have such failing" (Hunter 1951, p. 10). Accompanying the statement is the same proud photograph, wherein the newly created hybrid trees are compared with the "old kinds" and show faster growth. Certainly, the invocation of "science triumphing over nature" is not particularly unique to these photographs. Media reports of genetics portray the same sentiment through word choices (Hansen 2006), and indeed, it is an ideology going back to the Scientific Revolution in Western culture (Cohen 1994). Yet photographs, in their supposed ability to capture nature "as is" and to fix a graphic moment in history, can be an especially convincing testimony to the claim.

Moreover, being significant social artifacts did not preclude these photographs from serving as well adapted scientific evidence. The early twentieth-century natural scientists were preoccupied with machine-made mechanical images, images that act as transparent conduits to present nature as if it were speaking for itself (Galison 1998). Within this paradigm, the machine was trusted "as a neutral and transparent operator that would serve both as instrument of registration without intervention and as an ideal for the moral discipline of the scientists themselves" (Galison 1998, p. 332). Photographs were thus the scientific visual evidence par excellence, for their creation was, supposedly, a mechanical and automatic process accomplished by none other than the objective camera—provided that any retouching or post-processing was prohibited.

This, of course, was a naïve view of photographs. Photography, or other machine-based visualization, is far from being an automatic process void of human interaction. As Meyer (2007) wrote, a photographer has ample opportunities to influence the outcome of a photograph, even without obvious retouching: "The position where the photographer stands in relation to the scene, the instant at which the exposure is made, the choice of camera, lens, shutter speed and aperture, and the selection of which photographs among many to print and publish" (p. 102). Furthermore, from a science communication perspective, photographs that are automated and free of retouching are not necessarily preferable. Without these "interventions," the excessive visual details of a photograph can obscure significant clues from non-expert readers (Pozzer-Ardenghi and Roth 2004). It is thus around the last two-thirds of the twentieth century that scientists in various disciplines came to celebrate the interpreted images, which are created by trained experts who, having observed and critically assessed many visual examples, synthesized the observation to bring out their presumably universal patterns and salient points for less-experienced viewers (Galison 1998). In the popular communication of genetics, this shift contributed to the illustrative capture of electrophoresis and the rise of symbolic photographs discussed later in this chapter.

Of course, conventional photographs have not disappeared and continue to be used as informative evidence—though their function is undergoing both subtle and obvious changes. As modern genetic experiments replaced Mendelian crossbreeding, photographs are used to document the physical appearance of organisms that are subject to various testing. Figure 2.3, for instance, is used in a *Science News* article (Brownlee 2006, p. 393) to demonstrate the effect of epigenetics, an area of study that looks beyond genes as the sole determinant of life and examines how external factors (environment, diet, etc.) exert control by influencing which genes are expressed. As Fig. 2.3 shows, mice that carry the same gene (*agouti*), which affects their fur color, can exhibit a range of colors and weights depending on the food their pregnant mothers were fed.

As earlier photographs, Fig. 2.3 demonstrates, from a visual perspective, the experiment results: that is, the mice assume varying fur colors and sizes. But compared with Figs. 2.1 and 2.2, it is less capable of demonstrating the experiment process in question or its significance. The ways by which the mice's colors and sizes were manipulated cannot be discerned from the photograph alone. In addition, as it turns out, these physical differences are not the most meaningful findings

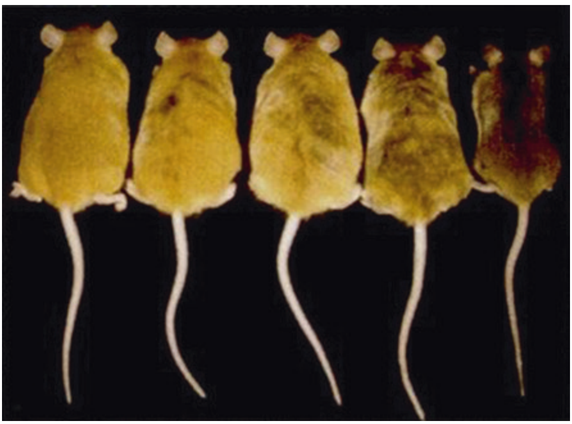

Fig. 2.3 Effects of epigenetics on mice fur color and size. Reproduced with permission from Dolinoy et al. (2006, p. 569) (color figure online)

either; what is of significance is that the brown and smaller mice have decreased risks for diseases such as diabetes and cancer, because their mothers were fed nutrients derived from soybean (Brownlee 2006).

By this, I am not suggesting that images like Fig. 2.3 are no longer valuable in popular communication. They are: They convey observable information and serve as evidence of contemporary research. What I am calling attention to is that as the scientific paradigm shifts, so does the function and relevance of particular visual genres. Classical genetics focused its inquiry on visible phenomena, which made photographs convenient and highly pertinent visual evidence. This research context changed in the 1950s: Experiments confirmed DNA's central role as genetic materials, and DNA's structure was subsequently determined. These breakthroughs brought about the DNA age of modern genetics and changed the discipline's focus from observable features to molecular-level activities. Because of this, photographs that depict objects and phenomena directly observable to the human eyes lost their prior advantage.[1]

What advantage they lost in conveying molecular information, however, the photographs gained in making genetics more "fun" and relatable for public audiences. Consider, for example, a photograph of a playful tiger and fish in a study that explores the molecular mechanisms behind the formation of animal skin/fur patterns (Saey 2010), or photographs of cuddly polar bears in a study that examines the bear's ancestral origin (Millius 2011), or a close-up of a beautiful monarch butterfly in an article that ponders the environmental effects of genetically modified crops (Brown 2001). These photographs do not try to function as scientific evidence the way Figs. 2.1, 2.2 and 2.3 do. Instead, they frame genetics in entertaining or at least familiar contexts for public readers. As such, they contribute to attracting reader attention, generating emotional interest, and developing a broader and arguably more socially, culturally, and environmentally grounded understanding of genetics.

Informative Photographs: DNA Fingerprinting

Although traditional photographs lost some of their advantages as direct evidence when genetics entered the DNA age, there is one important exception: the photographic capture of electrophoresis. Electrophoresis may not be a term familiar to public readers, but it is behind a technique often heard in mass media: DNA fingerprinting, which is commonly used in crime scene investigation, body identification, and paternal testing. More generally, electrophoresis is an analytical tool used to separate DNA, RNA, and protein molecules of different sizes.

Put simply, in electrophoresis, test samples such as a DNA chain is cut into fragments by enzymes. The fragments are loaded into some gel, which is then placed in an electric field. Because molecules are themselves electrically charged, they migrate in the gel. DNA, for example, is negatively charged so it migrates toward the positive end of the gel. Smaller fragments of DNA molecules move faster than larger ones, so given time, fragments of different sizes will travel different distances and form separate "bands." Agents and dyes can then be added to bind with the molecules and "stain" the bands, making them visible. The bands are captured via photographic techniques, including conventional photography and autoradiography.

Figure 2.4 provides one example, where electrophoresis demonstrates the unique reproductive practice of the nine-banded armadillo: A female typically gives birth to a litter of four genetically identical offspring, that is, a set of same-sex quadruplets. The left part of Fig. 2.4 shows electrophoresis results of four unrelated litters, separated by black vertical lines. Within each litter are four lanes, each representing one of the quadruplets. As can be seen, the four siblings within each litter have identical bands or the so-called DNA fingerprints; across litters, the bands differ. By contrast, the right part of the figure shows electrophoresis results of a great many random armadillos, who all display different DNA fingerprints.

With Fig. 2.4, readers get to "see" the abstract, molecular-level genetic research in more concrete terms. Even though the photograph itself is

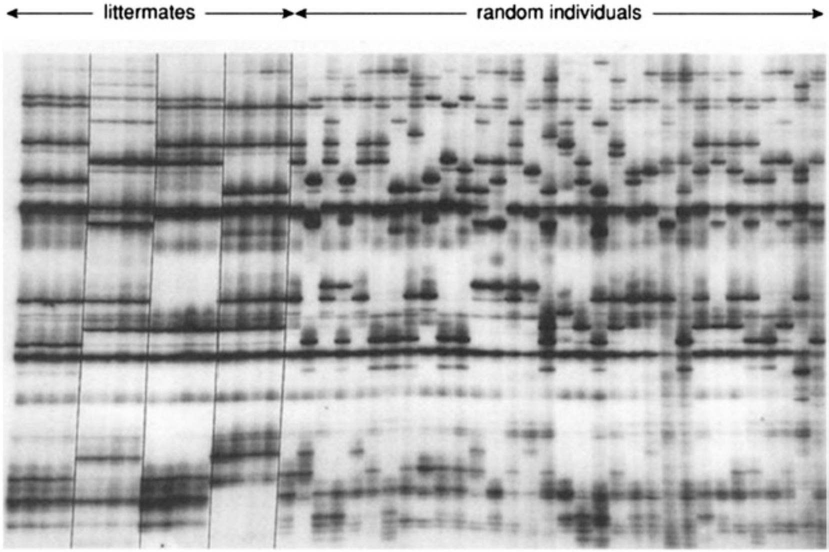

Fig. 2.4 Electrophoresis demonstrates nine-banded armadillos having quadruplet litters (Loughry et al. 1998, p. 278). Courtesy of William James Loughry and Paulo Prodöhl

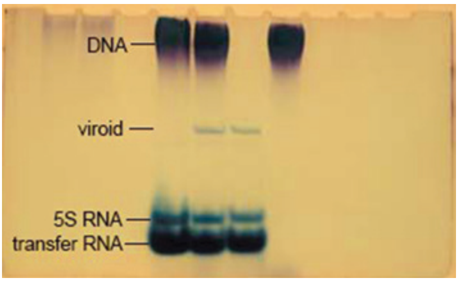

Fig. 2.5 Electrophoresis reveals that viroid is a type of RNA. Adapted by permission from Macmillan Publishers Ltd: Nature Reviews Microbiology (Diener 2003, p. 77), copyright 2003

incapable of explaining the full technique of genetic fingerprinting, it helps to provide a frame of reference as to what is being observed and examined.

In addition to providing a window to "see," these photographs can also engage readers in analyzing research findings. Figure 2.5 from a 1983 *American Scientist* article (Diener 1983, p. 483) is a case in point, which illustrates an experiment designed to test the nature of viroid, a substance believed to cause infectious diseases in plants.

In the experiment, researchers subjected multiple healthy and diseased tomato samples to electrophoresis, with the following results:

- Sample 1 (healthy tomato) revealed three bands: one for DNA and two for RNA (known as 5S RNA and transfer RNA).
- Sample 2 (diseased tomato) revealed the same bands as sample 1 and one extra: viroid.

The comparison between samples 1 and 2 thus provides physical evidence of the existence of viroid in diseased tomatoes.

- Sample 3 (diseased tomato with an added enzyme that digests DNA) revealed the same viroid band and RNA bands, but no DNA band.

Because viroid, as the other two kinds of RNA, was not digested by the added enzyme as the DNA band was, this is evidence that viroid is not DNA and may be a type of RNA.

- Finally, sample 4 (diseased tomato with an added enzyme that digests RNA) resulted only in the DNA band.

Because the added enzyme digests RNA, the disappearance of the viroid band, together with other RNA bands, confirms that viroid is a type of RNA.

Figure 2.5 thus functions as a scaffolding tool, and public readers are not excluded from analyzing the data just because they have no prior training in electrophoresis or do not have formal knowledge of, say, 5S RNA or viroid RNA. Rather than being the party who is "deficient" in background knowledge, readers are made capable of evaluating research findings. Though such experiences do not begin to reflect the full range of public engagement in science, they contribute to the broad agenda for public dialogue, at least at the normative level (see Jackson et al. 2005).

Despite these values of electrophoresis photographs for popular science communication, not all electrophoresis results are captured this way, especially in more recent publications. Consider Fig. 2.6, which is part of a larger illustration that appeared in a study of P-glycoprotein, a cell membrane protein believed to cause drug resistance. In parts not reproduced here, the illustration shows sample cells being sheared and membrane proteins being isolated. The membrane proteins are then subjected to electrophoresis, with the result shown in Fig. 2.6. Column *a* represents testing results for drug-sensitive cells, and column *b* represents those for drug-resistant ones. The horizontal lines drawn across each column are their respective bands. The two columns, as Fig. 2.6 shows, have identical bands except for an extra one in column *b*, which is colored green and marked by an arrow. A specific agent (an antibody) is then added; it binds with the molecule in that extra band and reveals it as P-glycoprotein.

To capture electrophoresis, as Fig. 2.6 does, in illustrations rather than photographs is an interesting rhetorical choice. Doing so allows a visual creator to integrate this procedure into larger illustrations of complex experiment processes. It also, arguably, helps distill complex photographic details so that a non-expert audience may more easily identify elements of interest. This, as discussed earlier, is the reason for favoring interpreted images over mechanical images. But photographs of electrophoresis, I

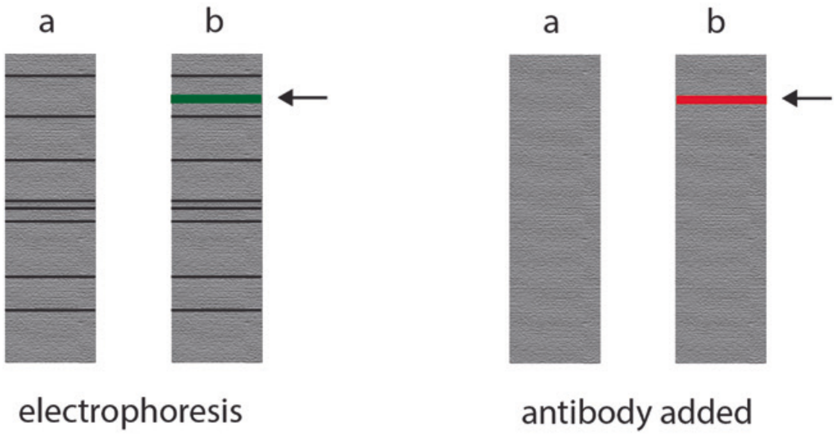

Fig. 2.6 Illustrated electrophoresis reveals P-glycoprotein. Redrawn based on Kartner and Ling (1989, p. 48) (color figure online)

argue, are different from other kinds of photographic evidence. While an X-ray photograph of the human skull would contain too many visual details that obscure the object of interest, say a lesion (Galison 1998), in the case of electrophoresis, the photograph contains virtually no visual excess. All that is photographed *is* the object of interest: the number, length, and position of the bands. When we transform these photographic details to illustrations, we are not so much providing more accessible visual evidence as reducing that evidence. A more vigilant viewer may also see this as a slippery road toward "cleaning up" primary evidence. Certainly, I am not suggesting that photographic representations of electrophoresis are free from selection or manipulation. As Knorr-Cetin and Amann (1990) reported, with photographs, researchers can perform a range of acts to make certain bands disappear, including cutting off bands, reducing film exposure time, or turning off the electrophoresis apparatus at a certain time. But if that is so, imagine the "artistic leeway" built into the illustration. It is no coincidence that illustrations of electrophoresis would never be accepted as publishable evidence by field journals.

Of course, what counts as valid evidence in field journals is a complex topic (see Frow 2012) and beside the point here. For our focus on public communication, I argue that illustrative representations of electrophoresis are inadequate for conveying the full range of implication and complication of DNA fingerprinting. From a superficial stance of visual impression, it is not easy to imagine straight lines in an illustration as traces of biological samples. Indeed, the defined lines may give the erroneous impression that genetic samples become visible lines after electrophoresis. More importantly, an illustrative view falsely represents the nature of electrophoresis: as objective "facts" that defy questions and judgment, especially questions and judgment from non-expert audiences unfamiliar with the technique.

Consider Fig. 2.7, which shows how electrophoresis is used to match suspect DNA with crime scene evidence in forensic DNA fingerprinting. Clear and uniform bands run down four columns, and it is but a quick visual scan for one to conclude that suspect 2 (outlined in yellow "matching" frame) has done it.

In reality, however, the bands formed during electrophoresis are much fuzzier (as seen in Figs. 2.4, 2.5). And interpreting these bands

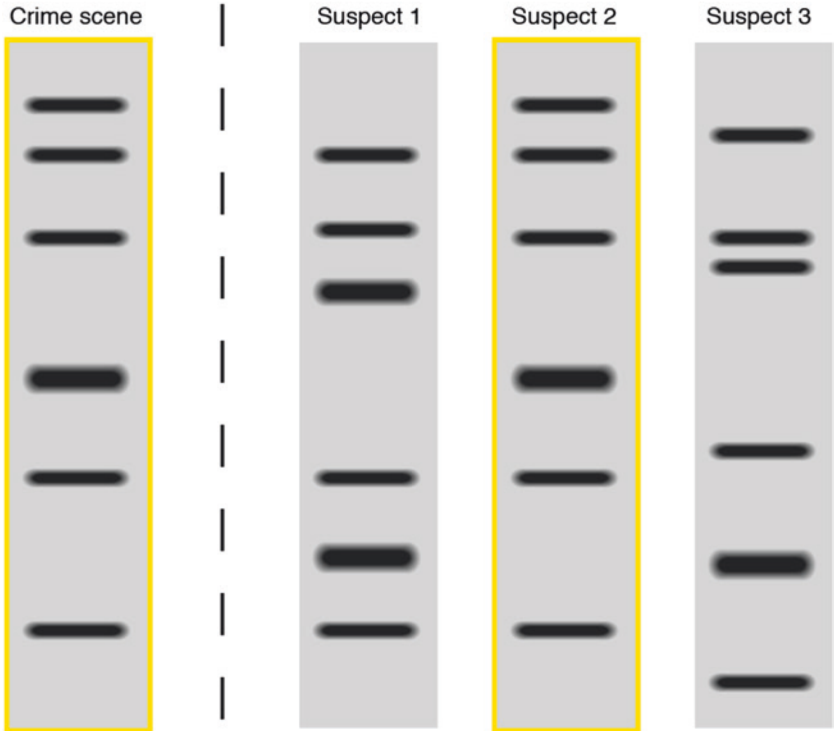

Fig. 2.7 DNA fingerprinting matches suspect DNA with crime scene evidence (Leja 2010) (color figure online)

is far from a clear-cut, straightforward process—hence the controversy of using DNA evidence in court. As Kirby (1992) wrote, "The ability to declare a match between two profiles…can be influenced by many factors"; one important factor is band shifting, which "is the phenomenon where DNA fragments in one lane of an electrophoresis gel migrate across the gel more rapidly than *identical* fragments in a second lane" (p. 119, emphasis mine). Various reasons may cause band shifting, such as different quantities of DNA being added in different lanes or gradient pockets in the gel (Kirby 1992, p. 123). An observer, therefore, has to determine whether the discrepancies in the bands are a result of acceptable band shifts or a non-match. Gray areas also set in in the cases of "extra bands." When sample A has identical bands as sample B plus some extras, it is possible to conclude that (1) the two are a match because sample A has been contaminated and therefore is taking on extra bands, (2) the two are a match because sample B has degraded and therefore is missing bands, or (3) the two are a non-match (Nelkin and Andrews 1999; Neufeld and Colman 1990).

The neat illustration in Fig. 2.7, in one decisive move, eradicated these potential complications and "black-boxed," as Latour (1998) would say, the visual evidence into something that resists inquiry. Rather than presenting inherently messy data that call for interpretation, it presents something that just "is." Rather than illustrating the "science" behind DNA fingerprinting, it disregards social debate surrounding the subject (Long 2007) and reflects what Durodié (2003) calls the patronization of the publics by "diluting the detail, eroding the evidence and trivialising the theory" (p. 85). Reinforced is the positivist view of science as the absolute reality, and lost are opportunities for readers to truly access data, raise questions, and consider issues of trust. Besides the influence of positivism, it seems likely that, in this case, photographs are passed over also because of their lack of visual glamor. In popular communication, grainy and often black-and-white bands are no competition, or so it seems, to sharp and colorful illustrations that draw their ethos from sophisticated design software and technical precision.

Symbolic Photographs: Visual Catachresis

Electrophoresis bands may lack visual appeal, but that does not mean they are affect-less. As rich semiotic objects, photographs are adept at evoking viewer reactions and emotions—just consider the everyday pictures we take of ourselves and our surroundings. Photographs used in the popular communication of genetics are no exception. The crossbreeding photographs from the early twentieth century signify the depicted plants and animals as experiment specimens, not part of nature to take delight in. The animals look away rather than at the viewer, forming what Kress and Leeuwen (2006) called "offer images": that is, what is photographed is offered "to the viewer as items of information, objects of contemplation, impersonally" (p. 119). The electrophoresis photographs, in their sober depiction of unadorned bands, convey much the same feeling and impression.

If this sense of detached objectivity or contemplation is often expected in scientific visuals, photographs that appeared in the last 20 or so years in the popular communication of genetics are charting new territories. Following Bloomfield and Doolin (2012), I call these images symbolic photographs, photographs that are less interested in being scientific evidence than creating or repurposing signs to channel and foster viewer reactions and emotions. An example, in the extreme, should demonstrate what I mean.

In 2003, to protest against transgenic cattle programs and the lift of a moratorium on genetically modified organisms (GMOs), the New Zealand activist group Mothers Against Genetic Engineering in Food and the Environment (MAdGE) erected a billboard at sites in Auckland and Wellington (Bloomfield and Doolin 2012). Pictured on the billboard is "a photographic image of a naked, four-breasted young woman, kneeling on all fours in side profile, with her breasts hooked up to a dairy milking apparatus and a red 'GE' brand on her buttock. The accompanying press release was titled 'Why Not Just Genetically Engineer Women for Milk?'" (Bloomfield and Doolin 2012, p. 515). Clearly, this billboard has other purposes than demonstrating the process of genetic engineering or otherwise serving as scientific evidence.

Such extreme examples, as may be expected, are not found in mainstream popular science publications or mass media. But similar visual and semiotic gestures exist, enabled, in no small part, by widely available graphic editing software such as Photoshop. An article on artificial human reproduction (Reynolds 2005, p. 72), for instance, presented a photographic image of a human baby, umbilical cord attached, inside a transparent bubble. The bubble, as the article suggested, stands for the artificial amniotic sac or more generally, the artificial womb. From outside of the picture frame, a hand reaches down and caresses the bubble.

The image features a calm blue color, the hand looks markedly female with a gentle gesture, and the baby inside the bubble looks comfortable and healthy. But the photograph, as a whole, looks eerie. The grown baby looks naturally human, but floating in a transparent bubble, it is apparently not a natural baby. The hand from above creates the same effect: it looks to be the hand of a mother, but common sense tells us that no natural mother can touch her baby thusly. Although fetus-in-womb drawings date back to as early as Leonardo Da Vinci, the example here has a distinct visual impact by being a photograph, a visual genre that is conventionally associated with recorded reality. Blending the perceived "real" and the apparently "unreal," the photograph is capable of creating the state of the uncanny (Mori et al. 2012) or, at least, an uncomfortable feeling of someone trying to play God.

The most common symbolic photographs used in popular science and media reports of genetics are, as in the cowgirl example, about GMOs. For example, an ear of corn would have its husk peeled back to reveal not yellow kernels but colorful pills—implying the genetic engineering of corn to produce proteins and other elements of medicinal value (Ferber 2003). Succulent vegetables and fruits would take a shot of suspect fluids from a syringe—a most popular portrayal of GMOs (see Fig. 2.8). Apples would be patched up with differently colored parts to suggest genetically engineered apples with extra apple genes (Pollack 2012), or they would slice open to reveal the inside of an orange, implying, ostensibly, a more audacious transgenic attempt. These examples, as may be imagined, generally accompany anti-GMO discussions. Though not nearly as extreme as the cowgirl example, they are visually shocking by fusing the real and the fantastic and by portraying the socially and culturally "unnatural."

While the semantic gist of these Frankenstein food photographs is easy enough to grasp, their semiotic effect on publics' perception of genetics is far from simple. A useful lens to examine that effect is catachresis, which, according to classic Quintilian definition, is a figure of speech wherein "the nearest available term" is adapted "to describe something for which no actual [i.e., proper] term exists" (Parker 1990, p. 60). This definition, I propose, can be productively extended from verbal adaptation to photographic adaptation. For instance, in artificial human reproduction, the process of implanting embryos on endometrial cells cannot be readily captured; similarly, the molecular-level differences between GMOs and non-GMOs are not visible to the naked eyes. There is, in other words, no actual way to photograph these scenarios for a viewer. In this vacuum, the nearest available means of representation—or more precisely, what a visual creator considers the nearest

Fig. 2.8 Catachrestic photograph of genetically modified tomato (color figure online)

available means—is used. Thus, a transparent bubble stood in for an artificial womb, female breasts represented "milk" genes, colored pills substituted for protein genes, and physical injections of fluid replaced genetic engineering.

What is remarkable about these substitutions is their ambiguous intention and effect. On the one hand, it is possible to see them as metaphorical expressions, clever figures of speech wherein a visual creator uses a familiar term to elucidate an unfamiliar or abstract concept. On the other hand, it is possible to see them as a form of misuse, taken after the original meaning of *catachresis*, from the Greek *katakhresis*. How to delineate these two different interpretations of catachresis has troubled rhetors for centuries. For Quintilian, catachresis is not a metaphor: To use metaphor is to replace a proper term with one transferred from another place; to use catachresis is to adapt a word for a situation where no proper term exists (Parker 1990). However, this rationale easily breaks down. As Quintilian himself admitted, one may "indulge in the abuse of words even in cases where proper terms do exist" (Parker 1990, p. 61). Later rhetors, attempting to clarify the matter, came to define catachresis as a "bad" metaphor. Cicero defined it as "an abuse of metaphor, the wrong or inexact use of it as a substitution for the proper term," and Northrop Frye called it the "unexpected or violent metaphor" (Parker 1990, p. 61). For these scholars, a metaphor is the friendly and neighborly borrowing of words, whereas catachresis is constrained and forced (Parker 1990).

To visualize "freedom" in the form of a flying eagle, many (at least in the U.S. context) will agree is friendly; to visualize women with cow-like breasts, most readers would concur is unexpected and forced. At the very least, such representations are semiotically excess; that is, what is depicted in the photograph is "greater than [what] the material foundation can warrant" (Anderson 1996, p. 55). This excess is what made the cowgirl billboard backfire: the image was critiqued by many as offensive and erroneous and ultimately ruled by the New Zealand Advertising Standards Complaints Board as a depiction that "[distorts] the debate on genetic engineering" (Bloomfiled and Doolin 2012, p. 519). The Frankenstein food catachrestic photographs, because they are less provocative, receive no such backfire, but from a semiotic perspective, they are similarly excessive. Consider the common approach to cultivating GMOs: it starts with splicing a target gene or genes into harmless bacteria, which then slip the gene(s) into a plant cell on contact; after taking up the gene(s), the cell divides and multiplies to generate a seedling, which then bears edible vegetables or fruits. This and other such processes, then, bear little resemblance to injecting fluids into grown and harvested vegetables or fruits, as Fig. 2.8 would have us believe.

But from an activist stance, a catachresis' ability to misuse, to shock, to insinuate subversive voice into the dominant discourse is its precise attraction. Termed a "secondary original" by Jacques Derrida, "catachresis is both an impropriety and an opportunity" because it is when we disregard the apparently proper meaning of a sign that we are liberated to expose a reconfigured relation to it (Hawthorne and Klinken 2013, p. 160). This makes catachresis an attractive frame of reference used by, among others, postcolonial and gender scholars to challenge the status quo (Hawthorne and Klinken 2013).

For the same reason, catachrestic photographs can function as subversive voice to formal scientific institutions' (and their media allies') portrayal of genetics as that which is scientifically groundbreaking and socially beneficial in an absolute sense. Catachrestic photographs do so by appealing to the powerful concept of nature as "good, pure…, balanced and harmonious…, a self-balancing system, a force that is best left to its own devices, a system which will continuously 'sort itself out'" (Hansen 2006, p. 813). Set on this background, genetic manipulation becomes unnatural, "a contaminating and polluting interference," and "has unpredictable outcomes" (Hansen 2006, p. 815). Employing concrete and incongruent images, catachrestic photographs make these abstract ideological stances instantly recognizable and relatable to a wide public audience. While the images may not be "real," they are the "paramount reality" people believe to be real and embody people's local understanding, value, and practice—in short, their "common sense" (Bauer and Gaskell 2008, p. 345).

Conceived in these terms, catachrestic photographs are commendable and valuable in creating a postmodern landscape of public science communication, a landscape that celebrates multiple agents, viewpoints, and voices. Created for and possibly by publics, they make tangible the abstract, unfamiliar, and threatening idea of genetic modification in ways that mount a creative resistance to it (Bauer and Gaskell 1999, 2008). They help to express public concerns; provide entry points for reflection; conjure up images that bridge science and society; and reveal, in a most relentless way, the broad and potential social and ethical implications of genetic research.

Just as catachrestic photographs mount a creative resistance to formal science, "pro-GMO" symbolic photographs constitute a resistance to public objection. Ironically enough, these photographs appeal to the same powerful concept of "nature," only in an opposite way, that is, by showing the apparent "naturalness" of GMOs. In these instances, GM papayas look just like ordinary papayas, GM corn grows like regular corn, and GM cattle appear no different than ordinary cattle (see, e.g., Harmon 2014; U.S. Food and Drug Administration 2014). Elsewhere, other scholars have made similar observations: Finland's transgenic medicine cow Morrow would be photographed in her cowshed, looking like any other cow (Väliverronen 2004), and a piglet genetically modified to aid transplant research would be photographed next to a regular piglet and look equally cute (Mellor 2009). In all of these instances, we witness apparently real evidence of GMOs being familiar, comforting, and pleasant, the same way nature intends them to be.

The contrast between the catachrestic and the pro-GMO photographs reflects the alternative experiences of different stakeholder groups in the GMO debate. Science communication per se cannot hope to change these alternative experiences, which are bound up with group-specific values, practices, and inter-group communications. For either party, the different representations of the "other" present a challenge, but the "other" and its alternative representations, as Bauer and Gaskell (1999) argued, must at the very least be acknowledged. Within the postmodern landscape, the "other" is "not necessarily a problem for the subject, but may help to structure and stabilize the subject's experience of the world within a constant flux of events…. It is through the contrast of divergent perspectives that we become aware of representations, particularly when the contrast challenges our presumed reality and is resisted" (Bauer and Gaskell 1999, p. 169). As such, the question about communication, to borrow Bauer and Gaskell's (1999) words, is not how to reach consensus but how to coordinate conversations between different voices.

With the photographic representations of GMOs, such coordination needs to consider at least two factors. First, as mentioned earlier, both anti- and pro-GMO symbolic photographs base their appeal on "nature" as that which is "universal," "right," "eternal," and "non-negotiable" (Hansen 2006, p. 813). But precisely because "nature" is presumed to be universal and non-negotiable, these images, in their respective ways, resist questions and debate and create what Hansen (2006) terms a "discursive stopper." They both assume certain "boundaries that separate the natural from the non-natural" without questioning those boundaries (Hansen 2006, p. 830). But clearly, where those boundaries lie is different for different people: for some, being natural means being free of any and all genetic alteration; for others, it means being intrinsically the same notwithstanding genetic alteration. Without both sides questioning their definitions of boundaries, the "natural" or "unnatural" photographs do little to move forward productive dialogue.

Second, when catachrestic photographs are repeatedly used in mass media (as they already are), they cease to be figures of speech but dead metaphors whose authority is taken for granted or at least evades conscious judgment. They become what Marilyn Strathern calls habitual images that "shape cultural expectations and the emotional structure of everyday beliefs" (Nelkin and Lindee 2004, p. 12). As habitual images, they affirm group values and facilitate "shorthand," taken-for-granted inter-group communication but do not facilitate dialogue with external groups who do not share those values. As shorthand communication, they also discourage abstract arguments on either side of the GMO debate. On the pro-side, researchers argue that "transgenic DNA does not differ intrinsically or physically from any other DNA already present in foods" and that the movement of genes from one population to another is a natural phenomenon that exists independently of genetic engineering (Nicolia et al. 2014, pp. 3, 6). On the anti-side, critics argue that GM crops can pose ecological risks because their effects are not locally contained: pest-resistant GM crops could release their insecticidal compounds into the soil through root and into the air through pollens, impacting non-target organisms and insects. These finer-grained arguments are what will enable publics to investigate, question, and interrogate GMO research, and neither the catachrestic or pro-GMO photographs are particularly adept at facilitating such conversations.

Symbolic Photographs: The Human Drama

Aside from catachrestic treatments, another group of symbolic photographs is prevalent in the popular communication of genetics. Their symbolism centers around the human body, what Douglas (1970) called a natural and prevailing symbol in human interaction and communication. The use of this symbol, as Douglas (1970) argued, is subject to social constraints, which determine what kinds of bodily representations are acceptable; at the same time, the representations of the body also serve to maintain or recreate those constraints. In the case of the cowgirl billboard, social outrage erupted precisely because the billboard digressed from, and attempted to drastically recreate, what is considered acceptable ways to represent the (female) body.

Most human bodies portrayed in popular science publications and the mass media are far less controversial, though they are equally significant in their configuration (and reconfiguration) of the public perception of modern genetics. These photographs cast the human bodies in different semiotic roles that, together, stage what van Dijck (1998) would call the human drama of genetics. Centered around medical urgencies and human needs, this drama is what pushes genetics into the foreground of public recognition and political attention (Dijck 1998).

The Victims

Any good drama needs a victim to be saved (or has, alas, been lost). In the human drama of genetics, the victim is the unwell, the potentially unwell, or more broadly, the "target" of genetic research and medical intervention. Earlier photographs in this category tend to focus on the apparently ailing: for example, newborn babies with physical defects or adults with observable medical symptoms. The contemporary cast of "victims," however, is significantly broader. In addition to those who are unwell in the traditional sense, we see photographs of the elderly (e.g., Fig. 2.9), the physically unfit (e.g., overweight), the socially maladjusted (e.g., alcoholics), and the statistically vulnerable (e.g., Google co-founder Sergey Brin, who was reported to have higher risks for Parkinson's in a *New York Times* article [Helft 2008]).

In addition to humans, anthropomorphized animals and plants occasionally play the role of the victim, for example, cows contracted with mad cow disease or plants that face epidemics. In these moments, animals and plants are photographed very differently from the way they were in the early twentieth-century informative photographs. Rather than being experimental specimens captured in "offer images" for impersonal contemplation (Kress and Leeuwen 2006), they are individual entities with human-like characteristics. Animals are by far

Fig. 2.9 Nursing facility-bound elderly woman awaits genetic solution. Because of copyright restrictions, the original photograph used in Rusting (1992, pp. 130–131) cannot be reproduced. The photograph used here resembles the original in essence and style. Credit/Copyright Attribution: Alexander Raths/ Shutterstock (color figure online)

the easiest to humanize: In close-up shots, their facial expression easily resembles that of humans and evokes human emotions. Plants are less conducive to anthropomorphism, though not impossible. In "Can this fruit be saved" (Koeppel 2005), we learn the impending pandemic faced by the banana plant due to its lack of genetic diversity. To demonstrate bioengineering as a potential savior, a photograph depicts a banana in a surgical tray and being operated on. Its peel is carefully removed by a pair of tweezers, as if a layer of skin removed from a human patient.

Photographs as these do more than providing a neutral context for genetic research. At the most basic level, they invite empathy from readers toward the photographed fellow humans or human-like life forms. A sense of personal identification is also palpable: I, my families, or those around me could be one of these people. Portraying real victims awaiting, the photographs also create a sense of social urgency. The photograph of a young girl, a cystic fibrosis patient, breathing through the nebulizer (Wright 1999) constitutes a powerful plea to loosen the human embryo research restriction so genetic therapy may be invented to "knock out" defect genes in unborn embryos. These photographs, then, help to invoke public support for genetics, for funding, and for favorable research policies—at least within the narrow confines of medical intervention.

Aside from scientific and social motivations, our apparent willingness and readiness to put human bodies—or human-like bodies—on display as "victims" reflects and reinforces the society's acceptance of and trust in genetics as the ultimate medical solution. This promised solution, however, also normalized our bodies in new and potentially problematic ways. While a 1980s study that probes the genetic predisposition to alcoholism opted to use a cartoon illustration of two gentlemen drinking in what seems a social context (Bower 1988), recent studies have moved on to photographing, in close-up shots, solitary, secretive, and desperate drinkers (e.g., Blum et al. 1996; Nurnberger and Bierut 2007).

This new norm, when it is—as it seems already—accepted by the publics, aligns with the reductive way of thinking about genetics, a mentality that Nelkin and Lindee (2004) termed genetic essentialism and Rose (1995) named neurogenetic determinism. This mentality reduces humans to their molecular entity, thus equating human beings, notwithstanding their social, moral, and behavioral complexities, to their genetic makeup (Nelkin and Lindee 2004). It attempts to find *the* cause for complex and dynamic biological and social phenomena (e.g., depression, intelligence, aging, or violence) in one or a few genes and, when appropriate, find ways to modify the genes to relieve personal pains and social disorders (Rose 1995).

Among the scientific community or at least as conveyed in peer-reviewed publications, such a mentality is not endorsed. Most researchers recognize that no single gene or genetic event underlies simple, let alone complex, life forms and functions. In depression studies, for example, despite decades of efforts, "no single genetic variation has been identified to increase the risk of depression substantially" and "multiple genetic factors in conjunction with environmental factors" are believed to play a role (Lohoff 2010, p. 539). Similarly, in the emerging study of pathological gambling, researchers acknowledge that family environment, traumatic life events, and social factors (such as the availability of legal gambling) all factor into the development and persistence of pathological gambling (Lobo and Kennedy 2009). When genetic influences are identified, researchers are careful to acknowledge limited research methods and use languages such as "contribute," "associate," and "explain" rather than the absolute "cause" or "determine."

These understandings, however, have not deterred media reports from finding the depression gene, gambling gene, fat gene, financial debt gene, et cetera. It is hard to say that media outlets are solely responsible for such sensational reporting; more likely, it is caused by the combined pressure of reporters, editors, and scientists to promote their respective research and communication products (Petersen 2001; Treise and Weigold 2002). Each report helps us to get a little closer to genetic essentialism and determinism, with far-reaching scientific and social ramifications: the pursuit of a linear and simplistic genetic research paradigm, a society absolved from trying to find social solutions for social problems, individuals absolved from taking responsibilities for their actions, and scarce public resources being wasted on ill-defined research (Rose 1995; Nelkin and Lindee 2004).

The Heroes

When there are victims, there must also be heroes. In the human drama of genetics, the hero, as may be expected, is played by scientists, researchers, and medical doctors, who attempt to find and/or implement genetic solutions to solve human suffering. This depiction of scientists as intellectual heroes is an age-old scheme (see Cartwright 2007) and also reflected in verbal reports of genetics (Petersen 2001), but carried into photographic forms, it is capable of evoking even stronger viewer reactions and emotions.

According to van Dijck (1998), "Until the 1970s, pictures of scientists were still rare in popular stories. If photographed at all, scientists were usually represented as part of a group in the non-descriptive, passport-size pictures that illustrated the articles" (p. 18). van Dijck (1998) theorized that the rise of scientist photographs in the popular communications of genetics had to do with the boom of the biotech companies in the 1980s: the photographs served to project the personal qualities and fame of the scientists onto an industry that had yet to produce physical products and thus helped to boost investor confidence.

My work, however, suggests a much earlier timeline for the use of hero photographs. They started to appear in popular science publications as early as the 1920s and 1930s, in the heyday of classical genetics. There are, however, certain differences between earlier and contemporary hero photos. The earlier photographs were often not posed; that is, the scientists were photographed engaging in their (presumably) usual work activities, conversing with each other, looking down into their microscopes, or working with experiment samples or laboratory equipment. These shots were often mid-ranged to capture the surroundings of the scientists and to give the impression of scientists at work, not of scientists per se. Even when the heroes were shot close up, they often faced an angle oblique from the viewer and did not make direct eye contact with the viewer.

Recent hero photographs are more likely to be close-up shots and posed frontal shots. Iconic displays of science and medicine (petri dishes, medications, non-descriptive specimens, and complex-looking tools), rather than being worked on by the heroes, serve as visual background or decoration. In the foreground, the portrayed characters are not engaged in any activities but look directly at the reader, often smiling (Fig. 2.10) but sometimes looking serious.

Fig. 2.10 Oral biologist Dr. Jeffrey Hillman, an advocate of transgenic microbial medicine (Sachs 2008, p. 66). Courtesy of Paul Figura (color figure online)

The different horizontal angles assumed by contemporary and earlier hero photographs are significant. As Kress and van Leeuwen (2006) pointed out, the horizontal angle "encodes whether the image-producer (and hence, willy-nilly, the viewer) is 'involved' with the represented participants or not. The frontal angle says, as it were, 'What you see here is part of our world, something we are involved with.' The oblique angle says, 'What you see here is *not* part of our world; it is *their* world, something *we* are not involved with'" (p. 136). When the hero faces the viewer with a direct gaze, the image constitutes a "demand" photograph; that is, the viewer is explicitly asked to enter into some imaginary relation with the person photographed (Kress and Leeuwen 2006). When the heroes are smiling, "the viewer is asked to enter into a relation of social affinity with them" (Kress and Leeuwen 2006, p. 118); when they look serious, the viewer is asked to trust the integrity of their work.

Aside from the economic incentive van Dijck (1998) mentioned, these photographs reflect scientists and researchers' motivation to "use the media to promote the importance of their work, to improve their public image in order to assure continuity of public funding for their research and to counter negative images of genetics" (Petersen 2001, p. 1257). While supporting data are difficult to find, given the contemporary emphasis on public engagement, it seems plausible that there is also genuine interest behind these photographs to involve the publics in the world of science or present the prospect of direct conversation. At the very least, contemporary photographs raised the stake for scientists' public accountability, which is best highlighted in the depiction of "bad" or controversial scientists. In these moments, readers question why scientists wear top-to-bottom protective suits when collecting "safe" biologically engineered bacteria (Baskin 1988). They witness the gleeful smile of South Korean cloning specialist Woo Suk Hwang, who reported fraudulent success in creating human stem cell lines (Hooper 2006). When public readers are explicitly invited to view the scientists as fellow citizens, as one of "us" and to see their work as part of social activities, as "our" work, they are "sanctioned," to an extent not possible even 20 years ago, to monitor and question science and scientists.

The Everyday Stakeholders

Besides the more dramatic roles of victims and heroes, the human drama of genetics also features everyday stakeholders: anyone who may be implicated in or impacted by genetic research—read, every one of us. Photographs of these characters often accompany reports that are beyond the narrow confines of medical urgency and as such, take a more lighthearted approach. An article (Stover 2002) that discusses the genetic relationships between species, for example, shows a chimpanzee playfully touching a human while an orangutan looks on; an article (Ast 2005) that explains the common genes shared among species photographs a human holding his rodent relative the mouse; and an article (Arking 2003) that examines the promise of genetic intervention to extend human life and vitality pictures a senior but fit citizen in a bright outfit cycling by (Fig. 2.11).

Visually interesting or relatable, these photographs serve to spark readers' general interest or personal curiosity in genetics even when there is a lack of explicit medical urgency. One, however, cannot help but notice that in photographs after photographs, the "everyday"

Fig. 2.11 Senior but active man sets the context for aging study. Because of copyright restrictions, the original photograph used in Arking (2003, p. 509) cannot be reproduced. The photograph used here resembles the original in essence and style. Credit/Copyright Attribution: Michaeljung/Shutterstock (color figure online)

human faces are those of men. The female body is conspicuously scarce, though there is no shortage of it in the victim category. These gendered visual choices, conscious or otherwise, reflect and reinforce the social perception that women are more likely to be victimized and that victimization is a feminine or potentially feminizing experience (Howard 1984). More particularly, in this context, they reflect and reinforce the historical and prevailing "male focus" in genetic research. As Clayton and Collins (2014) wrote in a recent *Nature* article, the "norm" in biological and clinical experiments is to use male animal models and cell lines, for several reasons: the belief that female animals' hormone cycles introduce complications into the experiments; a lack of understanding in the effect of sex on research findings; and the simple matter of following established protocols. However, the supposed female hormone influence is a questionable basis, as female mice may exhibit no more influence by their hormone cycles than male mice do; more significantly, researchers have started to realize that sex is a significant correlating factor in biological and clinical studies, influencing, among other things, subjects' reaction to treatments (Clayton and Collins 2014). With these understandings, the National Institutes of Health is taking measures stronger than its previous perfunctory expectation and enforcing gender diversity by requiring grant applications to balance their use of male and female samples and by developing training modules to help investigators evaluate sex differences (Clayton and Collins 2014).

As the research paradigm shifts, we may hope to see more diverse media representations of the everyday stakeholders and reconstruct our perception of females and their stakes in genetic research. This need for change is not limited to gender either, for not coincidentally, most of the male stakeholders currently pictured are also white. And probably not surprisingly, the same scientific backstory holds true. The majority of current genetic studies and verified data involve participants of European descents. As Haga (2010) reported, "The initial study populations of 79% of the US GWAS[2] publications were all white; 75% of the replication sample populations were also all white…. Overall, 92% of US GWAS participants were white, followed by African-Americans (3%)" (p. 81). Established conventions and datasets are, once again, cited as reasons for such practice, as is the difficulty in recruiting minority participants (Haga 2010; Knerr et al. 2011).

As a result, current research findings and clinical guidelines cannot be generalized to the wider population (Knerr et al. 2011). In the case of genetic testing, for example, only limited testing is currently available to minority populations. Of the three major companies that offered direct consumer genetic testing, two of them (23andMe and deCODEme) indicated that 16 and 11 of the 22 diseases they tested were not applicable to individuals of non-European ancestry (Haga 2010). The third company (Navigenics) chose not to reveal this limitation in their test descriptions, but their consent documents and test reports indicated that "most of their testing is based on studies of people of European ancestry and, therefore, [they] are uncertain as to whether the results are applicable to people of other backgrounds" (Haga 2010, pp. 81–82). If this healthcare inequality strikes one as astonishing, it is only going to increase with time and continuous research that follows the well-trodden path. The social and political ramifications of such practice are too obvious to need belaboring here.

When today's readers turn to Charles Darwin's *On the Origin of Species*, they are stricken by the conspicuous use of "man" as the representation of the human race: "nature gives successive variations; man adds them up in certain directions useful to him" (p. 35). The contemporary society has, fortunately, become more conscious in adopting non-biased language. The same, I argue, is imperative in visual representations and, more fundamentally, in research practices. For a field that has a professed goal in improving human (read, all human) welfare, we cannot afford anything less.

Conclusion

Even though I separated informative photographs that serve as visual evidence from symbolic photographs that evoke human emotions, this separation is more of a necessity in linear discussion than a suggestion of clear demarcation. Even when a photograph's primary purpose is to present cognitive information, it still embodies affective elements; similarly, even as a photograph's ostensible purpose is to create emotional appeal, it can belie scientific backstories.

Photographs, as this chapter shows, play multiple and sometimes conflicting roles in the popular communication of genetics. They can be used to convey visual evidence, to invite scrutiny, to attract and engage, to insert subversive voice, and to lobby for public support, all of which help to reflect as well as shape publics' evolving perception of genetics. Because of these varying possibilities, the use of photographs is not a straightforward process. This semiotically rich visual genre can be used (or avoided) to frame genetic research and public discourse in different ideological context with alternative value stances, sometimes in subtle ways that resist questioning, unless we pay conscious attention, as this chapter attempted to do. If one thing is certain, it is that photographs will continue to be prevalent in the popular communication of genetics. Their effects and implications are thus important to consider for everyone involved in creating these images, from scientists, science communicators, visual designers, activist groups, to public members.

Notes

1. The determination of the DNA structure relied on key information provided by X-ray crystallography, a diffraction imaging technique pursued by Maurice Wilkins and Rosalind Franklin at King's College, London. Most specifically, one such image, taken by Rosalind and her student Raymond Gosling, allowed James Watson and Francis Crick to develop their helical DNA model. This image, though often nicknamed "Photo 51," is not the kind of conventional photograph discussed here.
2. GWAS stands for genome-wide association study, which examines the complete sets of DNA from many people to find genetic markers associated with certain diseases.

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