MAKING DEATH MATTER

**A FEMINIST TECHNOSCIENCE STUDY OF
ALZHEIMER'S SCIENCES IN THE LABORATORY**

Tara Mehrabi

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Making Death Matter

A feminist technoscience study of Alzheimer's sciences in the laboratory

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Introduction

This thesis delves into everyday practices of knowledge production about Alzheimer's disease (AD) in the lab and explores what such scientific practices create aside from knowledge about AD. For instance, following scientists in the lab during one year of fieldwork and participant observation, I realized that through everyday practices in the lab, new forms of life—such as transgenic fruit flies embodying an AD-like disease, and new modes of living AD, as these flies lived with and suffered an AD-like disease—are also created. I also noticed that a prominent part of such scientific discoveries, creation of new forms of life, and the quest for an AD cure is death. In other words, as part of such scientific practices, new forms of death—such as AD-like death in the transgenic fruit flies, and a trail of dying and dead bodies—are also created and left behind; these dead and dying bodies need to be taken seriously and ethically and politically discussed. Moreover, as these forms of life and death are made, disposed of and give shape to the contemporary understanding of AD in the lab, they also shed light on the politics of categorization and the boundaries between natural and artificial. In other words, the modes according to which waste is approached, known, categorized and disposed of in the lab can clarify, for example, how nature inside and outside of the lab is understood, which bodies belong where, and which boundaries between natural and artificial can be crossed and which must be kept intact.

As I discuss in my thesis, such aspects of knowledge-production practices are relational and constitutive of the scientific knowledge produced in the lab. Therefore, I analyze how scientists, animal models and organisms, technologies, sociocultural imaginaries and scientific discourses about, for example, the body, AD, the stuff of life and death, and “natural” and hazardous waste are, *together*, constitutive of knowledge as it is produced in the lab. Although I explore such relationalities within the context of AD, AD is not the object of inquiry in this dissertation but rather the center of the underlying discursive, material, political and ethical dynamics that are part of AD practices in the laboratory as well as the consequence of such practices. How scientists relate to and understand their object of inquiry, such as AD-related misfolding proteins, informs modes of experiments. For example, scientists’ understanding of the neurodegeneration and folding processes of AD-related proteins generates modes of knowledge production, particular animal models and distinct categories of laboratory waste. On the other hand, proteins, animal models and technologies in the lab resist or interact with such scientific ideas. In these practices, meaning and matter (such as the material stuff of waste, or protein matter) are constantly negotiated, generating “facts” about AD, human and nonhuman bodies, protein-folding processes, neurodegeneration, life, death, biowaste and much more. Such seemingly straightforward concepts become meaningful in dynamic interplay, pushing the boundaries of scientific knowledge and sociocultural imaginaries (for example about life and death), as well as materiality (e.g., as they engender new modes and forms of living and dying with AD).

Furthermore, as I discuss throughout this dissertation, such scientific practices are not innocent but potentially violent and exclusive, while simultaneously offering new hope, for example, for an AD cure. My thesis also taps into the kind of asymmetrical relations and categories made and put to work in the lab that are necessary for AD scientific practices. As social anthropologist Marianne E. Lien writes, “cospecies histories”, and in my case, cospecies stories, “are difficult to tell”. She continues: “This is not only because some of us have been trained to think that having a history is a privilege of

humans, and thus we have ignored the ways in which nonhuman species have histories too. It is also because we are trained to tell the stories separately. We tend to think of histories as either *their* stories, animal stories, as they unfold without human interference, or *our* stories, with humans as the key actors and animals figuring as prey, property, or symbols. *Their* stories find an audience among biologists, *our* stories among anthropologists" (2015, 1–2; italics in the original). One way of revisiting such stories, she suggests, is to try to bring them together and read them as cospecies stories, which is what I try to do in my thesis as I write about natural sciences, transgenic fruit flies, mice models, cells, antibodies, proteins and bacteria, human scientists, imaging technologies, biowaste categorization and modes of handling living and dying matter. I wish to retell *their* stories and *our* stories as one entangled, multilayered, ever-changing story that sometimes has no happy ending. For instance, the overwhelming number of dead transgenic flies in the lab is an issue that became central to my thesis and urged me to write about death as a central theme—enacting and imaging death (chapter 4), the killability of animal models in the lab (chapter 5), or handling the leftover, dead and living, bodies of transgenic fruit flies as biowaste (chapter 6).

Specifically, I discuss scientific endeavors as they are carried out in three laboratories in Sweden. I believe Alzheimer's sciences are interesting, because, as many other laboratory studies and science studies scholar show, daily laboratory practices of scientific knowledge making is always already entangled with power relations (Martin 1991), technological possibilities and sociocultural structures (see, e.g., Thompson 2005), and transpecies connection (e.g., Sharp 2011), which enacts scientific facts as a multilayered, transformative phenomenon. Therefore, inspecting such an entangled phenomenon, which is Alzheimer's-sciences-in-action, can reveal stories about, for example, how categories are made and facts about nature are produced. It can shed light on how life and death are approached, how newly made alive bodies (such as transgenic animals) and dying processes are performed, how some lives are enacted as worthy of life and others killable. Attending to the daily practices with which AD is produced as scientific facts is an ethical and political issue worth

feminist engagement. Last but not least, because AD science is the context of my study and it is within such a scientific paradigm that I have collected my material and make my arguments, in the rest of this chapter, I will explain my understanding of AD sciences.

1.1 Alzheimer's disease and feminist studies

AD is often discussed within feminist studies in relation to sociocultural stigma and alienation of the subject (Behuniak 2011), personhood (Zeiler 2014), intersectional aspects of care (Calasanti and Bowen 2006; Persson and Zingmark 2006), and the importance of sociocultural and environmental factors such as the interplay of poverty, class, pollution etc. (e.g., Lock 2013). As I briefly present in the following, many attempt within such scholarship to problematize the human centrism of AD as it is understood, represented and discussed within popular culture, political discourse, drug advertisements and society at large, particularly within a Western context.

For instance, from the position of phenomenology, feminist scholar Kristin Zeiler (2014) problematizes the one-body-one-person idea of canonical personhood theories. Zeiler criticizes the cognition-oriented understanding of personhood as limited and exclusionary. She presents an alternative mode of personhood that relies on the intercorporeal conception of personhood in her study of AD patients and their interaction with others through music (2014). Literary, visual and media culture scholar Sadie Wearing (2013) stresses the complexity and multilayered emotions that are part of AD that do not necessarily indicate loss. She analyzes the movies *Iron Lady* and *Iris*, highlighting the importance of embodiment and the multiplicity of emotions: fear, stigma and repulsion as well as compassion.

From within feminist cultural studies, Cecilia Åsberg and Jennifer Lum criticize AriceptTM (donepezil) drug advertisements, one of the main drugs for AD patients, arguing that the discourse around AD treatment is not the promise of a cure but problematically advocates a hope for not “retiring from the human race” (2010, 331). Åsberg and Lum (see also 2009) argue that AD discourses within popular cul-

ture and pharmaceutical advertisements are problematically entangled with concepts such as dignity, loss of the self, cognitive decline, self-care, “successful aging”¹ and the ideal of the self-sufficient subject of modernism and neoliberalism. AD disrupts the fantasy of the transcendent, self-sufficient subject. Therefore, as political sciences and health politics scholar Susan M. Behuniak critically reflects, the cultural anxiety surrounding AD is mostly the fear of “fading away”, of becoming the other, monstrous, and the zombie (Behuniak 2011; Wearing 2013). Furthermore, AD is defined by Behuniak (2011) as a confused state between life and death: living and dying, which traditionally within the epistemic culture of Western philosophy have been defined as dichotomies, and mutually exclusive. In other words, although the unease, anxiety and frustration about AD can be traced back to the disruption of the modernist human subject, the myth of human exceptionalism, and the dis-configuration of the self’s clean and close body, it can also be located in the in-between identity that this dis-orderly body inhabits. Such a dis-orderly body is then disturbing because it is a nonperson self that inhabits a status similar to the “living dead”, like a zombie (Behuniak 2011). The identity of this nonperson self then falls “on the boundary between us and non-us”, which disturbs the modernist subject and its singular identity (Lykke 2010a, 177).

The way I interpret and relate to the work of the aforementioned scholars is their attempt to criticize the human centrism of AD. In other words, feminist work on AD often highlights the limits of the conceptualization of AD in relation to the modernist humanist subject: a subject that is cognition oriented, the one-body-one-person who is in control of the self and the body. As such, as these scholars show, many of the narratives and policy making around AD and care fail because they take as their starting point claiming and restoring a subject that is a fantasy of modernism—a subject that has never existed. In these critical studies of AD, it becomes a generative mode

¹Referring to health politics expert John Rowe and psychologist and public health scholar Robert Kahn (1987), feminist scholar Linn Sandberg describes the notion of successful aging as the reduction of the risk of disease, physical functionality and active engagement with society. Self-care and independence, which are strongly embedded in the neoliberal context, are other variables of successful aging (2011, 49).

of becoming, an “intercorporeal personhood” (Zeiler 2014) and a node of transformation. Although I hold on to such an understanding of AD as a node of transformation and a generative mode of becoming, I take my point of departure elsewhere, namely Alzheimer’s sciences. However, as I discuss in chapter 4, it is not the *human* body, brain, or life and death at stake in the lab, but animal models and organisms that are genetically modified to express humanlike AD. In other words, to do away with the human centrism surrounding AD, I write about humanized transgenic fruit flies, model mice, cells, proteins, technology, scientific discourses and scientists generating and giving shape to that which is known as AD.

Another point of departure within feminist studies of AD for me is the work of medical anthropologist Margaret Lock. Lock’s work is one of the few within feminist studies on Alzheimer’s sciences (e.g., Moser 2008). She investigates Alzheimer’s sciences in her book *The Alzheimer Conundrum: Entanglements of Dementia and Aging* (2013). She focuses on the “generation and transformation of expert knowledge” (4), looking into debates, publications, clinics, conferences, media etc. She speculates on the performative power of preventive measures traveling outside of the lab. In other words, she wonders what happens to healthy people once such measures become routine clinical processes, people who may never become ill with AD even if they are genetically predisposed. She argues that perhaps alternative mode of prevention such as “lifestyle changes, reduced exposure to toxins, reduction in poverty, increased community support” might be a more successful way to deal with the ever-growing Alzheimer’s dilemma rather than invasive, expensive, consuming “molecular micro-medical management” which often is only possible in wealthier countries to those who can afford it (4).

However, I am interested in writing about AD sciences related to the day-to-day realities in the lab and the processes through which the meaning and materiality of AD is made (before it travels outside of the lab). Even though Lock writes about AD sciences, she focuses on the social life of Alzheimer’s sciences and the uncertainties within such sciences. I, however, will focus on the laboratory practices through which science is done, every day and in multiple ways. I aim to

highlight that scientific practices of knowledge making about AD are genuinely interesting, stimulating and thought-provoking relational phenomena that are a politically important and ethically crucial point of investigation. Staying with scientific practices shows that scientific facts are anything but universal or singular. Scientific facts are always situated, entangled, relational phenomena, as I learned from the lab, of which scientists are well aware.

1.2 Aim of the study

In my dissertation, using the science-in-the-making approach through participants, I analyze how death is made and animated in the lab. At the same time, I thickly describe the everyday practices in the lab in order to make death matter in writing about killing flies and disposing of them as biological waste. In the lab, I watched scientists perform AD, listened to them as they explained it to me and helped with their everyday work so as to understand how knowledge about AD is materially and discursively made and what kind of ethical and political realities such knowledge-production practices enact. *I seek to grasp how AD is a matter of the entanglement of humans and nonhumans, biology and technology, life and death, facts and culture.*

This aim of study led me to the following research questions:

- What kinds of stories can the images of AD-related misfolding proteins tell about AD, life and death and their entanglement in the laboratory? What forms of life and death are made, imaged and animated in such AD-imaging practices?
- What kinds of biological economies of unconventional affinities and more-than-human connections are working—or made to work—in laboratory practices of knowing AD, and what are the ethics of such productive yet deadly entanglements? In other words, how are animal models made and enacted as killable as a matter of biological and material specificities, scientific discourse and sociocultural relations?

- How is biowaste enacted in different ways within AD laboratories? How does the conceptualization, categorization and handling of waste in the lab enact novel understandings of nature and artifact, hazardous and natural within the context of AD scientific practices in different labs?

1.3

Alzheimer's disease and life science: A science in the making

According to psychobiologist and dementia expert Nicole Berchtold and neurologist Carl W. Cotman (1998), cognitive decline and memory loss in individuals (particularly older adults) has been recognized not only in medical practices but in other practices, such as juridical, since the seventh century. The authors trace the genealogies of the disease back to ancient Greek and Roman philosophers and physicians, arguing that since then, senile dementia has been a disease associated with old age and memory loss, even though it has had many names. For instance, during antiquity and medieval times, senile cognitive decline and mental decline had been understood and acted upon variously as madness, witchcraft and crime, which all had negative connotations and dehumanized the senile subject. *Senile dementia* was established as an umbrella term to include unrelated types of mental illnesses, cognitive disorders and social deviancies with diverse etiologies. Despite its origin and the association with old age, as Lock, referring to G. E. Berrios (1990), writes, until the early nineteenth century dementia was “assigned to people of any age and was used to indicate ‘any state of psychological dilapidation associated chronic brain disease’” (Lock 2013, 31; see also Berchtold and Cotman 1998; Maurer et al. 2000).

In 1864, physician S. Wilks introduced brain atrophy as the anatomical description for first chronic alcoholism and CNS syphilis² and then senile dementia (Berchtold and Cotman 1998). Because atrophy was easy to identify, it became a “constant feature in the

²Neurosyphilis which refers to infection of the central nervous system (Marra 2016)

pathology description of dementia" (178). Such an understanding of AD, however, also links to a larger move within medical sciences, namely the mechanical body-life paradigm. In fact, as sociologist Catherine Waldby writes, "the scientific dissection of corpses, a commonplace practice by the early 19th century, was one of the earliest assertions of the fundamentally mechanical nature of the human body and the materialism of the natural world (2002, 31). Dementia, which was once a broader clinical phenomenon relating to abstract concepts and a variety of symptoms, became a brain disease with material roots. Through the common practice of (brain) dissections and a mechanical understanding of the body, the brain became the locus of the disease, and brain atrophy became the scientific signifier of it while it remained associated with aging bodies.

However, as I discuss in the following paragraphs, it was not until the neuropathological understanding of AD became prevalent that the disease became a particular medical neuropathological condition. Neuropathology made it possible not only to categorize conditions associated with aging and senile dementia but also to distinguish between different kinds of dementias. In the early 1900s, scientists started to look into the neuropathology of dementia in laboratories and on the molecular level, which links to yet again a broader shift within medical sciences known as the life sciences, from the mechanical to the molecular understanding of the body and life (Myers 2015). Indeed, as anthropologist Natasha Myers argues, within the twentieth century there have been major attempts to understand life and bodies on the molecular level, shifting between proteins as the locus of life to genes and back again to proteins. It was within such a paradigm that AD was conceptualized—specifically surrounding the discovery of the importance of proteins in bodily functions and as the drive for life. Another scientific paradigm with which Alzheimer's sciences shares a genealogy, according to Lock (2013), is the move toward organic neuropsychiatry and brain pathology, which enacted dementia as a neuropathological condition related to aging but not reducible to it.

In 1901, psychiatrist and neuropathologist Alois Alzheimer encountered a similar yet different disease from what was known as

senility or senile dementia. He started to study dementia when he encountered a patient named Auguste D., whom he met in the Asylum for the Insane and Epileptic in Frankfurt. After he left Frankfurt, he continued following up on her, and when she died after five years, he requested her brain tissue for autopsy (Maurer et al. 2000). He was searching for a disease that could explain Auguste's symptoms, namely hallucination, cognitive impairment and delusion, as he mentioned in a report in 1906. His report, though, was not very well received among his fellow physicians (Lock 2013). Working within a paradigm dominated by psychoanalysis and the Freudian approach, his colleagues were skeptical of the idea of a specific pathological cause of mental illnesses. Nonetheless, Alzheimer and his team continued to study more cases, reporting eight other cases similar to Auguste over the years. These patients, however, were not elderly people. Alzheimer also studied another patient closely, called Johann F., a 56-year-old man who had similar symptoms to Auguste's. Alzheimer came to realize that despite the similar symptoms in these cases, the neuropathological significations of them were different.

In the brain tissue of Auguste D., he had detected misfolding proteins of intracellular neurofibrillary tangles (these were tau proteins) and extracellular amyloid plaques (from amyloid-beta proteins or A-beta proteins). He introduced this new pathology in his report in 1906 and argued that this phenomenon needed to be classified differently because of its neuropathological significance, which distinguished it from what was then known as senile dementia (Maurer et al. 2000). He also noted that the case of Johann F. was different from Auguste, because Johann's brain autopsy did not have tangles. As psychiatrist Hans-Jurgen Möller and neuropathologist Manuel B. Graeber (2000) argue, amyloid plaques had been described by others before Alzheimer, such as Arnold Pick and O. Fischer (43). Indeed, as neurologist Peter J. Whitehouse, psychiatrist Konrad Maurer and historian Jesse F. Ballenger write, "Alzheimer is credited with the discovery of neurofibrillary tangles and with providing, in the case of Auguste D., an account that associated the clinical signs of dementia with *both* plaques and tangles" (2000, 2; *italics added*). As psychiatrists Konrad Maurer, Stephan Volk, and Hector

Geraldo mention, the two-page article written by Alzheimer, “A Characteristic Disease of the Cerebral Cortex”, in 1907 together with other publications by “Bonfiglio, Perusini, and again Alzheimer in 1911, led to the eponym *Alzheimer’s disease*” which was first used by Emil Kraepelin in 1910 in his *Handbook of Psychiatry* (Maurer et al. 2000, 22; see also Möller and Graeber 2000, 42). As such, AD “moved from being a clinical entity to being a pathological entity and now to being a neurochemical entity” (2000, 50). It became a “mental disorder [which was ...] organically based”, with particular visible neuropathological hallmarks (Maurer et al. 2000, 26).

During this period, AD was constructed as a rare form of dementia *in the laboratory* on the molecular level that, in the years to come, not only transformed the ontology of the disease but also the modes of engagement with the disease. In other words, through the move toward the materiality and neuropathology of mental illnesses, AD became a neuropathological condition rather than a mental illness. During the last hundred years a lot has been discovered about AD’s symptoms and AD pathology on the molecular level, such as the neuropathological hallmarks of the disease. Yet, the etiology of the disease is still unknown. At the same time, there are many factors that are associated with AD such as head trauma, Apolipoprotein E4 (APOE gene), high cholesterol etc. (Sadowski and Wisniewski 2004). This means that for over a hundred years AD has been and still is a *science in the making*.

Finally, like many other sciences, AD is in debt to the technological progress that made it possible to detect the neuropathological hallmarks of the disease in the laboratory. In fact, what was extremely important in Alzheimer’s quest toward unraveling the mystery of AD, aside from his curiosity and strong belief in neuropathology and physical explanations for such mental conditions, was the help of a new technique (Lock 2013). The novel staining techniques that were developed by Italian physician and pathologist Camillo Golgi in 1873, and developed later by Santiago Cajal, Spanish neurologist and photographer, were the crucial techniques that made it possible for Alzheimer to stain and image the neuropathological hallmarks he was looking for (32). Together, Golgi and Cajal won a Nobel Prize

for their discovery of staining technology—a discovery that changed the face of neurology and made it possible in the 1880s to move away from gross anatomy and visible changes in the brain toward molecular changes. It helped Alzheimer to clarify the extensiveness of protein accumulations and their locality: it made visible that these tangles were accumulated between the nerves. Today, creating novel forms of staining techniques is still an ongoing part of Alzheimer's sciences. Scientists aim to develop smarter molecular agents that can not only give clearer images of misfolding proteins but also dissolve these bundles in the early stages and before the disease manifests.

Thus, historically, dementia has been associated with madness and, later, aging. However, through the discovery of tau tangles and amyloid plaques, scientific obsession with molecular life and proteins within the life sciences and the new possibilities of staining techniques, AD as a form of dementia was developed and transformed from a mental disease into a neurophysiological disease. An effect of this ontological shift was that practices of doing AD science also shifted, as did the authority of by whom the diagnoses were to be made. AD moved from the psychiatry wards, to the hospital, to scientific laboratories. Nonetheless, despite all the scientific achievements in understanding AD, it still remains a science in the making.

1.4 Why laboratory study?

The laboratory is a curious place. It embodies traces of modernism and the Enlightenment; the ideals of science and scientific inquiries, objectivity and rationalism; and the great nature and culture divide (Latour 1993). The laboratory has been depicted and validated as a place in which objective facts are produced, a place in which nature can be isolated, measured, discovered and put on display without having traces of the political, social and the cultural. As gender studies and history of science scholar Sharon Traweek argues, it is a place with the “culture of no culture”³ (1988, 162), of sci-

³With the term, “the culture of no culture”, Traweek aims to reflect on the “culture of objectivity” within the context of high energy physics, which she explains is a culture

ence in a vacuum. As such, and as feminist technoscience scholar Donna Haraway (1997) critically reflects, the laboratory is a “modern, European, masculine, scientific form of the virtue of modesty”. In this space, as sociologist of science and technology Bruno Latour (1987) argues, “facts” are problematically understood as given rather than created by humans because the modernist illusion indicates that supposedly neutral technologies and instruments help scientists exclude the human role in the production of scientific facts, as if the machines are directly registering what nature says. In this space, nature has been imagined to be external, univocal and universal. In this space, nature is understood to be hiding a truth or essence. The job of scientists, then, is to understand and discover the hidden essence of nature by bringing bits and pieces of it into the lab and by using technologies and scientific methodologies. Last but not least, the laboratory also draws boundaries between sciences that study culture, namely the social sciences and humanities, and sciences that study nature (in the lab), the natural sciences (Callon, Latour, et al. 1992). Perhaps, therefore, as Latour (1988) writes, philosophers of science and historians of ideas often try to avoid the laboratory space (see also Traweek 1988).

However, for over three decades feminist technoscience studies (FTS) have entered the laboratory, to question the right to knowledge (production)—a question that often asks who is allowed in the lab and who is kept at a distance based on the power differentials of gender, race, class and more (Harding 1986, 2008; Schiebinger 2000). Scientific knowledge has been considered a powerful political apparatus (Foucault 1980) for inheriting the status and credibility of scientific facticity—the mythical claim of discovering the neutral laws of nature and the order of nature by the objective, professional scientists who can unveil the truth. In response to such scientific authority, FTS scholars aim to highlight how “natural” differences and scientific “facts” about nature are made meaningful in relation to sociopolitical imaginaries and ideals and language, as well as how narratives and discourses give shape to the possible questions

longing for “a world without loose ends, without temperament, gender, nationalism, or other sources of disorder—for a world outside human space and time” (1988, 162).

scientists can(not) ask or organisms they choose to work with⁴. For instance, feminist biologist, physicist and gender theorist Evelyn Fox-Keller (2002) argues that it is not only the scientific outcomes in the lab that matter but, through creating particular ways of talking about experiments and explaining the results, scientists create a conceptual framework for future scientific knowledge production. Discourses and narratives make epistemological frameworks or, as philosopher of science Ian Hacking (1994) says, a “style of reasoning” within which scientists interpret science in the lab in meaningful ways. Therefore, laboratory science studies can shed light on such underlying discursive and epistemological styles of reasoning, which enact scientific facts as a human-created phenomenon.

Furthermore, such an approach also engages with technologies, highlighting that modern ways of experimenting and advanced technological mediators (such as novel imaging technologies or genetic testing techniques) in the lab do not necessarily mean that the results are objective facts. Rather, such advanced technologies may reinforce the classical reductionist binaries, biological determinism and essentialism. Indeed, the illusion that modern high-tech technologies can reduce the human role in the production of scientific facts has been problematized by these scholars⁵. In other words, the more

⁴ Anthropologist Emily Martin (1991) shows how the cultural and gendered stereotypes about men and women, masculinity and femininity, and heterosexual penetrative sex are very present in laboratory reports and medical texts and in ways that scientifically proven biological findings about egg and sperm are discussed in these texts. Fausto-Sterling writes about the entanglement of not only gendered but also racialized economy of biology in nineteenth century through which biological accounts of sexual and racial differences was imbued with the “insecurity and angst about race and gender experienced by individual researchers and the European culture at large” (2000, 67). Fox-Keller (1991, 2002) argues that feminists need to take the narrative and linguistic of biological explanation seriously and critically reflect on the power of discourse that is not only explaining nature in the lab but it also generates “its own forms of truth” (Keller 1991, 228).

⁵ For instance, Dussauge and Kaiser (2012, 122) offer the example of neuroimaging and how it is embedded in the dualistic gender categories not only in the interpretation of produced data but also to recruit potential research cases which can affect the results in bias ways (for instance, recruiting only two sexes, male and female, reproduces the binary sex and gender system). Christina Fredengren argues that new technologies in the lab, is also questioned for “presumed racial analogies and essentialist claims” that are exclusionary (2013, 54). M’charek shows how DNA testing is “called upon

modern ways of doing experiments and using technological mediators in the lab do not necessarily mean that the results are objective facts; rather, the neurosciences reinforce the “classical issues of *innatism, determinism, reductionism, and essentialism*” (Dussauge and Kaiser 2012, 122; italics in the original).

Last but not least, as Haraway writes, the “laboratory is an arrangement and concentration of human and nonhuman actors, action, and results that change entities, meanings, and lives on a global scale” (1997, 66). Therefore, science in the lab is not only about human agency; nonhumans, such as technology and animals, also play an active role in the production of scientific knowledge. As such, many scholars such as Haraway propose a material-semiotics approach in order to shift the knowing and knowledge practices from a subject-oriented epistemology toward processes and material-semiotic entanglements (see, e.g., Knorr-Cetina 1999; M’charek 2005; Myers 2015). As I discuss in my theory chapter, material-discursive approaches have become one of the focal points within feminist theory for a variety of reasons.

The importance of the material-semiotic approach in doing a laboratory study is to attend to the question of nature as much as to attend to the question of science as culture. In other words, as Haraway (1997) argues, within the natural sciences and laboratories, not only has science has been projected as a value-free, culture-free and gender-free practice but nature has been problematically put on a pedestal. As such, “Nature” is often understood as not only universal but also passive. It has been depicted as an object of the scientist’s gaze, curiosity and endeavors. Nature is depicted as something without agency or any particular significance. Such an understanding of nature is problematic because, “when nature gets imagined as without inherent qualities, as passive resource for Man, culture and civilization, it stands as if lacking differentiation, intrinsic value, agency or the ability to resist” (Åsberg and Mehrabi 2016,

to produce genealogical lineage and to infer the descent” or populations (M’charek 2010, 313), even though, “DNA analyses are probabilistic and do not guarantee that an individual stems from one population or the other (M’charek 2010, 313; see also M’charek 2005).

273). It is as if nature is stripped from its liveliness and generativity. Referring to Traweek's concept of the culture of no culture, Haraway argues that nature, in such imagined passivity, becomes the "nature of no nature" (1997, 85). This nature is indeed hard to pin down, measure and define. She uses the Native American symbolic figure of the coyote in order to highlight nature as a trickster and as a witty agent, which I will discuss more in chapter 2.

Nature to Haraway is a matter of the entanglement of nature and culture and therefore always already *naturecultures* (Haraway 1999, 1994, 1991). In other words, nature in the lab cannot be grasped as something in a vacuum—something that embodies the culture of no culture—because the moment that the scientist approaches an object, or nature for that matter, and examines it, they draw boundaries within which nature is made meaningful in partial, situated ways. Moreover, nature cannot be reduced to nature of no nature, something passive, and something with no agency that can be manipulated in whichever way. In fact, to study nature is to account for nature's transformative and generative power that often escapes clear-cut boundaries. In other words, in order to study nature in the laboratory, it is important to attend to nature's materiality, agency and transformative, generative power as well as the context and technologies with which it is made in the laboratory. This is the FTS legacy that I take with me in doing a laboratory study about AD. In other words, I argue that AD is always already multiple and a matter of becoming in relation, and such it is always already AD's *naturecultures* that are at stake (Haraway 1994).

1.5 Chapter summaries

In this first chapter, I have introduced my thesis and discussed the aim and research questions. I also detailed the background to the thesis as a feminist laboratory study of Alzheimer's sciences and as science in the making.

In chapter 2, I discuss the fields of study within which I ground my thesis: gender studies, FTS, human animal studies (HAS), science,

technology and society (STS), and posthumanities. I expand on the theoretical approach in my thesis: *new materialism*. Finally, I discuss the theoretical concepts which provide background for each of my empirical chapters. As such, I will start with the molecularization of *life itself*, drawing on STS studies about practice-oriented ontology and on FTS of life sciences, within which scholars critically reflect on the concept of life itself and the scientific quest to capture the essence of life. Next, I discuss the theoretical background within HAS, in which I describe my understanding of human and nonhuman relations in the life sciences and the laboratory as always entangled and as a mutual becoming. Last but not least, drawing on practices as the ontological unit of reality, I write about the entanglement of practices and the categorization of waste in the lab.

In chapter 3, I present my methodology. I introduce how I collected my material and how I conducted and carried out my laboratory fieldwork and interviews. I discuss how I collected data about AD and animal models such *Drosophila melanogaster* (transgenic fruit flies⁶) from scientific discourses such as articles and a number of AD-related webpages. I close with situating myself as the researcher and a discussion about the embodied experience of becoming a laboratory technician and a laboratory ethnographer during participant-observation work.

Chapter 4, which is my first empirical chapter, focuses on practices of knowledge making in my fieldwork, in which death and processes of dying become an intrinsic part of life sciences. I argue that through imaging practices in the lab, not only AD but also death itself are made, animated and imaged on the molecular level. Inspired by Myers's concept of "intra-animacy" (2015), I argue that images and imaging practices are a matter of human and nonhuman performativity through which AD and death are performed in materially and discursively entangled ways.

In chapter 5, I discuss how different bodies in the laboratory

⁶In this thesis I interchangeably use the terms transgenic fruit flies, *Drosophila*, *Drosophila melanogaster* and *D.melanogaster*. However, when I use the term fruit flies, I am referring to a broader category that encompasses both transgenic and nontransgenic fruit flies. When I use the term *flies*, then I am referring to an even broader category of flies in general (different species).

become killable as a matter of material and discursive entanglement or, as Barad (2007) says, “material-discursive cuts”. I argue that within the biomedical sciences and experimental biology there is no escape from killing living organisms, yet there is a curious dynamic at play in life science within which different organisms become killable differently on a spectrum that I call the *spectrum of killability*. In other words, I try to discuss the hierarchical structural power relations in the lab and sociocultural alienation of particular animals such as flies, which enacts them as killable. Simultaneously, I try to nuance the concept of killability as something that goes beyond such structural boundaries. In other words, I try to show that the materiality of the animals’ (e.g., fruit flies’) bodies and their biological characteristics enact them as killable—in ways that at times defies structural hierarchies and enacts particular models as the proper model for the lab and therefore killable.

In chapter 6, I write about waste in the lab. Following Myra Hird (2012), I argue that transgenic fruit flies in the lab are ambiguous entities as biological waste, which points to the agentiality of waste. This ambiguity is also a matter of different modes of handling waste as situated practices that enact them differently in relation to their level of hazardousness.

Chapter 7 is my conclusion in which I present my empirical and theoretical contributions to the field of feminist technoscience studies. I also present my ideas for further research on practices of care within the context of laboratory and thinking with *Drosophila*.

Mapping the Fields, Theories and Conceptual Building Blocks

My thesis is theoretically grounded within the fields of science, technology and society (STS), gender studies, feminist technoscience studies (FTS), and human-animal studies (HAS). In this chapter, I start with broadly introducing these fields of study. Next, I discuss the overall material-discursive theoretical approach that informs my work, which I encountered in all of these fields. Last, I ground my study more specifically within these fields, as I introduce the theoretical concepts that I borrow from them and explain how I will use them in relation to my empirical work.

2.1 Mapping the fields

Gender studies

Today, gender studies is a well-known field of research that does not necessarily take gender as the only point of departure. Rather, as gender studies scholar Nina Lykke (2010a) argues, having its roots in historical moments such as women's rights, Marxist and antiracist movements, as well as in many theoretical approaches such as psychoanalysis, queer theory and sexual difference theories,

gender studies has transformed into a broader field that deals with phenomena such as power relations, embodied subjectivities and knowledge production, beyond the boundaries of gender (see also Åsberg et al. 2011b, 2011a).

One of gender studies' most influential approaches is the turn to body and materiality that allows feminist scholars to move beyond the binary positions of, for example, sex-gender and nature-culture. As Lykke argues, gender studies was successful in "making corporealities matter" (2010a, 106) and moving beyond social constructionism, which abandoned biological sex in favor of "socioculturally changing and changeable gender" (107). For instance, from the position of sexual difference theory, feminist philosopher Elizabeth Grosz (1994) argues that instead of taking their point of departure from the dichotomy of gender deconstructionism, feminists need to discuss subjectivity and identity in relation to corporeality, which is both the material body and its sociopolitical situatedness, through which it is sexed, sexualized, racialized etc. Another example of the centrality of the body and materiality for feminist theorists is the work of feminist philosopher Rosi Braidotti (1994). With her concept of the *nomadic subject*, she argues that feminists need to take the position of embodied becoming as their point of departure for discussing sexual difference, subjectivity and identity. To understand sexual difference apart from the binaries of same-other and male-female, she suggests that feminists should stay with bodily differences—between men and women, between women and, last but not least, within each and every woman. Another feminist approach that favors embodiment (and therefore the body as not purely discursive) is that of feminist phenomenology. Feminist philosopher Margrit Shildrick problematizes modernist boundaries of the body as fixed and closed, on the one hand (1997, 1999; see also 2009), and the medical understanding of bodies as machines, on the other hand (Shildrick 2008, 2009). She argues that bodies and identities are "intercorporeal" (2008, 13)—always in relational becoming with other bodies. Such relational becoming with others is also similar to Haraway's concept of "becoming with", which aims to highlight that, as she writes "to be one is always to *become with* many" (2008b, 4; *Italics in the*

original). Other theorists discuss bodies in relation to technologies within gender studies; they suggest bodies and technologies create each other in gendered, racialized ways (see, e.g., Balsamo 1996).

Feminists have also discussed bodies, embodied subjectivities and sex and gender from within natural sciences. For instance, Anne Fausto-Sterling (2000), biologist and gender studies scholar, argues that if feminists stay with the biological significance of the body and its materiality, it becomes clear that the social construction of the body, for instance in the sex-gender binary, is more rigid than the biological and material body. She argues that staying with the body and the biological differences between bodies shows that binary sexes are more a social construction than a biological reality. In recent decades, the question of biological sex differences within gender studies has moved beyond the human subject. Feminist STS scholar Myra Hird (2009) and gender studies and STS scholar Cyntia Kraus (2000), with empirical material collected from fieldwork on nonhuman organisms such as bacteria and fruit flies, discuss the fluidity and multiplicity of biological sexes as nonbinary, as well as the openness of the body as a process of becoming in relation. It is within such a corporeal understanding of the body as material and discursive becoming that feminist scholar Sarah Franklin argues that feminists need to engage with the biological sciences, to discuss the body and biology both as “the thing itself”—namely the biological, material body that has been the object of natural sciences—and as “the knowledge about what [biology/body] is”—which is the sociocultural, political and scientific discourse about bodies and the object of social sciences and humanities (see 2006, 174). Indeed as gender, nature and culture scholar Cecilia Åsberg and feminist biologist Lynda Birke write, “biology is a feminist issue” that tackles not only biological determinism but also the “cultural and socially reductionist approaches” that leave materiality untheorized (2010, 43).

Within contemporary gender studies, many scholars such as Donna Haraway (1991, 1989), Hird (2009), Stacy Alaimo (2010), Elizabeth Wilson (2016), and Åsberg and Birke (2010) have moved beyond sex-gender in their engagement with natural science in order to problematize the hierarchical divides between human and nonhu-

man, nature and culture as equally problematic. These scholars show that not only bodies but also nature and life itself have been subjected to gendered, racialized and sexualized regimes of power relations. Whereas traditionally gender studies scholars discussed power relations in terms of gendered relations and eventually moved toward theories of intersectionality (see, e.g., Lykke 2010a), today they have expanded the scope of their analysis of power relations and subjectivities to include nonhumans as well. As Åsberg argues, referring to philosopher Julia Kristeva's concept of the "stranger to ourselves"¹, currently humans' Other is not necessarily "of a psychic nature but, for instance, lively microbial strangers we hardly knew we needed for our daily survival, for foods to be digested and nutrients to reach our blood" (2014, 61). As such, gender studies is moving toward a critique of "human exceptionalism" (Haraway 2008b) that takes the human subject (often the white, heterosexual, European man) to be at the center of the world and separated from the rest of the world, including nature and the nonhuman Other.

Gender studies, indeed, promotes a more inclusive understanding of not only humans but also "subjects of a life" (Birke et al. 2004, 174), acknowledging the entanglement of human bodies with other life forms, as well as human abilities and consciousness as always already multispecies (see Nayar 2014). As anthropologist Anna Tsing writes, thinking with mushrooms, "Species interdependence is a well-known fact except when it comes to humans", because often humans are blinded by the idea and the politics of human exceptionalism (2012, 144). According to Tsing, one of human exceptionalism's perks is to perceive the human species as *being* autonomous and self-maintaining rather than *becoming* in relation—making humans appear to be "constant across culture and history" (144). As such, human nature is then appropriated by androcentrism, colonialism and capitalism and their "autocratic and militaristic" assumptions (144). In other words, it appears that similar to categories of sex and gender, or race, which are socially constructed and arbitrary (as has been discussed within gender studies), categories of human, life and

¹This is a concept that discusses the abject and the stranger within the subject with which and against which the subject is produced.

animal are also fuzzy and multiple. Tsing (2012) asks what would happen if human nature was imagined as a node and a becoming rather than a fixed prescribed category. What if human nature is relational and interdependent with other species, and changes once these relations have changed? To think about nature as such highlights that human nature itself is an “interspecies relationship” (141). This approach is often known as posthumanism, and it takes “interspecies identity” and “humanimal” becoming as the basic units of analysis (Nayar 2014, 5), as I discuss in the following paragraphs.

Posthumanism is an umbrella term that has been used across a wide range of fields of study and disciplines including philosophical, cultural and critical posthumanism; transhumanism; feminist materialism; antihumanism and much more (see Ferrando 2013). The term has generally developed, as philosopher and gender studies scholar Francesca Ferrando writes, so as to cope with and redefine “the notion of the human, following the onto-epistemological as well as scientific and bio-technological developments of the twentieth and twenty-first centuries” (2013, 26). However, despite their shared interest in dealing with the question of natureculture and the human (which is mostly understood as a vibrant becoming rather than a fixed, preexisting, disembodied subject), these approaches are different from one another in terms of their genealogies, perspectives and ambitions. In my thesis, I mostly draw on feminist posthuman work² and particularly the work of biologist, feminist cultural studies and technoscience scholar Haraway (1991, 2008b) and feminist philosopher and physicist

² Braidotti traces the genealogies of posthuman(ism) within the fields of moral philosophy, STS, and anti-humanist postmodern philosophies of subjectivity (2013, 38). She argues that antihumanism movements (such as antifascism, postcolonialism etc.) disregarded the human in humanism because they considered the human to be “a normative convention, which does not make it inherently negative, just highly regulatory and hence instrumental to practices of exclusion and discrimination” (2013, 26). Similarly, postmodernism and poststructuralist theorists tried to overcome the problem of the human as “a normative frame and an institutionalized practice” that does violence (26). However, she argues, the postmodern antihumanist attempt was not very successful in dismantling the human because it was trapped within discourses of emancipation and progressive politics, which were the legacies of humanism (26). Ferrando (2013) argues that postmodern and poststructuralist accounts often stay within the binary of language and materiality, which reproduces the binary hierarchies they are trying to problematize with deconstruction.

Karen Barad (2007).

Haraway traces the origins of posthumanism to Freud and his account of three historical moments in which human exceptionalism was wounded. First is the “Copernican wound”, which removed the earth from the center of cosmos into an “open universe of inhumane, nonteleological times and spaces” (Haraway 2008b, 11). Second is the “Darwinian” understanding of *Homo sapiens* as a critter among many others in the world that has evolved in relation to other nonhumans. Third is the Freudian move to outrank the conscious (and reason, for that matter) by introducing the unconscious. Haraway introduces the fourth moment particular to our time, which is the informatic or cyborgian understanding of the human, life and the world, as I discuss later in this chapter. In other words, as Haraway (1991) argues with her concept of the cyborg, humans are always already entangled with nonorganics and informatics; in other words, the human body is always technoscientifically mediated and sociopolitically embedded. However, in later works, Haraway (2003, 2008b) elaborates on her previous figuration of the cyborg with the figure of “companion species” (see chapter 5), focusing on human and dog mutual material-discursive becoming. She writes, “I appropriated cyborgs to do feminist work in Reagan’s Star Wars times of the mid-1980s. By the end of the millennium, cyborgs could no longer do the work of a proper herding dog to gather up the threads needed for critical inquiry” (2003, 4). She argues that the material coevolution of dogs and humans (e.g., the exchange of organic matter and bacteria) and their long history of companionship testifies to multidirectional gene exchange and interspecies connections but also highlights that “we have never been human” (quoted in Gane 2006). In other words, the massive number of bacteria and fungi in a human body as well as the molecular exchanges between bodies and beyond species boundaries bring up the question of what is human about human beings. The way I understand Haraway’s work as posthuman is in her understanding of multispecies coevolution in material-discursive ways, which reconceptualizes ethics, politics and materialities. Posthumanism, then, is not about the technoscientific progressiveness imagined by popular culture, called transhumanism and criticized by feminist posthuman

scholars (see Ferrando 2013; Hayles 1999; Rossini 2006). Transhumanism suggests transcendence and disembodiment—abandoning the material body and its vulnerabilities for a “better” version of the human subject of the Enlightenment. The feminist critique of popular posthumanism, or transhumanism, is that it focuses on the technological and technoscientific possibilities for the evolution of the human into a better version of itself instead of critically engaging with what it means to be human in the contemporary era saturated by technoinformatics. Therefore, the posthumanism I am concerned with, inspired by these scholars, is similar to Manuela Rossini’s, whose posthumanism “would above all be the home of post-anthropocentric and anti-speciesist cultural studies whose practitioners are aware that ‘culture’ is not ‘ours’ only but who nevertheless take responsibility for the consequences of human culture for nonhuman others—for their sake, for human’s sake and for the sake of retaining the meaning of humanity and humanism in posthumanism” (2006).

Posthuman theories take the “posthuman condition” seriously as the reality of our contemporary time (Braidotti 2013, 2). Posthumanism is a story about technologically assisted reproduction (Franklin et al. 2000; Franklin 2006) and transgenic animals (Haraway 1997), which questions the assumed closed boundaries of human nature and between species. It is a way of being in and of the world as well as a mode of engagement with our present and our pasts—for instance, familial genetic diseases which enact us as pre-symptomatic patients consuming health care before even getting sick (Roberts 2002). In other words, today, humans and nonhumans are living material-discursive technoscientific predicaments; humans and nonhumans are making such predicaments, made by them and, most importantly for me, dying with them. Environmental changes; waste landfills; genetically modified animals, foods and plants; health screening programs and biological citizenship; posthuman warfare; human excursions into deep seas, into the galaxy, and into humans’ and animals’ bodies as scientists map their genomes and proteins—all are witness to the inseparability of science, technology and (non)human bodies as they testify to the ongoing transformations of our worlds, ourselves, our bodies. Posthuman theories not only are situated in such ongoing

transformations and transformative dynamics but take them as a point of departure in discussing worlds, subjects, epistemologies, ontologies, ethics and politics as always in relational becoming. Situated within such an understanding of reality, I choose the space of the laboratory as a site in which humans, animals and technologies create each other as animals and organisms die in order to produce knowledge about human bodies and diseases such as Alzheimer's disease (AD).

Another legacy of gender studies that I bring to this thesis is the engagement with knowledge and science. Against the disembodied residues of modernist sciences and the view from nowhere, feminist scholars have long emphasized the embodiment and situatedness of knowledge, which I discuss more in chapter 3 (see also Haraway 1988). Of the natural sciences, biology has been most discussed among feminist scholars due to a long history of biological determinism—through which normative regimes of power have been safeguarded by means of “scientific knowledge” and social and cultural relativism—which discarded the materiality of the world (see, e.g., Oudshoorn 2003; Schiebinger 1989, 1993, 2013). These feminist scholars often asked questions such as the following: How is knowledge produced within natural sciences, and by whom and for whom is it produced? What kind of norms and subject positions are produced through such knowledge-production practices (see, e.g., Roberts 2002)? Which bodies and forms of life are allowed and hindered in regimes of knowledge production? As Åsberg et al. argue, for a long time the question within feminist studies, inspired by philosopher Michel Foucault among others, has been about “the relation of power and knowledge, and the embodied subjectivities they engender” (2011a, 227). Therefore, feminist scholars have paid attention to the performative relations of power and knowledge through which worlds are made (in)habitable for particular bodies, a discussion I will return to later in this chapter. Last but not least, these scholars also ask which forms of knowledge are qualified as scientific facts and which are disqualified as unscientific and fiction (see, e.g., Ehrenreich and English 2005; Harding 2008; Martin 2001). This generation of feminists emphasize the entanglement of knowing and being in and of the world, arguing that scientific knowledge is always embodied and

embedded in sociopolitical contexts and therefore subjective. They also problematize the myth of disembodied objectivity, which I will discuss more in chapter 3. As such, the very content of scientific knowledge has become an object of study for feminist scholars, giving shape to a subfield within gender studies known as feminist science studies (FSS).

Feminist science studies (FSS)

In 1986, *The Science Question in Feminism*, a book by feminist philosopher of science Sandra Harding, argued for a crucial shift from the woman question in science (why are there so few women scientists?) to a question about the possible feminist content of science. She argued that feminists need to seriously investigate the very production of nature in the lab from feminist perspectives. In 2001, in an edited volume with the significant title *Feminist Science Studies: A New Generation*, feminist science studies scholars Maralee Mayberry, Banu Subramaniam, and Lisa H. Weasel explained that FSS had developed into a rich and diverse field “in its goals, theories, actions, activisms, methodologies—its production and effects” (2001, 5). The authors argue that FSS, as a “field in motion”, mostly engages with key feminist issues, such as the intersections between race, class, gender and science and technology (5–6). They mention that FSS is concerned with feminist analysis of scientific ideas and practices, in order to explore the relationship between feminism and science and what each can learn from the other. It is a field that has critically engaged with objectivity in knowledge production within sciences and works with the implications of situated knowledge. In FSS, gender politics not only addresses the hierarchical and binary relations of men and women but also focuses on alternative modes of understanding agency, materiality and the body, and boundaries between nature and culture. It discusses science as always already political and social.

FSS overlaps with—and is even sometimes interchangeably referred to as—FTS. In my thesis, I use the latter term (feminist technoscience studies) because I believe that the difference between FSS and FTS is how the latter attends more to the importance of tech-

nologies as an inseparable part of knowledge production, meaning making and the materialization of bodies and realities. Within FTS, much discussion surrounds nature and culture as being inseparable—ranging from the canonical assisted reproductive technologies studies (e.g., Wajcman 1991; Thompson 2005) to studies of the human genome diversity project (M'charek 2005), from critical engagement with transgenic animals within life sciences (e.g., Haraway 1997) to the relation between technologies, sciences and the production of bodies and realities. FTS scholars, using empirical cases, discuss that technologies such as imaging, genetic modification, microscopes and more not only make meaning and knowledge about nature and bodies but produce nature and bodies as they engage with them in order to make them visible and therefore knowable. Moreover, FTS scholars argue that today, not only are body and body parts made visible but, with the new high-tech possibilities, the interiors of the bodies have become “visible matter” (Waldby 2000, 5). Last but not least, the making of bodies and nature has reached a point within sciences so that today, the molecular component of bodies, nature and even life itself has become a visible matter as it is made, simulated and visualized in laboratories (see, e.g., Franklin 2000; Franklin and Lock 2003; Haraway and Goodeve 2000). In other words, to make bodies, nature and life visible is to intervene in material and discursive ways; it is to make that which has been imaged and made visible (see, e.g., Sturken and Cartwright 2009). It is within such feminist technoscience analyses of nature, science and life itself that I ground my thesis. I will further discuss these analyses in the last part of this chapter, when I discuss the concepts of molecularization and life itself (Franklin 2000; Haraway and Goodeve 2000).

To recap, gender studies today is an epistemological, methodological, ethical and political approach that vouches for theoretical diversity and methodological multiplicity, embodied realities and relational ethics. It aims to “unlock fixed and stereotyped ideas and concepts of gender, sex, science and knowledge production” (Lykke 2010a, 3). It approaches materiality, complexities and multiplicities, as well as the problem of the hierarchical dualisms of self-other and nature-culture. As Åsberg, Redi Koobak and Ericka Johnson argue, it

appears as though the heterogeneous field of gender studies “is open and ready to engage with not just the problem of androcentrism but that of anthropocentrism as well” (2010a, 227). In my thesis I will not discuss anthropocentrism but I am inspired by its theoretical contributions on posthumanist agency and relational, mutual material-discursive becoming that exceeds the imaginaries of humans, nonhumans, and agency, among others. It is in line with such a posthumanist understanding that I contribute to feminist engagements with molecular biology, nature in the lab, knowledge-production practices and human-nonhuman-technology entanglements as I discuss AD in the lab as fluid, material flows of transformation and material-discursive relational becomings. My approach taps into a new theoretical train within gender studies known as “corporeal feminism” (Grosz 1994), “material feminisms” (Alaimo and Hekman 2008), “post-constructionism” (Lykke 2010b) and “new materialism” (Tuin and Dolphijn 2012), which I will discuss in the next part using the term *new materialism*. Within this framework, I am concerned as well with the relation of power and knowledge through which embodied realities (if not subjectivities) are engendered through practices of knowledge production about AD in the laboratory. However, in response to Åsberg et al. (2011a), I am interested in not only what kinds of human and nonhuman bodies and forms of embodiment are “engendered” by, for instance, practices of knowledge production within life sciences but also which bodies and forms of embodiment are *endangered* as a constitutive part of engendering processes.³

Science, technology and society (STS)

Another field of study I draw on is STS, earlier known as social studies of knowledge (SSK). SSK displaced “scientific knowledge” from its ivory tower and transformed it into an impartial “object of the study”, approaching science as a social construct rather than the positivist universal facts of nature (Pinch and Bijker 1984; Sismondo 2010). However, SSK was criticized for its relativism (e.g., by Bloor,

³I do not use the term *endangered* as in animal rights discourses and extinction of a species. I use it to point out that forms of life are produced to embody dangerous diseases and exposed to biological risks that put them in danger.

quoted in Hird 2009). In other words, as much as SSK was successful in making science into the object of study for sociologists, it reinforced the separation of the social, technical and scientific and left out “sociology’s Other, the nonsocial”, namely the nonhuman (Lee and Brown 1994, 777; see also Hird 2009).

Actor network theory (ANT) succeeded in engaging science and culture, subject and object, human and nonhuman, and matter and discourse as entangled. Latour (1993) argues that the very separation of nature and culture, which he calls the “great divide”, is a construct of modernism, arguing that nature is always a mix of natures on the one hand and nature and culture on the other. Moreover, according to ANT scholars such as Latour, things-in-themselves should be a main analytical focus aside from human actors. He suggests the term *actant* to refer to both humans and nonhumans. As actants form alliances, networks are established and realities are made in relational ways. Emily Martin criticizes Bruno Latour and Michel Callon for their ANT approach, because according to her such an approach humanizes the nonhuman actor, stripping down its agency and reducing the nonhuman to “simple forms” namely “the competitive, aggressive, accumulating individual” (Martin 1998, 27). In other words, as feminist STS scholar Celia Roberts writes ANT “only allow[s] for the activity of nonhuman actors insofar as these actors can be said to compete in the same way as human actors (as accumulating entrepreneurs) and this negates differences between human and non-human actors” (Roberts 2007, 17). Similarly, Hird argues that ANT scholars “focus much more on definably social actors (paradigms and politics for instance) than material objects” (Hird 2009, 18). Last but not least, early ANT works have also been criticized for leaving the Other untheorized, which is an important question within FTS (see, e.g., Law and Singleton 2005).

Christopher Gad and Casper Bruun Jensen (2010) write that post-ANT scholars have been trying to bridge the problematic mentioned above by shifting the perspective from following the actors to, for instance, focusing on the “enactment”, or doings (Mol 2002; see also Law 2008), and performativities as the ontological unit of realities. Inspired by philosopher and gender theorist Judith Butler’s concept of

*performativity*⁴, STS scholar and ethnographer Annemarie Mol argues that in order to understand reality, it is crucial to hold on to the practices through which realities are performed, rather than bracket them and make them disappear. To Mol, what is at stake is the ontological inseparability of the doer and the deed in their relationality. However, she uses the term *enactment* instead of performativity to exceed social construction, which she believes is the limit of Butler's performativity. She writes that if an object is real this is because it is part of a practice. It is a "reality enacted" as always relational (Mol 2002, 44). As such, knowing as a practice is not about the subject. It is not about a subject knowing an object's one true reality. Neither is it about multiplicity of the object as a matter of multiple perspectives that aim to know the (same one) object differently. Rather, reality is about multiple enactments of object and subject in practice. This is an *ontological politics*, Mol argues, that advocates for the ontological multiplicity of realities and things as matters of practice. What I mostly take from STS is the focus on practices as the ontological unit of reality. I think with and I write about everyday laboratory practices through which realities are enacted in relational, material-discursive ways. I write about processes of observing and intervening through which not only humans but also nonhumans perform that which is established as scientific realism.

Human-animal studies (HAS)

The question of animals within feminist theories is not new, but it is not vastly discussed either (Birke et al. 2004). Animals have been discussed in different ways within feminist works, one of which is regarding animal treatment and ethics. For instance, aiming for the ban of animal exploitation in sciences, some feminists question the efficiency of animal experiments and their biological compatibility with human and animal suffering in scientific practices (quoted in Birke et al. 2004, 47; see also Birke 2012a). Furthermore, emotion and embodiment in science make laboratory animals a crucial node of

⁴Feminist philosopher and gender theorist Judith Butler (1993) argues, through the concept of performativity, that normative discourse often materializes in terms of not only gender but also sex through lifelong repetitions and doing.

engagement for feminists. Many feminists criticize the masculine nature of scientific methodologies and epistemologies, which also dictate modes of care for and handling the animals in the lab. In other words, as scientists are trained and learn to suppress emotions, to be objective and to distance themselves to do proper science, as Lynda Birke, Arnold Arluke and Mike Michael (2007) argue, writing about feeling empathy and connectedness in the laboratory can not only open up alternative modes of doing science but also enable feminist ethics of care for the animals (see, e.g., Holmberg 2011).

Moreover, as Lynda Birke, Mette Bryld and Nina Lykke (2004) argue (see also Birke 2012b), discussing animal(ity) has a political and ethical importance to feminists. For instance, animal(ity) is a highly gendered, sexualized and racialized category. Biological facts and making references to biology at large are often used to define what is natural and therefore assumed to be good and morally right (in Åsberg and Mehrabi 2016). As Birke et al. (2007) argue, naturalizing definitions and arguments about (human) nature either arise or are justified by biological “facts”, which are said to be “scientifically proven” in animals. Such naturalizing definitions of nature then are often misrepresented as nature or natural themselves (Birke et al. 2007). Animal(ity) has been discussed by feminist scholars in relation to Otherness and how human subjectivity has often been constructed in contrast to and superior to the animal and that which has been animalized. As Birke (1994) argues, many assumptions about animals (generally and in science) are based on a false distinction between human and animal—a separation that constructs humans as unique from their Other, namely animals, which are often problematically imagined as homogenous. This distinction reinforces the domination and supremacy of the human over the animal, while the oppression of the animal directly affects the human treatment of nature (Birke 2012b).

Furthermore, as Birke et al. argue, “animality itself (or, the specificity of any particular kind of animal) is just as complexly constructed as gender or humanness” (2004, 168). In the article “Animal Performances”, Birke et al. (2004) argue that categories of human and animal and the relation between the two are a matter of performativity

rather than essence. In other words, what is at stake is not only how animals are used in natural sciences and the creation of biological knowledge but also how humans and animals are defined as species within such scientific practices. Feminist concerns have become even more pressing regarding transgenic animal models. Today, animals are not only purposefully bred (Birke 2012a) or “born and made” (Franklin and Roberts 2006, 14) but “made and born” (Franklin 2006, 171). Birke shows that genetically designed animals are disassembled and produced in ways that are closely connected to humans, which therefore has implications “for how we conceptualize the body (human or nonhuman)” (2012a, 156). In my thesis, I am inspired by the work of feminist scholars such as Birke et al. (2004), who argue that human-animal is a relational becoming, materialized and made meaningful through material-discursive performative doings. I will come back to this idea later in this chapter.

On posthumanities

Åsberg et al., suggest the term *posthumanities* “as feminist analytical practices work for us to *re-tool* the humanities so as to meet up with the on-going transformations of our worlds” (Åsberg et al. 2011a, 228). Posthumanities as such acknowledge the contemporary realities and conditions of life to which humans and nonhumans are exposed and with which they become: conditions that are affected by social, cultural, historical, linguistic specificities but not reducible to these. Åsberg et al. (2011b, 2011a) trace the genealogy of their concept of posthumanities back to gender studies, FTS, STS and HAS, which is similar to the field of study in which I ground my dissertation. Åsberg et al. do not necessarily separate these fields, and nor do I. The concept of posthumanities then becomes “a form of transdisciplinary mapping exercise of the changing notions of the human” and nonhuman (Åsberg et al. 2011a, 227) against the modernist understanding of these categories as given.

In my dissertation I also use Åsberg et al.’s (2011b, 2011a) concept of posthumanities as an umbrella term to address my interdisciplinary approach in conducting my study. Although I borrow certain ana-

lytical tools and theoretical concepts from each of the fields that I mentioned (STS, FTS, gender studies and HAS), I also wish to use a theoretical approach found within all these fields, that is, one that focuses on material-discursive relationalities. In the following sections, first I will discuss my theoretical approach, namely material-discursive becoming that I refer to as new materialism (Tuin and Dolphijn 2012). Next, I will tackle each empirical chapter separately as I discuss the theoretical concepts I use for my analysis. This approach, I hope, will offer the reader an overview of the theoretical grounds and fields of study relevant to my thesis. I also wish to provide readers with the tools they need to read each empirical chapter. These tools consist of the human, nonhuman, technological, social, cultural, material, discursive, political and ethical entanglements through which not only knowledge about AD is produced in the laboratory but also life and death and dying bodies (chapter 4), killable bodies (chapter 5), and dead bodies and waste (chapter 6) are produced in relational ways.

2.2 New materialism as the theoretical approach

What compels the belief that we have direct access to cultural representations and their content that we lack toward the things represented? How did language come to be more trustworthy than matter? Why are language and culture granted their own agency and historicity while matter is figured as passive and immutable, or at best inherits a potential for change derivatively from language and culture?

— Barad 2003, 801

Feminist philosophers Peta Hinton and Iris Van der Tuin, the editors of the special issue “Feminist Matters: The Politics of New Materialism” of the journal *Women: A Cultural Review* (2014), argue that new materialism is mostly known for problematizing the nature-culture dualism that is not taken up that much within postmodern and poststructural theories. In other words, and as mentioned by Barad in the above quote, new materialism situates nature, objects and

matter as far from being passive: they are not merely the materialized effects of discourse and language. Neither are they the interpretation of the rational mind nor the blank slate on which culture writes itself. Matter, nature and objects are vibrant (Bennett 2010). They are “agential” and performative of realities (Barad 2007).

Thinking with new materialism attends to the generative, dynamic and self-regulating characteristics of matter, which demand a different political and ethical approach toward questions of agency, materiality and discourse (Tuin and Dolphijn 2012; Hinton and Tuin 2014). New materialism theorists do not claim that previous feminist generations did not engage with materiality. In fact, as philosopher Rick Dolphijn and feminist philosopher Van der Tuin argue, new materialism embodies “new” readings of the older canonical discourses within philosophy, for example: “‘new’ readings that do not fit the dominant reception of these texts” (2012, 13). As such, the *new* does not merely add something to the past but “traverse[s] and thereby rewrites thinking *as a whole*” (13; italics in the original). In other words, new materialism rethinks “materiality’s dynamism”, agency and realism (1). It positions materiality as a force and as lively—as a vitality that maintains itself (Braidotti 2013). This ontological turn (from the understanding of matter as passive to generative) is an invitation not only to analyze discourse about the body and nature and how that “discourse comes to matter” but also to attend to “how matter comes to matter” (Barad 2007). It is to, as Alaimo and Susan Hekman argue, “‘make matter matter’ in more significant ways”(2008), which has been discussed in other branches of feminist theories. I will expand more on my understanding of new materialism in the following, drawing on the work of Barad, whose *agential realism* is one of the well-established frameworks within new materialisms. I am in conversation with this concept in my thesis.

Agential realism

In my agential realist elaboration, phenomena do not merely mark the epistemological inseparability of observer and observed, or the results of measurements; rather, phenomena are the ontological inseparability/entanglement of intra-acting

“agencies”. That is, phenomena are ontologically primitive relations—relations without preexisting relata.

— Barad 2007, 139

In *Meeting the Universe Halfway* (2007), Barad explains the “uncertainty principle”, representation and its limits in the work of the German physicist Werner Heisenberg. According to Barad, Heisenberg argues that there is “a necessary limit to what we can simultaneously know about certain pairs of physical quantities”, because variables that do not commute cannot be measured simultaneously (7). Once the knower experiments on measuring one aspect of a particle, for instance the position, they get further away from measuring the other, for example momentum. He discusses this uncertainty principle as an epistemological problem. In other words, if the experimental system can be controlled in ways that do not interfere with the reality being measured, or if the interference and disturbance can be measured, calculated and accounted for, one can theoretically measure the direct cause and effect relation of quantum mechanics (quoted in Hird 2012).

Barad (2007) draws inspiration from the work of Danish physicist Niels Bohr and his theory of quantum physics⁵ in order to argue that there is more at stake than the epistemological uncertainty that Heisenberg suggests. As Barad writes, measurements are constitutive parts of any phenomenon both in the work of Heisenberg and Bohr. To measure, then, is the “criterion for determining what is real” (50). However, while Heisenberg discusses the relation between measurement and causality as an epistemological issue, Bohr understands it as ontological. Barad, inspired by Bohr, explains this idea through the phenomenon of light (2007, 100). While Newtonian physics understands light as a wave, the two-slit experiment proves that light is also a particle. It is this duality of the wave-particle reality

⁵ Bohr and Heisenberg were colleagues and collaborated with each other on developing the field of quantum physics. Whereas Heisenberg was known for his contribution in quantum mechanics and his uncertainty principle, Bohr was known for his quantum theory of the atom and complementarity. In other words, as I discuss in this section, the philosophical stands within which these two scientists were grounded differed in terms of the ways they understood the relation between ontology and epistemology.

of light that Barad takes as a an inspiration to articulate her concept of “agential intra-action” (2007, 139), which is the inseparability of the object, subject, and the measuring agencies on the one hand and the “in/determinacy” (2012b, 12) principle on the other hand, which I explain in the following paragraphs.

Barad argues that, depending on the measurement apparatus, the ontology of light can be either wave or particle. The issue, then, is *complementarity* rather than Heisenbergian uncertainty. It is about the inseparability of ontology and epistemology or, as Barad writes, an “onto-epistem-ology” which is “the study of practices of knowing in being” (Barad 2003, 828). Onto-epistem-ology is always a dynamic mattering which is actualized in intra-action. She argues that intra-action is about “relationality between specific material (re)configurings of the world through which boundaries, properties, and meanings are differentially enacted [...] and specific material phenomena” are made (Barad 2007, 138). In Barad’s agential realism, there is a difference between interaction and intra-action. She argues that interaction is to assume preexisting subjects, things, objects etc. that come together to represent what is out there, as in, for example, the work of Heisenberg. The concept of intra-action, however, is the condition of possibility of objects, subjects and phenomena becoming together, as in the work of Bohr. Intra-action implies ongoing becoming, on the one hand, and “agential separability” on the other (345). Subject and object can only be separated provisionally once the apparatuses are enacted and cut the boundaries of the phenomena. She terms this intra-active boundary-making relationality, which is the core of mattering (in both senses of the word), an “agential cut” (345). In other words, as agential cuts materialize the properties of a phenomenon, one reality is enacted, and the cuts prevent another reality from being materialized. Barad writes that, through measuring a phenomenon, “certain properties *become determinate*, while others are specifically excluded” (19; italics in the original). Barad calls this temporary, situated separation “exteriority-within-phenomena”, or “cutting together apart” (140). In other words, as Barad argues, reality “is composed not of things-in-themselves or things-behind-phenomena but of things-in-phenomena” (140).

In the article “What is the Measure of Nothingness? Infinity, Virtuality, Justice”, Barad expands on the concept of *in/determinacy* by using the example of the void. She argues that to measure the nothingness, one needs to set up an experiment and begin with a vacuum, which is supposedly “the absence of everything” (Barad 2012b, 9). For instance, one can introduce different probes, such as a flash of light, to do an experiment. Yet, regardless of the method of experimentation, it introduces “at least one photon (quantum of light)” into the void, destroying the very condition of possibility for being a vacuum, the very condition of nothingness. In order to determine the existence of nothingness by doing experiments, nothingness is disturbed. The way I understand Barad’s argument is that to name something, to categorize it, is to measure it, and to measure is already to intervene. Therefore, categories are ontologically *in/determinate* until they are measured. For instance, once the boundaries of light as a particle are materialized in an experiment and in relation, they exclude the condition of possibility of becoming a wave. Barad writes, “*In/determinacy* is not the state of a thing, but an unending dynamism” (2012b, 12). Such ontological *in/determinacy* is a “radical openness, an infinity of possibilities”, which is what she calls “the core of mattering”. As such, “matter in its iterative materialization is a dynamic play of *in/determinacy*” (18).

Posthumanist performativity

Barad (2008) argues that agency is not an attribution of the rational mind, nor of the human. It is not something that one has. Neither is it something that can be given or granted to the Other, for agency regarded as such—as a possession, as a grantable or claimable attribution and belonging—would be to assume inherent characteristics to dispersed entities. It would be representationalist rather than agential realist (Barad 2003). Within the representationalist understanding of agency, all of humans’ Others, that is, nonhumans (such as nature, animal, technologies etc.), are taken to be passive, solid and stable

entities ready to be manipulated and exploited or at best represented⁶. Instead, agency in a posthumanist and new materialist account is an intra-active dynamic relationality. As Barad writes,

On an agential realist account, agency is cut loose from its traditional humanist orbit. Agency is not aligned with human intentionality or subjectivity. Nor does it merely entail resignification or other specific kinds of moves within a social geometry of antihumanism. Agency is a matter of intra-acting; it is an enactment, not something that someone or something has. Agency cannot be designated as an attribute of “subjects” or “objects” (since they do not preexist as such). Agency is not an attribute whatsoever—it is “doing”/“being” in its intra-activity. Agency is the enactment of iterative changes to particular practices through the dynamics of intra-activity. Agency is about the possibilities and accountability entailed in reconfiguring material-discursive apparatuses of bodily production, including the boundry articulations and exclusions that are marked by those practices in the enactment of a causal structure.

— Barad 2008, 144

To understand agency as dynamism and realism as intra-active material-discursive becoming changes Butler’s concept of performativity, which Barad (2008) elaborates on and redefines in terms of “posthumanist performativity” (129). In other words, as Barad (2008) argues, to understand performativity as a material-discursive relationality reconceptualizes given categories, such as human and nonhuman, in favor of categories as always being performed. Categories are then made through practices which are not necessarily the doing of a human subject but human and nonhuman performativity.

⁶The problem of representation has been discussed by many scholars such as Haraway (1992) and Vicki Kirby (2008). For example, as these scholars argue, often representation brings about the question of who is representing whom? Who is excluded from representation? Who am I to represent the Other? Representations are also criticized for appropriating the object of representation in order to become a subject and in order to be granted agency; the Other would never become fully a subject in such a system.

Thinking with new materialism, agential realism and posthumanist performativity, together with knowledge-production practices about AD in the lab, allows me to reconceptualize phenomena such as killability, death and waste, which I discuss in my three empirical chapters. In other words, my thesis is posthumanist not only because AD is a phenomenon performed by posthuman dynamism, or posthumanist agentiality, in the lab. AD in the lab is a disease that is not not only about human subjects fading away—nonhumans also constitute AD and what it becomes, and this characteristic as well contributes to my thesis being posthumanist. However, my study is of life and death performed in the lab being constitutive of AD within everyday practices: the ways in which life and death are made through posthumanist, interspecies, coevolving, relational, material-discursive dynamism within the context of AD practices in the laboratory contribute to my posthuman perspective here. In chapter 4, I argue that while AD is performed on the molecular level in the lab, death is animated, bred, measured and finally imaged in transgenic fruit flies: through this process, AD acquires meaning. In other words, death in the lab is not an abstract concept but a material-discursive, intra-active performance in which nonhumans are as agential as humans in enacting death in meaningful and material ways. Death becomes an agential matter in the form of molecules, transgenic fruit flies and proteins. In chapter 5, as I write about human and animal relations and the phenomenon of killability, I use Barad's agential cuts to highlight how the material components and agency of the animal models' bodies are a performative force that enacts particular animals as the proper model organism and therefore killable. In that chapter, death is not only about the matter and materiality of death itself, as in the first empirical chapter, but also about how death matters differently. In chapter 6, I write about waste and transgenic fruit flies' bodies in the lab. I show how the materiality of nonhuman bodies troubles the preexisting categories of laboratory waste.

2.3 Mapping the theoretical concepts

So far, I have discussed the fields of study that I draw on as well as my theoretical approach in this study, new materialism. In the following section I address each empirical chapter separately to discuss the theoretical concepts I apply for my discussions.

Theorizing the molecularization of AD, performing death

In chapter 4, which focuses on molecularization, I am grounded within FTS and STS. As I focus on practices, I am particularly inspired by the work of ethnographer and STS scholar Mol (2002) and her concept of enactment. In other words, as I discuss further in chapter 4, according to Mol, realities are always already performed. What makes STS interesting for me is its focus on *practices*. In my thesis, practices are one of the central points of departure for a discussion of knowledge production (human and nonhuman). The reason I focus on practices comes from my fieldwork experience. I was working as technician in the lab, mostly alone and without that much contact with the scientists, which turned my analytical focus toward human and nonhuman doings through which knowledge was performed in intra-active ways. As such, and as I will discuss in more detail, realities and phenomena in the lab—I focus specifically on AD, death and waste—are enacted as *matters of practice*.

Matters of practice

STS scholar Bruno Latour discusses the concept of “matters of concern” in the article *Why has critique run out of steam? From matters of fact to matters of concern*, distinguishing between that and “matters of fact” (Latour 2004, 22) in his understanding of science and nature as coconstructed. He argues that the problem with matters of fact is not necessarily their assumed closeness to nature or their positivism but the positivist claim of objectivity according to which matters of fact appear contextless. Colin Ripley, Geoffrey Thün and Kathy Velikov reading Latour, write that matters of fact appear to be “developed

without the consideration of desire (moral, ethical, or other), [whereas] matters of concern embrace and are centered in those desires” (Ripley et al. 2009, 6). In other words, in a Latourian way, matters of concern highlight the entanglement of messy and controversial networks of instruments, scientists, politics, laboratories and humans and nonhumans in the production of scientific facts.

STS scholars Isabelle Dussauge, Claes-Fredrik Helgesson and Francis Lee (2015) read Latour’s matters of concern in relation to practices. In their discussion of (social, cultural and economic) values in life science, they argue that value is not an attribution or self-evident quality of objects. Rather, values are performed in practices. People and institutions deal with ethical, moral and economic dilemmas differently, and it is through these practices that value is performed in situated ways. Inspired by feminist STS scholar Maria Puig de la Bellacasa (2011), they argue that to engage and be accountable to the production of a thing, in their case value, one needs to engage with “commitments and attachments”, as in, the concerns that are attached to values (Dussauge et al. 2015, 10). To discuss value in terms of practices is to discuss matters of concern, which in return links matters of concern to practices as performative of one another. As they write, “value practices are crucial practices by which people and things make stakes, matters of concern or matters of care—or displace them” (10). Within an understanding of matters of concern as a matter of practice, concerns that are produced in practices and simultaneously engender practices also bring forth another important reality, that of materiality. Thinking with practices, it appears that matters of concern are also “matter-real” or, in other words, “not reducible to discourse, culture or social construction, but brought into being in material practices and relations that include laboratories and research instruments” (Moser 2008, 99).

Thinking with the aforementioned scholars, realities in the laboratory in my thesis are also matters of concern: concerns that are always embedded in knowledge-production practices, that are performed by such practices and that are also matter-real. However, I will use the term *matters of practice* because it emphasizes matter itself rather than the concern, which may still be read as a human-oriented notion. As

such, not only are matters of concern performed and materialized in particular practices but, as STS scholars Andrew Pickering (1995) and Karin Knorr-Cetina (1999) argue, the very materiality of nature, objects and technologies resists and accommodates matters of concerns in situated ways. It is the materiality of the matter, as well as the nonhuman agentiality, that comes to the fore alongside the human in the concept of matters of practice: the nonhuman that performs, the nonhuman that does. Matters of practice then encompass the materiality and discursive components of practices, material for the practices, materialization of practices, and matter and discourse as they are practiced.

On life and death molecularized and feminist studies of technoscience (FTS)

According to French philosopher Michel Foucault (1971), *life itself* is an invention of the nineteenth century (quoted in Myers 2015). As anthropologist Natasha Myers writes, quoting Foucault, before the nineteenth century “all that existed was living beings, which were viewed through a grid of knowledge constituted by natural history” (quoted in 2015, 230). However, in this period a divide happened between life as the force that runs through all beings and life as that which can be captured as an essence. As Foucault argues, the very attempt to capture life is the undoing of life; to hold on to life is to kill its vitality. In Myers’s interpretation of Foucault’s take on life itself, “the ‘itself’ of life, figured as a force, could be named only once it was extracted from rhythms of life and its manifest beings. Any attempt to capture its essence would extinguish it and the beings whose lives it propelled. ‘Life itself’ thus would remain always a secret force lurking behind living beings” (230). Unraveling the mystery of this secret force, namely life itself, according to Myers, has been at the heart of life sciences for a long time. Life itself and its mechanism has, since the nineteenth century, been understood differently over time, while at the same time the locus of life has been fetishized in different bodily matters such as genes or proteins, which I mentioned in chapter 1. STS and feminist scholars have critically discussed the

very attempt to capture life itself within life science and medicine, for a variety of reasons, some of which I discuss in the following paragraphs.

Sociologist Nikolas Rose (2003) writes that within vital contemporary politics, medicine and medical intervention have changed focus from their disease-, health- and illness-oriented origins to life itself. Medicine has shifted its gaze from the molar body to the molecular body (Rose 2003), from the “clinical gaze”⁷ to the “molecular gaze” (Rose 2007) and from a mechanical understanding of the body and its function to unraveling the mystery of life and replicating it on the molecular scale (see also Franklin 2000). Discussing Foucault’s concept of the clinical gaze, Rose acknowledges the fundamental changes that took place in medicine in the nineteenth century as a focal point in the history of medicine, namely, the developments in postmortem dissection and pathological anatomy (Rose 2007, 4). Rose claims that a second shift took place in the twenty-first century that defined, rearranged and enacted medicine but also life itself. In other words, life itself has been molecularized. Rose argues that biomedicine today pushes through the limits of the biological on the molecular scale. Biotechnical interventions are not anymore constrained by “the vital norms of a natural body”—that is, reestablishing the vital natural norms of a body as the matter of clinical intervention and curing diseases (7). Biomedicine today visualizes, enacts and intervenes in life and vital processes differently—on the molecular level. For instance, life has been enacted in terms of genetics and coding sequences, molecular pathologies and protein structures over the past decades.⁸ Moreover, contemporary molecular biology does not simply seek information about life or diseases; it aims to understand, engineer and optimize vital processes of the future. This is to say that biomedicine

⁷When a person is reduced to a disease and the wholeness of their body has become abandoned, or when the disease is located in an organ, not only does that organ become the disease but the person is also reduced to that diseased organ as if it is separated from the rest of the body (Foucault in Sheridan’s translation 1973). However, as Rose argues, in contemporary medicine the gaze has shifted into the molecular body, as people, bodies and lives are reduced into molecules, genes and coded biological information, which he refers to as the molecular gaze.

⁸This does not mean that the molar practices have disappeared but that these practices are accompanied by molecular medicine.

and biomedical technologies are no longer “technologies of health” but “technologies of life” with a futuristic vision of what life can or should be, which aim to “optimize the vital future by action in the vital present”⁹ (Rose 2007, 8; see also Rose 2010; Roberts 2002).

Rose (2007) writes about the molecularization of life itself at large from a distant position rather than talking about practices of molecularization as they occur in different settings. He writes about molecularization in biopolitical accounts of citizenship, medicine and management of the self.

Life itself has also been discussed within FTS. For instance, Franklin (2000) and Haraway (2000) argue that the contemporary approach toward life within life sciences tends to fetishize genetics, DNA or proteins as the source of life, reducing life to information. These feminists’ critical analyses of the idea of life itself compose an approach that investigates the biopolitics of such reductionist understandings of life. FTS scholars of life itself also critically reflect on the cultural imaginaries about life and realities as well as the worlds that such imaginaries enable or hinder (Franklin 2000). These scholars aim to highlight and critically reflect on how life within contemporary natural sciences and cultural imaginaries have been detached from bodies and have been isolated, dematerialized, capitalized on, imaged and represented in terms of codes and information that can be collected, stacked, manipulated, made, (re)animated and imaged (e.g., Franklin and Lock 2003).

Inspired by these scholars, I understand life itself in relation to three major characteristics. The first is, as Rose (2007) argues, that vital elements of life, such as DNA and proteins, are detached from organs, tissues, organisms and species as well as separated from their affinities with individuals and diseases, yet simultaneously these vital elements have been fetishized as the locus of not only

⁹In other words, today we can subject body and mind to molecular technologies not to cure an illness but to become what we are imagined to be in the future. Not only is our corporeality now available on the molecular level to be measured, judged and improved but our *selves* (for instance, our personality) are up for such optimization by molecular interventions. Rose terms such a biopolitics as “molecular biopolitics”, which is to “control and manage vital processes of the body and mind” on the molecular level (2007, 8).

diseases but life itself. Life as such is imagined as something to be “contained and fixed”, which ironically defies the very fluidity and uncontainability of life. The molecularization of life itself is a simplification of an otherwise abstract and complex biological process. According to Haraway, life itself as a form of literalism is an effort to “turn the processural relatedness of nature-culture world into a fixed code or a fixed program” (2000, 92), which brings me to the second point.

The second characteristic of the molecularization of life itself is the reliance of scientific practices and molecularization on informatics, which Franklin (2000) refers to, inspired by philosopher George Canguilhem, as the shift of scale from the mechanics of life to molecular information and communication codes. As STS scholar Jutta Weber writes, “with the rise of system theory, cyberscience, and new life sciences, there is a move towards the molecularization of matter, breaking up organisms or cells into micro-parts down to the subatomic level” (2006, 403), which enabled the translation of worlds and life into problems of coding. As Haraway (2000) argues, in such an informatics and algorithmic understanding of life, life has been reduced into fixable bits and pieces of information, which undermines if not denies the procedural naturecultural transformative flow of life. Haraway refers to such disembodied literalism as life itself.

The third characteristic of life itself is how life has become a spectacle, as the new *imaging technologies* discern “life itself as one that belongs to a visual register” (2000, 197). Franklin (2000) argues, inspired by the visual arts, communication and science studies scholar Lisa Cartwright, that life has become a spectacle within contemporary genetics and biology. In other words, new imaging technologies are a constitutive part of what life is today. Just like the interior of the body that, as sociologist Catherine Waldby (2000) argues, has become visible matter with the rise of new imaging possibilities, life also becomes a “visible matter”—a disembodied, detached matter that can be isolated and imaged. It has to be mentioned that the images of life are always in relation to not only cultural imaginaries but also scientific imaginaries of life. Therefore, as Franklin writes, life becomes an imaginary—one that it is about “imaging the future,

and re-imaging the borders of the real, life itself is dense with the possibility of both salvation and catastrophe" (2000, 198).

The biopolitical and biocapital accounts of life itself, though necessary, according to Myers (2015) run the risk of giving deterministic and singular accounts of life sciences. Instead, Myers suggests that an anthropological take on life sciences and the study of life itself in the laboratory would provide alternative modes of relating to a life science that appreciates its own multiplicity and partialness in producing knowledge about life, living matter and living processes. Staying with practices within life sciences opens space to think about "what it is possible to see, say, feel, and know about both scientific practice and the stuff of life" (27), while accounting for the material and semiotic entanglement that are performative of and performed by such practices. Myers (2015) stays with protein modeling and crystallography as the object of her study and as such argues that even though scientists have tried to capture life, in practice such attempts to capture life come to be unruly, messy and difficult to capture. She writes, "while practitioners may boast that they have captured and put 'life itself' to work in the cell, they also simultaneously animate molecules as wily creatures who continually evade capture" (232). The alternative modes of understanding life sciences that can be achieved from an anthropological study of life science practices give "attention to the affective entanglements of life science inquiry" and show "a lively mechanism [...] pullulating below the surface [...], [a] liveliness that continuously erupts inside of and alongside mechanistic description of life" (232). Inspired by Myers and her understanding of life itself on the one hand and Mol's concept of enactment, which I discussed earlier in this chapter, on the other, I am concerned with the small-scale, messy and chaotic mundane practices in the laboratory that show the coexistence of the mechanistic understandings of life and laboratory attempts to capture it, and the unruliness of life and its liveliness that escapes capturing. To think about the molecularization of life itself as enactments then begs the question, what if molecularization not only affects humans but changes nonhuman lives and bodies? In other words, every day in the lab, as a matter of the molecularization of AD within

life sciences, new “forms of life and partial life” (Catts and Zurr 2008, 126), such as transgenic fruit flies, have emerged and been patented that push the boundaries of biological imaginaries as well as vital materialities. They demand critical engagement. Moreover, thinking about molecularization in terms of enactments suggests that molecularization, occurring through relational situated practices of knowledge production, is not only the *doing* of a human subject but a more dynamic, complex and multispecies performativity. Molecularization as enactment is an analytical tool with which one can trace the changes in the meaning and materialities of life in everyday practices of natural sciences. Last but not least, I wonder if it is not only life but also death that has gone molecular within everyday practices of knowledge production about AD in the lab.

On death itself

Cartwright writes that, “no longer concerned with the body as such, medicine is interested in isolating life—in regulating and extending it, and in gaining control over death in the process” (1995, 82). In other words, there is a relation between life and death on the molecular level, as attempts to decode life entail not only producing and replicating it in new forms but gaining control over death and processes of dying. This is to say that death (of bodies) and life as performed processes are closely linked to biomedical practices and to one another. Yet, as I show in chapter 4, the entanglement between death, life and biomedical practices involves not only gaining control over death but death being performed and performative of AD. For instance, in order to gain control over death, many forms of life are made and born to die. A constitutive part of knowledge-production practices about AD in the lab are new forms of death and dying bodies, which are made and bred.

In my discussion about death, I am curious about whether it, similar to life itself, has also been detached from bodies and species and made and isolated, measured and imaged in the laboratory. I do not write about death as a matter of cultural imaginaries, literalism or biopolitics. Rather, I am concerned with the very practices of breeding,

imaging and isolating (neural) death through which AD and death are enacted in situated ways. I acknowledge the entanglement and inseparability of life and death in material and real ways, yet I choose to stay with death as I discuss in the following paragraph.

Feminist scholar Clare Hemmings argues that the vitalist approach towards death privileges “life over death, capacity over structure, and it asks for a shift from the epistemological to the ontological” (quoted in Hinton and Liu 2015). In other words, this new materialist approach, precisely because of its political commitments to materiality and ethical accountability to matter’s agential force, often emphasizes generative processes over death. For instance, the focus on vitality and generativeness in Braidotti’s work may have caused her new materialist philosophy of death to be read as leaving death and dead bodies untheorized (Cielemecka 2015). In my reading of Braidotti (2013), she discusses death as a part of life. In other words, to understand life as a generative force that goes beyond subjectivity would then enact death as a part of life-generative processes, because as one life ends so starts another. The life force will never stop (e.g., bacteria live on decomposing matter). Such an approach to death is what Olga Cielemecka (2015) criticizes, and I agree with her criticism, as reducing death to a particular form of vitality. I find it ethically and politically important to stay with death because death and dead bodies are an intrinsic part of knowledge-production practices through which transgenic fruit flies, in this case, are made invisible and banished into a land of nonhumanness, nonbelonging and nongrievability. Therefore, it is important to account for the death of the animal models whose bodies are heavily colonized, regulated within the regimes of knowledge production and made killable. Despite the creation of novel modes of death and dying and despite the large number of fly deaths in laboratories and their crucial role in experimental biology, these deaths and dead matter are not discussed as much as those of bigger animals, not even by theorists of nonhuman bodies. Nonetheless, I approach death itself in relation to new materialism, arguing that death is materially and discursively performed in the lab. The entanglement of death, imaging technologies and practices, and the materiality of human and

nonhuman bodies is interesting to me.

Last but not least, an ethical point at stake in my thesis is how medicine not only exploits dead bodies but has been *producing* dying bodies to gain knowledge about living bodies whose lives matter. Making dead and dying bodies for the sake of scientific curiosity is not particularly new. Medicine has long expanded its reach past the corpse, making sick and dying bodies,¹⁰ as well as transgenic animal models suffering humanlike diseases,¹¹ in order to create scientific knowledge. However, today such dying bodies are produced on the molecular level, as I show in chapter 4 with the case of transgenic fruit flies and AD-related proteins.

On theorizing killability

In chapter 5, I draw mainly on the intersection of HAS and FTS. A number of critical texts address the objectification and pathologization of nonheterosexual, nonwhite bodies, particularly within feminist, queer, critical race and postcolonial studies. The critiques focus primarily on how bodies of the Other (e.g., women or people of color) have been exposed, exploited and examined for scientific curiosity and as material for science: how bodies become test objects (Cartwright 1995; Cohen 1998; Fausto-Sterling 1995; Schiebinger 1986, 2003, 2013). In other words, not all bodies have been circulated and subjected to scientific experimentation as test objects. Often dehumanized, racialized and sexualized bodies move around and become provisionally stabilized and capitalized on as the test subject

¹⁰For instance, in late July 1972, Jean Heller of the Associated Press leaked the scandal of Tuskegee. It was said that United States Public Health Service (PHS) had been experimenting on and studying black men suffering from syphilis in Macon County, Alabama for the past 40 years. The tests subjects had been kept in the dark about their disease and the fact that they were being experimented on. They were told they had “bad blood” and they would receive free medical help if they showed up for their routine checkups and refused any other medical assistance from other hospital or doctors. As James Jones writes, the procedure was “a nontherapeutic experiment, aimed at compiling data on the effects of the spontaneous evolution of syphilis on black males” (1993, 275). In other words, they would not receive any treatment so the doctors could examine the last stages of the disease if not treated.

¹¹See, e.g., Practical ethics scholar Hugh LaFollette and philosopher of science Niall Shanks (1994) and their reflection on animal experiments within medicine.

in relation to a variety of actors, scientific paradigms and discourses, cultural imaginaries, social conditions and ethical concerns. What I take from such feminist work, in discussing killability in chapter 5, is the critical lens on the entanglement between power, knowledge and bodies. In other words, a matter of power and knowledge entanglements I explore is how bodies and forms of embodiment are *engendered and endangered*. I believe it is crucial to account for the production of dying bodies as a resource for knowledge production because, to acquire knowledge about AD, masses of transgenic fruit flies must die. In fact, masses of transgenic fruit flies are made and genetically bred for the sole purpose of dying from AD-related causes. I analyze such human and animal relations through the lens of new materialism, which has specific implications for how I theorize human and animal entanglements in the laboratory in terms of agency and ethics.

Criticizing the objectification and instrumentalization of animals in sciences, many feminists try to shift the focus to animal agency. They discuss how animal models in the laboratory are not passive “nature” on which scientists can experiment, but active agents in practices of knowledge production. According to human geography scholar Gail Davies, the humanized mouse is not a “technical object”¹² or an “epistemic thing” (2012, 128–29). Rather, it entails complex material relations enacted between species’ bodies in lab experiments in which “corporeal equivalence” is constantly reconfigured to accommodate inter- and intra-species specificities and clinical expectations (129). In a similar vein, philosophers Mary S. Morgan and Margaret Morrison

¹²Biochemist and sociologist H. J. Rheinberger (1997) makes a distinction between “technical objects” and “epistemic things”. According to him, “technical objects” hold concrete features and are stabilized and standardized, and therefore they are traceable across time and space as the standard organic or nonorganic devices. According to Mike Michael, Steven Wainwright and Clare Williams’ reading of Rheinberger, the stability of the “technical object” allows researchers to make sense of the “epistemic thing”, which is a locally specific transformation of the technical object that fits in and allows the ongoing experiment to be a matter of “ensembles of experimental systems” and “local epistemic fluctuations” (2005, 378). In other words, a “technical object” embodies all that is known about an animal model, whereas the “epistemic thing” embodies all that is to be known and discovered. Rheinberger (1997) touches upon the simultaneous fluidity and stability of the animal model, but he does not account for the agency of the model.

(1999) write that biological models are mediators: living entities whose functioning can be somewhat independent from all epistemological certainties. Nonetheless, they argue, models are also affected by the theoretical scientific context in which they are embedded. As such, model organisms are as much biological, agential and witty as they are bound to the theoretical hypothesis they represent and to which they contribute.

In thinking about animals in the lab in my thesis, I am inspired by accounts of agentiality and posthumanist performativity in Barad's work. I understand biological models or animal models as autonomous and agential, yet simultaneously entangled with scientific discourses (Barad 2007; see also Holmberg and Ideland 2009, 2012). A humanized animal such as a transgenic mouse or a fruit fly is then not an object, a technology or a singular thing but, as Davies argues, inspired by Deleuze and Guattari (1987), "a series of overlapping vectors, which have direction and velocity, but no singular identity" (Davies 2012, 130). Reading Davies (2012), I also understand the humanized animal as a contingent assemblage or becoming—or, to use Barad's terminology, an agential intra-active phenomenon. In my thesis I do not approach a transgenic animal as "an easily bounded object, an inert receptacle, or simply the human body writ small" (137). Rather, I approach transgenic animals as "random moments of biological emergence" within heterogeneous "possibilities of fact": always uncanny, unruly and agential (Davies 2013, 273).

Modernity suffers the anxieties of mixing between humans and their Others, one of which is the category of animal, which has often been assumed to be internally homogenous within such ideological views. Animals as such have been positioned as inferior and oppositional to humans and therefore raw material for exploitation. In HAS, it is argued that "species differences and boundaries have been drawn up by humans through centuries of speciesist cultural representation so that the borders of the human might be sustained, even though contemporary research shows that these categories (nonhuman, human) are not really sustainable" (Nayar 2014, 79; see also Holmberg 2013). Therefore, on a material and discursive level, feminist animal studies addresses human and nonhuman construction and the performative

power of species boundaries. For instance, HAS scholars deconstruct the category of animal as unified and singular by demonstrating differences between animal realms: some are domestic animals (in Donaldson and Kymlicka 2011), others companion species (Haraway 2008b) and others lab animals (Birke 1994, 2012a). Problematizing the universal category of animal, they show that animals are entangled within a web of social relations, beliefs about animals and the ethics of using animals that enact these animals differently from one another (Birke et al. 2007). They do not argue for animals as a purely social and cultural construction nor a discursive and linguistic category but acknowledge the material components that blur the boundaries of the categories of human and animal.

A new materialist approach aims to position the material inter-species entanglement against the myth of “human exceptionalism” (Haraway 2008b). Thinking with nature makes it obvious that in material ways there is not much that is “human” about humans. As Haraway (2003) argues, the genetic material of microorganisms, bacteria and fungi on/in human bodies outnumber human’s. And as Hird (2009) shows, the precondition of survival of a species is coexistence and cohabitation. “Human nature”, then, as I mentioned earlier, is “an interspecies relationship” (Tsing 2012). The approach I embrace shows material connections and entanglements between life forms, ecosystems and environments “by demonstrating how life forms evolve together, embedded within relational structures” (Nayar 2014, 81). One figuration of such transspecies becoming is the transgenic animal model. As Haraway writes, “transferring genes between species transgresses natural barriers, compromising species integrity”, especially that of humans (Haraway 1997, 60), while testifying to new forms of relations and materialities in the laboratory, renegotiating naturecultures.

In my thesis, particularly chapters 4 and 5, I discuss the transformative relationality through which human and animal models are becoming together within the context of AD in the lab. For example, the insights into the cellular pathways that govern molecular and neural structures—which have revealed a lot about the entangled roles of various proteins, genes and enzymes and how they might

bind or entangle each other in diseases such as AD—often come from transgenic animal models that stand in for humans in the lab. The transgenic animal models highlight the vast complexity of cellular events taking place, potentially in human diseases and bodies as well, enacting biomedical insight into human molecular biology and diseases as a set of constantly recalibrating knowledge practices. Knowledge about human bodies is, then, equally enacted in nonhuman bodies, as they are produced as living test tubes in order to mimic human pathologies.

However, as I show in chapter 5, transgenic life forms such as *Drosophila* evolve with other actors—namely, amyloid protein plaques, Alzheimer’s neurochemistry and human genetics—while being embedded within relational structures such as sociocultural imaginaries about flies that together enact flies as killable. I argue, using Barad’s agential cuts, that human and animal becoming in the lab is a relational process that does violence as a constitutive part of knowledge production, as it enacts particular forms of life as killable. I attempt to discuss the entanglement of structures and relationalities simultaneously with the concept of a spectrum of killability. In my chapter 6, however, I argue that a constitutive part of such transgenic animals and the worlds around them is handling their dead bodies as biological waste.

On theorizing waste and the problem of categorization

Chapter 6 is theoretically grounded within the fields of FTS and STS, as I explain in the following paragraphs. “Creation of garbage is an unequivocal sign of a human presence” (Rathje and Murphy 2001, 10) and as such, understanding, approaching, categorizing and handling waste has been an issue for a long time, for example within anthropology and sociology. I choose the term *waste* instead of other equivalents such as trash because I take my point of departure in my empirical material. As I show in chapter 6, my informants and also the waste management guidelines use the term waste to refer to disposed transgenic organisms in the lab. However, I have to mention that the category of waste has been discussed in many dif-

ferent ways within social sciences and humanities, revealing various characteristics. For instance, philosopher Greg Kennedy understands trash as a “modern species of waste” (2007, 1). Kennedy argues that the difference between the concepts of waste and trash is embedded in the “repudiation of the subjective nature of waste” (1). An object becomes trash once its usability for humans is complete.

In its social, cultural and philosophical sense, waste has often been discussed in terms of value. For instance, regarding cultural and social value, waste has been understood as a “cultural misfit”, or “un-wanted by-product” (Sundqvist 2002, 7). As Kennedy (2007) argues, once an object loses its value, the value that is often assigned to it by humans in the first place, it becomes disposable, and as it is discarded it becomes waste. The association of waste with negative traits such as lack of value, problems and insufficiency has been discussed and criticized by sociologist Zsuzsa Gille (2007). Depending on the discipline and positionality of the person who approaches the question of waste, she argues, waste’s position changes. For instance, whereas a natural scientist may locate waste in relation to pollution in contrast to cleanness, an anthropologist may understand waste in opposition to order and value (Gille 2007). As Gille argues, concept of waste is a context-specific, sociohistorical category with a fluid definition¹³. However, as Hird (2013) argues, such a perspective on waste often leaves its material agency untheorized. I will return to this thought later. But for now, what I take from these scholars is that waste is not a bounded object, fixed in its definition, but ambiguous. In fact, “anything and everything can become waste” (Kennedy 2007, 1), even life and living matter.

For example, feminist philosopher Marietta Radomska (2016) shows in her study of bioart and biophilosophy that once the living models in the lab serve their purpose, they become “useless living” things and as such they are enacted as waste—as disposable, discarded materiality

¹³For instance, she argues the very definition of waste tells tales about social orders, economy and material cultures which in return define waste significantly differently, for instance in Hungary as compared to in the United States. In other words, while waste is mostly associated with hazardousness, something that needs to be disposed and kept at a distance in the United States, in Hungary waste is that which is close to the subject and part of everyday life.

to be handled in restricted ways. Based on her participation in an artistic project in which she took part in laboratory work, Radomska explores the relation between life and waste through care and killing. Staying with relationalities, she writes,

The infected—affected—tissue also evokes a broad sense of the intertwinement of life and waste: how that which has been discarded impacts the living embodiments of both human and nonhuman kind; and how the line between things and processes that are deemed to be “life”, and those that are abundant and disposable, becomes blurred. It is common for organic matter initially framed as “life” to later become categorized as “waste”: this is precisely what happens to the cells, tissues, and organisms used in bioscientific experiments; once their bodies have been experimented on and, subsequently, are no longer needed for research purposes, they become (biohazardous) waste.

— Radomska 2016, 167

On the one hand, Radomska shows in this art project that despite efforts to contain the living tissues and to keep contamination at bay, life appears to be uncontainable matter, as the project gets “contaminated” unexpectedly by fungi. As such, the very materiality, uncontainability and vitality of life (in the form of bacteria and fungi) enacts life (in the form of the bioart project) as waste and therefore to be killed and exposed. On the other hand, the same life form, namely the cells and tissues once valuable to the project as a piece of art, loses its value with the arrival of the fungi contamination and as such becomes waste. Not only are life and waste here understood as relational becoming but Radomska also critically reflects on the relation between killing and waste. In other words, as she argues, “for living matter to be ascribed a value (the status of life) or a lack thereof (waste) often entails further consequences” (167): that of being killed, disposed of and discarded. What I take from the discussion above are three main points: first, the urge to categorize waste; second, the ambiguity of waste; and third, the agentiality and materiality of waste. It is in these three modes that I discuss waste

in my third empirical chapter. In the following paragraphs, I theorize the three dynamics of waste to set the groundwork for chapter 6.

Categorization

As Hird (2012, 2013) writes, waste and handling waste can reveal a lot about cultural imaginaries of what constitutes a human, or a modern civilized human, by drawing boundaries between (bodily) waste and the self-sufficient subject, the pure and the dirty, and stretching to include not only objects and nature, human and animal but also Others in terms of race, religion, ethnicity and gender. Waste is about the politics of categorization. It has often been defined by dichotomies such as efficiency-inefficiency, usefulness-uselessness, order-disorder, gain-loss, clean-dirty, alive-dead, fertile-sterile and, one that is particularly important to my analysis, hazardous-nonhazardous. However, as Gille argues, in reality such dualistic understandings of waste are problematic, because waste is liminal and easily slips in between these dichotomous categories as the context changes (Gille 2013, 1; 2007). Feminist theorists have long discussed the problem of categorization, particularly in hierarchical dualistic dichotomies (Butler 1993), which is relevant for discussions on the categorization of waste, both in its cultural, social and symbolic ways as well as in a material sense.

In chapter 6, I rely on one of the well-known works of anthropologist Mary Douglas, *Purity and Danger* (1966). I start by showing that laboratory waste has a particular meaning according the guidelines in the lab. I show that biological waste is always categorized based on assumptions about the danger of waste—that which can leak and contaminate if not contained and handled carefully. I borrow Douglas's argument about social order and waste. As she writes, "matter out of place", such as dirt, is often approached as dangerous because it threatens the social order of which it is a part. As such, matter out of place triggers actions: to retrieve the social order, it needs to be contained. However, as I argue in chapter 6, it is not social order as such that is assumed to be threatened in the lab but that which is understood as nature outside of the laboratory.

I already argued, referencing Radomska's (2016) work, that the

very definition of *contamination* is situated within a binary logic of separation and containability, which is an illusion. Hird (2012) argues that waste is not simply a symbolic, discursive, cultural or social product but material and performative (see also Viney 2014). Yet again, it is also the materiality of waste that brings about the im/possibility of categorizing waste once and forever. Life is simply uncontainable (Radomska 2016), and biological models are agential and interact with the experiment and their surroundings in unexpected ways. As sociologist Knorr-Cetina writes, “the machinery used in molecular biology is largely the life machinery of the cell and of the organism” (1999, 93), which has its own agency, often surprising scientists. It is at this intersection of life, or living matter, and its agentiality that laboratory regulations strictly inscribe the form of handling waste by introducing several laboratory waste categories. Based on the level of their “hazardousness”, there are guidelines for each of these waste categories to be handled differently. However, as I show, such clear-cut categories fail as the agency of transgenic fruit flies’ bodies and realities, as well as the practicalities of everyday laboratory work, disrupt these categories.

Ambiguity

Categorization of waste in the laboratory is often grounded within a discourse of contamination and hazardousness, in which *risk* refers not to the disruption of the social order (Douglas 1966) but to a material risk of contamination (see, e.g., Radomska 2016). This discussion folds around the risk of contamination (rather than being situated in contamination as a condition of life). It is grounded within the fear of the uncontainability of life itself, which triggers action: to contain that which can contaminate life, namely waste.

Once thinking with practices of knowing and handling biological waste, it becomes clear that the boundaries of waste as a particular kind of waste, or the ontology of waste, become determinate only in relation. I use Barad’s (2012b) term *in/determinacy*, discussed earlier in this chapter, to show that the ontology of waste is an *in/determinate* materiality that becomes determinate once agential

cuts are made and relations are bound in everyday practices of knowledge production. As Hird argues, “knowing waste” and the ways in which one interacts with waste in order to define it and to make knowledge about it—cut the boundaries of waste in situated ways, determining what it is (2012, 454). She writes, “Knowing waste is, in other words, about rendering indeterminate entities determinate” (2012, 454). Waste as such is not a unified category but in/determinate (both epistemologically, as a matter of knowing waste, but also ontologically, as Hird argues for its materiality).

Waste as matters of practice

While the meaning of waste—its philosophical, cultural and symbolic importance—has often been discussed, waste has not been much discussed in terms of practices. Once discussed in relation to practices, it is often the management practices of handling waste that are at stake (quoted in Gille 2010). My approach to practices is different than that of management practices, as I have already discussed. In other words, I approach practices of handling waste as relational and performative of waste categories. In this framework, to think with practices, categories do not exist before relations or before practices. Categories of waste are performed as scientists handle waste in situated ways. Waste is then *a matter of practice*. Waste reveals the problem of categorization, highlighting that categories are always partial, particularly if one takes practices of handling and knowing waste as the ontological unit (Hird 2012). Waste is always ambiguous; it is material as well as symbolic; it is socially and culturally constructed, as it is closely linked to notions such as human and nonhuman, natural and unnatural.

To recap, handling novel forms of transgenic organisms, animal models and living creatures or infectious bacteria as various kinds of (laboratory) waste is quite specific to our time and therefore in need of careful rethinking. I show how handling waste gives shape to and problematizes the existing categories of biological waste as the material agency of the transgenic fruit flies takes over. I argue that the ambiguity of waste in the laboratory is not only a (social and cultural) construction, and neither it is purely epistemological—

it is also material. The indeterminacy of waste is not only due to its cultural and social liminality but also waste's own materiality. Relying on Hird's (2012) and Barad's (2012b) concept of in/determinacy instead of ambiguity, I aim to show the material and discursive becoming of waste in the laboratory. In Barad's and Hird's perspectives, nothing is ontologically fixed, detached and closed, once and for all. Rather, the world, entities, bodies and humans are always already a matter (discursively and materially) of relatedness and constant transformation in their becoming with others. As such, there is no dichotomy but only "intra-actions" (Barad 2007, 2008, 2011). There is no nature-culture binary, but there are "naturecultures" (Haraway 1994, 2003). There is no human that is a closed, detached, rational, singular subject. There are only nonhuman hybrids, composites, material and discursive entanglements and becomings. As I write about the ambiguities of waste as a category, I draw attention to the situated material and discursive practices through which such categories are produced instead of discussing the category of waste as fixed.

2.4 Conclusion

In this chapter, I started by briefly introducing the fields of study relevant to my thesis—gender studies, FTS, STS, and HAS—which I, following Åsberg et al. (2011b, 2011a), referred to as posthumanities. I argued that a similar theoretical approach, flourishing within posthumanities and counter to both positivism and cultural relativism, is a turn to materiality that has been theorized under many different terminologies. Following Dolphijn and Van der Tuin (2012), I chose the term new materialism, which accounts for the legacies of gender studies and STS that gave rise to it yet highlights their differences. Namely, new materialism involves a different reading of the older canonical works: one that understands materiality and matter not in terms of materialization of discourse but as agential. I introduced Barad's agential realism as a theoretical framework within new materialism as my main theoretical approach. Next, I grounded

each empirical chapter of this document exclusively in one or two of the above-mentioned fields of scholarship and in relation to new materialism.

I argued that my discussions about animating AD and performing death (chapter 4) and waste (chapter 6) are grounded within STS and the ontological politics of turning to practice, which I referred to as matters of practice. Reading practices within STS and agential materiality from new materialism, I argued that I approach AD and death in the laboratory as a reality performed by human and nonhuman actors in inseparable ways. Relying on FTS analysis of life itself, I situated my discussion of death itself. As such, I discussed that I approach death in the lab as a phenomenon performed by both humans and nonhumans. I also situated my take on waste within the same theoretical framework, arguing that I will be discussing waste as matters of practice. Last but not least, I situated chapter 5 within HAS. I outlined that I will use the Baradian analytical concept of agential cuts to show how killability is a phenomenon in the lab that is materialized in intra-action. As such, I aligned myself with the work of HAS scholars, who acknowledge the animal as agential, rather than passive, yet embedded within structural power relations. This will have ethical and political implications for chapter 5, because as I argue the ethics that such an approach advocates is not one of animal rights discourse but one of relationality.

Methodology

My research is interdisciplinary and therefore it collects methodological inspiration from a number of disciplines. In this chapter I will discuss my methodology, which consists of a feminist laboratory study inspired by gender studies, STS and anthropological methodologies. Laboratory study, as the anthropologist of science Amade M'charek phrases it, is "an ethnography of scientific practices" (2005, 4). In her study of the genetic diversity, she writes, "Genetic diversity is not an object that lies waiting for the scientist to discover, nor can it be treated as a construct of scientists. Genetic diversity is enacted in a complex scientific practice. It is not only dependent on the scientists and DNA but also on the various technologies applied to produce it" (4). In other words, as she suggests, in order to understand the complex dynamics and realities of such a project, one needs to attend to the details and the day-to-day practices in a laboratory "in which humans, samples and technology are aligned to produce the stuff of which the power and prestige of science is made" (4), leading to my understanding of an ethnography of scientific practices as a methodology to investigate how knowledge comes about in situated relational entanglements. This methodology also enables the social scientist to analyze how such situated and partially produced knowledge shapes the contemporary understanding of life sciences, with specific social and political implications. As I discuss in this chapter, in my study of Alzheimer's disease (AD), I also use an ethnography of scientific practices as my methodology in order to

touch upon the complexities of AD in the lab and to analyze how the alignment of humans, animals and technologies in my fieldwork shape AD and the worlds that come with it.

Anthropology and feminist studies have always been entangled. As feminist anthropologist Marilyn Strathern (1987) argues, the very fascination of anthropology with kinship and reproduction was one of the main entry points for feminist intervention, which has played a crucial role in reshaping anthropological epistemologies. As she argues, referencing Judith Stacey and Barrie Thorne, feminism has achieved a paradigm shift in anthropology: not only did feminism succeed in changing the “existing conceptual frameworks” in anthropology, but others in the field have adopted these changes and transformations (279). For instance, ethnography has been *traditionally* understood as a representationalist methodology; she writes that ethnography was conventionally understood as the accounts of a distant observer writing about experiences in the field they once visited (Strathern 2004). She further argues that such a separation between the subject and the object, on the one hand, and the separation between the field and the research outcome (as though the field is somewhere external from and outside of the research), on the other, constitute the problem of representation. Finally, she suggests that the field is not an external place scientists go to in order to collect objective data as disembodied people. Rather, as researchers collect data via methods such as participant observation, narrate and write about that which they have collected, intellectually reflect on and describe their material and experiences, and interact and communicate with her surroundings, they are indeed partially making the field (2004).

The field as such is a mingle of methods—enabling fractional data collection in subjective modes, narrations and descriptions, experiences and emotions, and interactions and communications—through which the field research is partially shaped. In this sense, the field is one in which the reader, writer and informants are part of the process of knowledge production together. The fieldwork is then a transformative process of knowledge production that is embodied and lived as much as it is intellectually narrated and written. I will write about writing and its relation to ethnography later in this

chapter. For now I will mention that today, feminist ethnography is grounded within more embodied and relational understandings of doing research than representationalism, which retains the problematic dichotomies of object and subject, internal and external, nature and culture. I ground my study in such a feminist ethnographic tradition.

Strathern (1987) argues that anthropological approach is fluid enough to have allowed it to become part of other disciplines, such as sociology and gender studies. Anthropology, which was once the study of exotic cultures in a distant place, has not only evolved and changed within the discipline itself but also been adopted by, for instance, social scientists, sciencey, technology and society (STS) scholars and feminist technoscience studies (FTS) scholars, among others. For decades, anthropology has been practiced in the study of medicine and medical cultures. This is known as medical anthropology (see, e.g., Rapp 2001; Lock 2001). Another famous implication of anthropology is that of the anthropology of science, which often studies laboratory practices (see M'charek 2005). STS scholars Bruno Latour and Steve Woolgar refer to the anthropological study of science as "quasi-ethnography", which is a "kind of anthropological probe to study a scientific culture" (1979, 12). Anthropological studies are done in many ways; in my study I use an interdisciplinary methodology situated within anthropology, gender studies, and social studies of science and medicine.

Last but not least, ethnography today as a cross-disciplinary method has changed anthropology from the study of distant cultures into a methodology for studying social and cultural context, at "home" where a laboratory in town can be a curious place. An ethnographer does not need to move to distant, unknown places to collect novel data—that is the colonial legacy of knowledge production. In a colonial mode of doing anthropology, as anthropologist Barbara Tedlock critically reflects, the "intellectual value was placed on travelling to distant places in order to study and reconstitute a humane order out of devastation and disorder" (Tedlock 1991, 69). Such a problematic understanding of ethnography is embedded within the oppositional binaries and hierarchical relations between "objectivity and subjectivity, between scientist and native, between Self and Other, as an

unbridgeable opposition” (Tedlock 1991, 71). In this position, the researcher is—if not appropriating—representing that which is Other to him, that which is crucial to his identity yet not the same; it is a position in which the knowledge produced by the researcher holds authority over relative Others in terms of gender, race, ethnicity etc. (see Harding 2008). Today, however, ethnography also encompasses a genuine curiosity about how things can be otherwise.

This study, following such a genuine curiosity, aims to explore the question, what is it like to be in a modern science lab? I take inspiration from the work of above-mentioned scholars, as I understand ethnography as a method that shares epistemological, political and ethical grounds with fields of study such as feminist studies. If one is curious, as I am, about learning and pushing the boundaries of conventional knowledge, the very space of a laboratory around the corner from one’s home or the local hospital can be interesting, unfamiliar sociotechnical and cultural settings in which multiple realities are performed and unprecedented and complex social arrangements are made (Agic 2012; Mol 2002). Science and medicine are sociocultural practices and therefore of interest for an ethnographer as well as for a feminist social scientist like me. I chose ethnography for conducting my research because it inseparably ties together methods such as participant observation, writing, embodiment, and knowledge (see Hammersley and Atkinson 2007; Strathern 2004; Tedlock 1991; Hammersley and Atkinson 1983). Therefore, in the rest of this chapter, I will write about and discuss these intertwined components of ethnography, which are crucial and which I use as building blocks for my research.

3.1 Making of the field

As it is often the case with PhD students at the beginning of their project, when I started my fieldwork in January 2012, I did not have a very clear vision of what my thesis would be. I was five months into the first year of my PhD studies. Having been trained as a feminist STS researcher with some background in the sociology of health and

disease, by the time I started fieldwork, I knew I was interested in knowledge production, scientific practices, bodies, power relations, medicine and technologies. I was particularly interested in AD, not only personally, as my grandmother was suffering AD at the time, but theoretically. AD is not only a disease in the making but also a science in the making. It is a disease that is in the process of meaning making and mattering, as cultural imaginaries about it constantly shift and transform, clinical diagnostic measurements change and scientific facts about the disease are made, produced and simulated in laboratories across the globe. It is a disease that has created sociocultural anxiety all over the world, particularly in the West¹ (Cohen 1998; Lock 2013). Science in the making and sociocultural anxieties are interesting phenomena for a feminist social scientist. As I began my fieldwork in the lab, I was looking to understand how AD is produced in the everyday practices of a laboratory. What are the main practices with which AD is imaged, produced, theorized, made?

Meeting my gatekeeper

I planned to start my data collection as soon as possible, in the early stages of my project. I met Karin, my supervisor in the lab, for the first time by accident. It was lunchtime, November 2011, and I was coming back from the university restaurant with a packaged hot meal in my hands, running through the entrance of thematic studies department, when I came head to head with Karin and Cecilia, my PhD supervisor. Cecilia cheerfully introduced us: “Karin, this is Tara, my PhD student I was talking about. She is interested in Alzheimer’s disease”, and “Tara, this is Karin. I told you about her and her amazing work with Alzheimer’s and [transgenic] fruit flies”. I could feel my fingers tingling and hear the scream in my head: “Here

¹AD creates cultural and social anxiety not only because it is a deadly disease but because it disrupts Western ideals about humanness—about the wholeness of the human subject, who is assumed to be rational and in control of their body. Such a problematic relation between AD and its cultural imaginaries is most obvious in drug advertisements targeting AD patients, on which Cecilia Åsberg and Jennifer Lum (2009) critically reflect.

is your chance, take it!" And I took it. After greeting her and quickly introducing myself and my project, I asked if I could join her laboratory crew to learn more about AD and how they practiced science. In the spirit of feminist collectivity, with which all three of us identified, Karin generously invited me on board. However, she had a surprise for me. She told me she was short a technician for a new project she was launching. She offered to train me and proposed that I help the team and work with them during this project rather than observing. I immediately accepted. I figured I would think about the methodological implications of this new arrangement later. We set a date, and I said goodbye and turned back toward the lunch room. Just like that, on that November day and at the entrance of the department, I became a participant observer in the fly lab. My food was cold.

Participant observation as a method

In a sense, all social research is a form of participant observation, because we cannot study the social world without being a part of it.

— Atkinson and Hammersley 1994, 249

As sociologists Paul Atkinson and Martyn Hammersley (1994) argue, to study a social and cultural world one needs to become part of it, which they refer to as the participant-observation method. Becoming part of a social world has no singular recipe. It can be done in many ways and take on multiple dimensions. What is always evident, however, is that becoming part of a social world and doing participant observation is a transformative process, because it is about creating knowledge, and by creating knowledge the world is already changing. As feminist technoscience scholar Donna Haraway says, "nothing comes without its world" (1997, 137). Participant observation is also a transformative process for the researcher. In what follows, I tell the story of how I became part of laboratory life during my year of participant observation.

Participant observation has been a crucial part of ethnography research and a key method for data collection for decades (Atkinson

and Hammersley 1994). Tedlock notes that participant observation has been discussed in different ways—for instance, the conceptual paradox embedded in the words *participant* and *observation* that come together as a method has been one of the critiques posed toward it. Referring to anthropologist Paul Rabinow, she cites the contradiction as being that participation indicates getting involved and emotionally invested in the field, and as such it is a subjective position that indicates subjective knowledge. On the other hand, observation has in itself the promise of objective knowledge and requires researchers to distance themselves and become observers. Social anthropologist and medical ethnographer Haris Agic (2012) writes that participation indicates that researchers are immersing themselves in daily rituals as insiders, whereas observation implies that they are standing in the distance as outsiders and watching the subjects' behavior. However, as Agic argues, the reality is more complicated, and even though two parts of the concept of participant observation seem to be at odds with one another, in reality they are not as separate as they seem to be. He writes, "My experience was that I observed through participating and participated through observing—there was no clear-cut discrimination among the terms" (2012, 76).

As I discussed with Karin on that November day, I would not only observe the scientists but practice biochemistry. I was about to become a member, to become a part of laboratory routines. I was to interfere with and enact alternative modes of meaning making about AD in partial, situated ways, not only as I was collecting, narrating and writing about my experiences in the lab from the position of the feminist ethnographer but as I was performing science, working with the transgenic fruit flies and doing experiments. I was to become a participant observer. To borrow Agic's understanding of participant observation, during my fieldwork, I did not simply observe, or reflect, but I "observed through participating and participated through observing" (2012, 76).

As the result of immersing myself in fieldwork and becoming a participant observer, my research questions and my project changed as I entered the lab. Indeed, the very nature of ethnography means that there is not much control over the research process (Gleisner 2013).

Doing ethnography means being open to the unexpected during research. Therefore, a research project is continuously changing and shifting once in the field (Agic 2012), as my research did. Initially I was interested in inspecting how knowledge is produced in the lab and transferred to the outside world and how it shapes humans lives in unexpected ways. However, when I entered the lab, I got stuck there. Mesmerized with the presumably ordinary, quotidian practices in the lab, I came to realize how such routine practices are anything but ordinary. I got stuck in the lab for almost a year, and I devoted my dissertation to discussing how AD is made in the lab in ways that involve more-than-human subjects, rather than focusing on how AD travels outside of the lab into the realm of the popular culture. I became fascinated with the entanglement of humans and nonhumans in the lab, namely the animal models and technologies through which AD was being performed.

Another aspect of my project that changed through my work in the lab was a shift from the focus on AD to the ethics and politics of knowledge-production practices within the context of AD. Even though knowledge-production practices remained one of the main threads in my thesis, I changed my lens from the disease itself into the worlds that are made and prevented by practices of meaning making about the disease in the lab. For instance, the kinds of animal models that are made and are killed and the categories of biological waste that are enacted in the lab became part of my research. The overwhelming presence of death in the lab—for instance, the large number of dead and dying transgenic fruit flies, the animal model of choice in the lab—eclipsed the possibility of any other questions being as pressing. How death is made, materialized and arranged within the everyday practices of knowledge making about AD became central to my project. How different forms of life, for example flies and mice, become killable differently in the lab turned into *the* question for me to write about.

3.2

Feminist laboratory ethnography: Embodied subjectivity as the only way to be objective

The laboratory is interesting to me as a feminist STS researcher because it implicates sociotechnological dynamics and processes, power relations and human-nonhuman relationalities. It is a space in which realities, bodies and identities are made in ways that are entangled with social, political and cultural aspects (see Traweek 1988). As FTS scholars show, scientific facts are often made in the laboratory in racialized, sexualized and gendered ways not always visible to natural scientists and therefore in need of feminist engagement (see Fausto-Sterling 2005; Haraway and Goodeve 2000; Schiebinger 2000).

Moreover, I am interested in technologies, and a laboratory is a promising place in which I thought I could get insight into technological complexities and the relations, realities and meanings that such complexities generate in the context of AD. In the end, however, there were none of the fancy technologies that are often used in clinical settings for AD diagnoses like a PET-scan or an MRI as I had initially hoped for. My fieldwork took place in humble science laboratory. It was not at all like what I had in mind. Reading about “laboratory life” (Latour and Woolgar 1979), I expected a flow of scientists, papers, books, machines and more. The lab, instead, was a “bench laboratory” (Knorr-Cetina 1999, 36), with two interconnected rooms, approximately two by three meters. The first room was the entrance to the lab, with a small sign by the door saying, in Swedish, “Fly Lab”. It was a modest, quiet space, empty of human actors’ active presence. It was only machines and *Drosophila*. The traces of human actors were obvious though. The white coats hanging on the wall, brushes and boxes with name tags on them, and trays full of carefully labeled fly tubes on the shelves all attested to the human presence, not to mention the microscopes and computers or guidelines pinned on the walls. Even in their absence, humans were present in the labor that was done in the lab.

On my arrival, my lab supervisor, Karin, a biochemist, explained that aside from me, three people used the lab: herself and her two PhD students. She showed me a schedule to fill in in advance to

indicate when I was going to be there, because the lab was so small. There was not enough room for all of us at once, nor were there enough technical apparatuses. They arranged the schedule so that there would be maximum three people in the lab simultaneously. She told me that after my training, I would be there on my own without much human contact. We would meet, of course, if I had questions.

The first lab room, had two big noisy incubators on the right and a smaller one next to them. At the far end of the room was a small refrigerator. Another big incubator was on the left side of the room, next to the sink. White coats hung above the sink. Each incubator indicated a different temperature—18°C, 21°C, 25°C and 29°C—and in each there were trays of fly tubes. The fridge, though, was full of food tubes, tubes with a premade food for transgenic fruit flies which was often a mixture of yeast and sugar and sometimes some added medicine for experimental reasons, ready to host new flies. There was no fly tray in the refrigerator. I realized that temperature mattered here. The room was about “becoming with” (Haraway 2008b) the temperature. It was the place we would keep the transgenic fruit flies in closed vials, carefully contained. But it was not where the scientists worked with them. The first room was connected to a second room by a door.

In the second room, on the left side, there was a table with a computer. A box was placed next to the computer which, I realized later, was an imaging measurement device. On the right side of the room was another table with a giant microscope on it, one that I was not authorized to use. On the far end was a smaller microscope that I could use. And the third microscope stood on the table across the room. There were shelves all around the room with trays full of fly tubes with *Drosophila* crawling on top of each other in them, larvae and pupae. Transgenic fruit flies were everywhere; as the sign on the door indicated “Fly Lab”, flies were indeed the “work objects” of the lab (Casper 1998). This room was the room where scientists would do most of the labor, performing daily scientific experiments. Karin reminded me to close the middle door between the rooms at all times to prevent transgenic fruit flies from escaping the lab, as these flies were genetically modified. I realized the first room was

also a mediation, a safe room. Should a fly dare to escape the second room, it would be contained in the first.

After my first visit to the lab, I realized I had to expand my understanding of technology. Through weeks and months of working there, I learned to appreciate the old noisy incubators in the lab, which were used as a technology to engineer reproduction cycles in the fruit flies. I learned to appreciate the simple tubes as an essential artifact in breeding *Drosophila* and keeping them in stock. The scope and advancement of technological complexity in the fly lab may not have been as shiny and glamorous as giant laboratories in other parts of the facility, but it was equally alluring and exciting for me. The simplicity of the laboratory was also because of the specificity of the workers' chosen animal model, *Drosophila*, which brings me to the next point: the relation between subject and object in feminist ethnographic research.

Attending to the complex relations between the object of study and "researcher subject" has been one of the antidotes to positivist or relativist methodologies as well as to Eurocentric, misogynist and speciesist epistemologies (Lykke 2010a). As such, to understand and approach science as a multilayered procedural, cultural phenomenon that goes beyond the human informs a feminist methodology (Haraway 1997, 1991, 1989). In other words, feminist ethnography attends to the relationship between the ethnographer and the object of study. Often ethnographers are warned against a phenomenon known as "going native" (Malinowski 1922), implying that the ethnographer should get close to the object of study but not close enough to lose objectivity. The phenomenon of "going native" is linked to the problem of positivism. In other words, within conventional anthropology, in which the research is out to represent the Other, too much closeness can contaminate and threaten the rigor of the data collection by obstructing scientists' objectivity. This view, however, is not what I referred to when I discussed attending to the relation of the object and the researcher subject. I do not think that object and subject are separated. Rather, I am talking about what (Haraway 1988, 1991) calls "situated knowledge".

Situated knowledge and objectivity

So, I think my problem, and “our” problem, is how to have *simultaneously* an account of radical historical contingency for all knowledge claims and knowing subjects, a critical practice for recognizing our own “semiotic technologies” for making meanings, *and* a no-nonsense commitment to faithful accounts of a “real” world, one that can be partially shared and that is friendly to earthwide projects of finite freedom, adequate material abundance, modest meaning in suffering, and limited happiness.

— Donna Haraway 1988, 579

Situated knowledge is an epistemological take against scientific positivism on the one hand and cultural relativism and social constructivism on the other hand. It challenges disembodied scientific objectivity and the view from nowhere which is an infinite vision laying claim to true knowledge about nature only achievable by scientific methods and gaze. Haraway calls it the *god-trick*. Situated knowledge also challenges the cultural relativism and social constructivism which understand nature as immaterial, and in terms of rhetoric of nature. What is at stake, according to Haraway, is to deconstruct “the truth claims of hostile science by showing the radical historical specificity, and so contestability” of scientific knowledge but also genuinely engage with science, materiality and the agency of the world rather than abandoning it. She writes that feminists need the power of “modern critical theories of how meaning and bodies get made”, not to deny them but “to build meanings and bodies that have a chance for life” (1988, 580). So, what is at stake in situated knowledges is not only taking responsibility for “what we learn how to see” (583) but also which technologies, mediation and translation devices we use to form a locally situated vision. Haraway suggests situated knowledges as a form of feminist objectivity (581). Situated knowledges implies that knowledge is as much a social phenomenon, embedded in a specific cultural and political setting, as it is material. Through situated knowledge, Haraway argues, feminists can claim the vision, not in terms of scientific gaze and the

transcendent knowledge that denies its limits and responsibility, but visions as embedded in a body, and sociopolitically situated, which then affects what is seen and what is excluded from the vision. In other words, while the vision, according to Haraway, is all visions, it is not the vision from everywhere. It is a vision that is partially located in terms of the apparatus of knowledge production—namely semiotic technologies and theories as well as measurement devices and technological apparatus—and the sociopolitical context in which the knowledge is produced. It includes all the nonhuman others like lab animals or optical devices that forge the knowledge produced. Situated knowledge has methodological implications, for example in terms of an understanding of objectivity against the position of the modest witness and the separation of object and subject. She criticizes the position of the “modest witness”, which was suggested by the modernist and positivist sciences as a position in which the subject and object are separate (Haraway 1997). The position of the modest witness is then that of the disembodied scientist, detached from their context, doing science from nowhere, which has been understood in such traditions as “objectivity”.

As feminist cultural studies and feminist technoscience scholar Nina Lykke argues, “the researcher is involved, in compliance with and co-responsible; and knowledge production will always imply a subjective dimension” (2010a, 5). Science is a storytelling practice, as Lykke argues with reference to Haraway, because “the researcher cannot produce an objective depiction of the world ‘out there’, but produce a story, of which she or he is a part” (5). Situated knowledge is, then, a position from which the researcher gives an overall description of her “sitting”, meaning her historicity and political selves, and “sighting”, meaning the material-discursive technologies she uses to produce knowledge (quoted in Lykke 2010a, 152). As Haraway (1991) argues, situated knowledge is the only way to be accountable and objective and to avoid the god-trick, namely a position of talking from out of nowhere.

To take situated knowledge seriously changes the concept of the modest witness. Being modest becomes something different. One can argue that to be modest is to be accountable to the sitting and

sighting of the researcher and their entanglement with the object of study. Modesty is, then, to embrace the limits of knowledge production not as something external but as something that is the condition of possibility for knowledge production in the first place. In other words, to produce knowledge one needs to make cuts, and those cuts are the limits of knowledge, because knowledge as such is always partial. Situatedness enfolds the social, material and literary technologies of knowledge production while proposing embodied and marked subjectivity as the necessary foundation of objectivity and the only way to avoid not only the god-trick but also relativism. To think about situatedness is, then, to think about how knowledge is a relational phenomenon, in which object, subject, field, technologies, historicity, politics and culture are performative of knowledge (see also Barad 2007).

3.3

Becoming a participant observer: On embodiment and research

For a researcher to be accountable and to conduct research in ethical and responsible ways, as Lykke (2010a) writes, they have to contextualize not only the object of research but also the researcher subject and how they relate to one another during the course of the study, for object and subject are always entangled. In other words, participant observation is not only about keeping a diary. It is a transformative process for the researcher (Coffey 1999; Wolf 1993). It is about taking a role, following and doing precise rituals, speaking a particular language, wearing the white coat. It is about joining the crew (Agic 2012). It is about making oneself useful (Latour and Woolgar 1979), being transformed, becoming someone else. In the next part of this chapter, I will try to situate myself as the researcher subject and tell my story of becoming a participant observer.

Entering the lab

The first time I visited the lab, I got lost en route in the maze of the science department's hallways. Nevertheless, walking in a long corridor lined with taxidermied animals on stands up near the ceiling, with labels indicating their species, gave me the sense of being in the biology unit. Looking down at me, the lifeless bodies of the animals, cleaned up and gracefully tamed, ironically represented wildlife. Finally I arrived at the lab. A small sign on the door indicating "Fly Lab" confirmed that I was in the right place. I waited couple of minutes for Karin to arrive. As a new part of the team, I had to be registered in the department's data base as a "scientist". Interestingly, the registrar's office employee identified me as a scientist in the department, not because I was a gender studies researcher but because of my newly established semiaffiliation with the biochemistry lab. I became a scientist through what I was about to do. Doing science in the lab and working with transgenic fruit flies enacted me as a scientist in the registrar's office more than did my education background and affiliation with gender studies. Being a scientist indeed had its local parameters, while being a gender studies major did not mean as much in the registrar's office; working with these flies in the lab fulfilled the criteria of being a scientist.

Entering the lab—and the field—was simple yet complicated. Becoming a scientist as such was as simple as signing some papers and getting my lab card and the key to the lab. I entered the field just like that. It was complicated because if it had not been for the coincidental overlap between the laboratory's lack of budget, my uncanny interest in AD and in flies as a feminist researcher, and my supervisor's connections with my lab supervisor, I could not have entered the lab as easily as I did. Because of these coincidences, I got access to the lab, and I also became a participant observer. However, this was just the beginning. I did not know that I would keep that position for almost one year, during which at times I visited the lab every day, sometimes even twice. At other times I went there couple of times a week. Sometimes I spent twenty minutes quickly checking on the transgenic fruit flies and moving them between the room temperature in the second room and the incubators located in

the first room. Other times, I spent hours in the lab, even half a day, collecting them or video recording them (see chapter 4). At the end of the project, during some of my final days in the lab, I was generously told that I could contact staff and go back anytime: an open invitation that I exploited a couple of times until the very last stages of my project.

Learning the language: On becoming liminal

The first thing I picked up on, upon my arrival, was that I had to learn the language of the lab. Of course everyone was speaking English instead of Swedish for my sake, but that did not help me much. Scientists in the lab had their own language. I read books and many articles, which were to some extent helpful but also confusing. I read lab reports often written in Swedish, and with my limited knowledge both in biochemistry and in Swedish, reading those lab reports was like decoding ancient treasure maps and manuscripts from another planet. I talked to people every single chance I could get, in the lab or in the coffee room. When I was going through my notes, I could see the same questions coming up over and over, on different occasions, because I simply could not grasp the meaning of the words I was hearing. I had to learn the language! I had many talks with Mona, my flatmate who was a medical student, over the dinner table in our collective. We would push the plates away after dinner for some space on the table; she would bring a pen and a paper and draw molecules, cellular structures and protein structures; she would explain them to me patiently and I would ask questions.

Even though I had problems with getting the exact meaning and implications of what I was doing in the lab, the work itself was pretty routine and mechanical. Of course, jumping into lab life completely had its advantages. Living it. It was productive to immerse myself in everyday practices and experience how a graph or protein images are produced out of thousands of *Drosophila* (see chapter 4 and 5). Often, I would manage to do it correctly because I had learned the steps and the tricks without knowing what I was doing and the meaning behind the routine practices I was performing. Not that I thought I could gain

proper knowledge on advanced genetics and biochemistry in couple of months, but it was frustrating, and I was becoming obsessed with biochemistry, the genetic matrix and the graphs. It was only months later that I realized I did not need to know everything in order to complete my own project.

One evening, when I was going through some of my notes, I realized that sometimes scientists in the lab did not know all the details either. The lab was an interdisciplinary context, and even though the scientists all shared common knowledge, they didn't always know the details of each other's work. They could give me an advanced, detailed explanation of what they were doing, but when I asked about other projects in the lab I could easily get an "I don't really know" or "I guess ...". Moreover, when I asked Karin about the genetic processes through which the transgenic fruit flies in her project were made, she simply told me she did not know all the details because she was not a geneticist, and that was why she ordered them from a different laboratory. When I asked about her vision for the results of her experiment, she said, "Well, if we are lucky we get a result. Otherwise we have to start over". My point is not that scientists in the lab "lacked" knowledge. My point is that knowledge is always partial. It was not only me who "didn't know it all" because I was an outsider. Situated knowledge was the name of the game in the lab.

This experience also made me realize that I was there not to perform biochemistry research but to do social science. I learned to remember my own limits and to work within those limits—that those limits are always intact not in terms of lacking something but as the reality of partial knowledge. I had to acknowledge that limits are productive rather than restrictive. I found myself in a limbo of knowing and unknowing, and I came to terms with being in a liminal space in which I could develop a limited understanding of AD and biochemistry that was specific to the project I was working with rather than absolute. I had to find a balance between understanding the rituals and goings-on in the lab and not fully grasping every detail. I had to learn feminist objectivity and practices of situated knowledge. I had to become a feminist embedded, embodied participant observer.

On becoming fly-sensitive

Participant observation, in this project, also involved learning to be embodied. Not only did I observe, learn the language, master the techniques and join the crew but I learned how to use my body in different ways, as well as to trust and follow my senses such as vision, sense of smell, touch. As anthropologist of science Natasha Myers, argues, molecular biology and protein modeling needs the technicians to “engage their bodies actively in their work” (2015, 1). She calls it the “kinesthetic” of practicing molecular biology which is “the visceral sensibilities, movements, and muscular knowledge that modelers bring to their body experiments” (1). In participating through observing and observing through participating, I experimented with the transgenic fruit flies and as such, as I explain in the following paragraphs, I had to engage my body actively and kinesthetically.

One of the first things I learned in the lab was to work with the microscope to tell the sex of the flies. The first time I looked into one, I was disoriented. I had to sedate the transgenic fruit flies and put them on a plate under the lens. I used sedation to make them still so that they would not move away. However, sedation was risky for the flies. It would have killed them if I had them sedated for longer than I did. After sedating them, I had to collect the transgenic fruit flies under the microscope using a brush, then move them around with it so that I could get a good look at their bottoms to see if there were male or female.

Collecting ten flies out of the pile of fifty (sometimes up to a hundred) sedated flies with a brush under the microscope was indeed an embodied action. It enacted me as the AD technician in the lab as much as it enacted the transgenic fruit flies under the microscope as objects of exploration. I had to learn how to synchronize my hand, holding and moving the brush and pushing and pulling the flies with it with the right angle and amount of pressure so as to avoid squashing them or knocking them off the plate². I had to learn to coordinate my hand movements with my vision while looking through the microscope, which was far from familiar. And I had to

²The plate was constantly releasing nitrogen to keep the flies under sedation. Once moved away from the plate, the flies woke up quickly.

learn to see and recognize the “right”³ transgenic fruit flies quickly. In other words, and as feminist sociologist Tora Holmberg (2008) writes, handling the nonhuman in the lab is a matter of embodiedness and habituation. As such, technicians or “experimentalists-in-the-making must [...] become habituated to the laboratory animals. To get the right grip, [they] must get to know the animal” (322). I had to get habituated to the transgenic fruit flies, their bodies, their movements and their bodily vulnerabilities. Furthermore, I had to get habituated to the practices of working with the flies as well as to my own extended body: to my new vision and to my extended hand with the brush. I had to care for the flies not only in terms of mindfulness but in material ways, as I touched them, looked at them and poked them with the brush under the microscope. I had to become *fly-sensitive*.

Becoming fly-sensitive is important for my research for the ethical reasons and methodological implications I discuss in the following paragraphs. It stresses that science is always embodied. Using the concept of becoming fly-sensitive disrupts the positivist imaginary of the male scientist doing scientific practices in the vacuum. Through stressing the embodied position of becoming fly-sensitive, I attest to the bodily materiality, specificity and situatedness of the scientists as well as the flies. This approach demonstrates that science is produced not in the distance but in proximity to bodily encounters, when the intensity of scents, touch and vision become the constitutive part of scientific facts. Becoming fly-sensitive brings to the fore an alternative mode of scientific practices that is different from modernist ways of doing science. In other words, claiming the position of becoming fly-sensitive helps me to move away from the ideal of progressive scientific discoveries accompanied by narratives and practices of domination, conquering and exploitation of nature as passive and inferior. To work through the embodiment and situatedness of scientific practices in a fly lab underlines the importance of feminist modes of doing science and care. It highlights the existing power relations that are constitutive parts of everyday practices of doing life science and the facts produced in the laboratory. Last but not least, it supports the argument that care is not innocent but care and caring

³Those with the exact genetic combinations I needed.

for the transgenic fruit flies is also entangled with killing (see, e.g., Holmberg 2011) and embedded in a relation of use (Haraway 2008b). In such an economy of knowledge production, which is fully capable of violence, care(ing) for the transgenic fruit flies becomes a matter of that which is made killable. I discuss killability in my second empirical chapter.

3.4 Disgust and ethics

FIELD NOTE APRIL, 2012: *A visit to the laboratory. The same sensation of disgust that always makes me feel nauseous hits me again, even before I enter the lab. The flies. The flies are haunting me. They are getting into me. I put on my lab white coat. I am sitting behind the microscope, holding my brush. Turning the tube and bouncing it on the plate; the plate releases nitrous oxide. The flies fall sleep on the plate. I push it under the microscope. The legs are frozen straight upward as if they are dead. The legs are pointing at me. The two front legs look like a sharp arrow, following the rest of the body. Looking at it through the lens of the microscope, the arrow is piercing me through. I can't breathe. My pulse rises up. The arrow changes as the fly moves, the fly is alive. I am shocked. Pushing the first tube away, I take the next one, trying to forget about the fly inside me. Try to forget that it is moving, crawling and growing. That it is taking over. Repeat to myself like a mantra: curly wings, red eyes, hairs on the shoulder. Trying to imagine as if I am picking berries and separating the black berries from the white ones. The blacks are male, the whites are female⁴. I try to focus on the colors only and the hair as if they are disembodied, as if there is no fly. As if my body closes up in this act of disembodiment. I rub my hands against the white coat. My skin is not the barrier but the white coat is. What is it about the white coat? It is a sense of security and protection, I guess. It resonates cleanness and control. It is where my body ends and the flies' bodies begin. It is the distinct line. It is an extra skin. It detaches me, distances me and protects me from touching and being touched, from closeness and connection. As*

⁴The male flies have darker genitalia (almost blackish), and the females have white genitalia.

if nothing can pierce in and nothing can get out. Closed and clean. The border between the inside and outside. The nonnegotiable border between "I" and the flies: steady, fixed with the long history of modernity and human exceptionalism. The flies move inside me again. The white coat is a fraud! I ask, who are you who are so strangely me? I am disturbed.

Becoming fly-sensitive is also about my personal relationship with the flies, as it was complex. I have always hated flies—or at least been disgusted by them. Imagine my face upon entering the lab and realizing that I had to look at dozens of fruit flies every day, not from the safety of a distant, closed vial but closely magnified under the lens of the microscope. The first time I had such an encounter, I contained myself for over twenty minutes but then the dizziness and nausea strongly took over and I had to let go. I had to go to the coffee room, find an empty couch and lie down for some minutes until my vision was clear again. That was the intensity of working with the flies for me. Imagine my ethical dilemma over killing them, which gave me guilty pleasure. The funny thing was that I did not have such a strong dilemma about killing them in the kitchen in our collective. To the contrary, I would hysterically chase them around and smash them on the wall. But it felt different in the lab. The very fact that I was wearing the white coat and had control over their lives put me in an awkward position of having an ethical dilemma, which inspired me to write my second empirical chapter. I wrote it about human-animal relations and the ethics of killability in laboratory practices.

I used disgust as a tool to explore ethics in the lab. I realized that the feeling of disgust is ethically important, not only because it made me sick or because it exposed an ethical dilemma in the lab—whether to kill a living organism for scientific purposes or not. Disgust was ethically important to me because it communicated my anxieties to me about science, laboratory, death, disease, waste and flies. As Sara Ahmed (2013) argues, feelings such as disgust are closely linked to social abjection; they are cultural, historical stories that are associated with particular bodies. Moreover, such feelings are not something abstract that happens inside a subject but affective performative bodily realities that happen in between bodies and through close encounters.

Those feelings do things, materializing realities in different ways. Inspired by Ahmed among others, Jacob Bull (2014) writes about ticks, discussing the possibilities for an ethical response to negatively loaded encounters that are accompanied by feelings such as disgust, fear and repulsion rather than love and compassion. In fact, he identifies a limit within ethical writing about human and animal encounters, in which only animals that are close to humans have been the object of ethical concern. As Bull (2014) argues, often accounts of multispecies ethics or the ethics of relationality are limited to the scope of animals with which humans have close relations such as domestic animals, “companion species” (Haraway 2008b), animals on which we rely as food resources (Twine 2010) and at points laboratory animals with which we recognize kinship as mammals, such as apes and mice, (Haraway 1989, 1997). I would like to define disgust as a methodological tool, relying on Bull’s work.

So, why is it important to stay with the disgust as an ethical and affective method of inquiry? First of all, it highlights the embodied reality of doing science “affectively”, as Myers says (2015, 1). She argues that doing laboratory work requires the technicians to “get entangled—*kinesthetically and affectively*—in their modelling efforts” (1; italics in the original). I discussed the kinesthesia of doing laboratory work in the previous section. In this section, I discussed feelings as an affective component of doing science. In other words, I tend toward what Myers defines as affect, namely “the energetics, intensities, and emotions that propagate through” laboratory work (1). It opens possibilities for an ethic that does not rely on humanistic morality. Myers understands both the kinesthetic and affective realities of doing laboratory work as “feeling”; the former highlights the feeling *of* the organism and the latter refers to the feeling *for* the organism. Staying with such affective moments of laboratory work is also essential because it makes it possible for me to write about ethics and the flies, which are the Other of not only humans but a majority of the animal kingdom. In other words, as I will discuss in chapter 5, on killability, flies are indeed *nonanimal* in the lab. To stay with this position of nonanimal, which is often accompanied by fear and disgust, challenges the available ethics and ethical thinking within

the humanities and social sciences, which are more attuned to the bigger and familiar animals as the objects of (humanistic) ethics. In other words, as Bull (2014) writes, animals such as ticks are unlovable parasites with which humans do not often feel close. He argues that staying with the negative emotions that overwhelm him in his encounter with tick, and attending to such dynamic emotions, is crucial to understanding “human-animal interaction” because it can tell stories about how particular bodies are constructed as the undesirable, abject Other (79). His “aim is not to replace an ethics of love with one of disgust”; rather, he wishes to stay with the intensity of disgust to highlight what staying with disgust may create” (78).

The intensity of my encounter with the transgenic fruit flies may not have been as physical as Bull’s encounter with ticks. Fruit flies do not bite, and I did not have swollen, itchy bumps on my skin after I left the lab. However, the intensity of my emotion and my proximity to the transgenic fruit flies were equally affective. Indeed, in the lab and under the microscope, I was brought into a position of knowing the transgenic fruit flies’ bodies intimately. For instance, I had to learn details about body hair, the curve of a wing, eye structure and much more. In fact, being in the lab made me look closely at and get to know a species that I had hardly been aware of before. Indeed, I had never met a fruit fly in Iran, my country of origin. I encountered them for the first time after I moved to Sweden. Still, those encounters were seasonal, maybe even limited to few annoying weeks when the creatures would swarm around my fruit basket and disappear before making a mark on my memory. Before I entered the lab, I was hardly aware of their existence. However, in the lab, I had to breathe with them, feel them, care for them and know them intimately. I had to do so through containing my feeling of disgust.

I decided to follow my feeling of disgust and stick with it to see what stories it could tell me about flies, death, AD, science and laboratory work. I wondered what would happen if I followed the disgust. What kind of material would I get if I looked into those affective moments of disgust? What would I learn if I focused on the intensity between myself and the transgenic flies? Was it possible that I treated these flies differently, maybe even unethically, in the

lab because I was disgusted by them? Or could such a position of disgust actually inspire an ethic of relationality in human and animal encounters in the lab, one that goes beyond humanistic morality on the one hand and fluffy lovable animals on the other hand? As Bull writes, “parasitism and the disgust it conjures reemphasizes the politics of multi-species worlds” (Bull 2014, 80) and an ethics that is inspired by Harawayian *response-ability*, which I will discuss in chapter 5. In focusing on moments of intensity, offensiveness, stomach twisting and “sensuous proximity” (Ahmed 2013) between myself and the transgenic fruit flies, I came to write about death in the laboratory, human and animal relationalities, waste, ethics, multispecies worlds and AD.

3.5 Other laboratories

I was halfway through my laboratory work when I felt the need to visit other labs working with AD. I visited two other labs in addition to the lab in which I did my fieldwork. I did not want to do a comparative study. Rather, I thought that visiting other labs could broaden my understanding of how “it could be otherwise” (see, e.g., Woolgar and Lezaun 2013). Visits could help me effectively grasp the relational reality and material significance of laboratory work in the fly lab. I visited these laboratories because I was hoping to get a broader overview of AD and practices of knowledge production about the disease within the Swedish context. One of these labs was across the hall from the fly lab. I chose this lab because it worked within the same paradigm as the fly lab, namely the A-beta hypothesis. I also chose this lab because I had personal connections with the scientists in the lab, and so it was easier for me to access than others. However, in this lab the animal model was mice, so from now on I will call it the mouse lab. The mouse lab was bigger than the fly lab, and at least twice as many people worked in it. Unlike the fly lab, in which we were actually breeding the animals as a daily practice of doing science, scientists in the mouse lab ordered the mice brains they needed from a German university, their European partner in

their project. The main activity in this lab was purifying proteins and imaging practices. I was curious to see multiple modes of doing science because it could help me put my data from the fly lab into a larger perspective in order to understand practices of knowledge production not only about AD but also about human, animal and technologies relationalities through which AD was enacted differently. I visited this lab three times, and I interviewed three scientists who were working in it. The other lab I visited also worked within the scientific paradigm of the A-beta hypothesis. There, the scientists were working with human cell models, and therefore I will call it the cell lab. I visited the cell lab only once. The lab was situated in a hospital in the city. I also visited this lab to broaden my data collection on the practice of knowledge production about AD on the one hand and human and animal (or model organisms) relations within those practices on the other. I only interviewed one scientist in the cell lab.

I also visited the web pages of all three labs, as well as the university website, to develop an understanding about the rules and regulations regarding handling transgenic animals involved in scientific practices and the laws and regulations about how to handle biological waste when these animals were disposed of at the end of or during the experiments. I write about biological waste in chapter 6. I also visited several websites of the genetic companies that create and sell transgenic fruit flies, and I collected some information about transgenic fruit flies from these. One of them was the website of a commercial genetic company that the fly lab closely worked with, often buying their cultures from it, and this site was the one from which I collected the majority of my data. I call this one company the fly factory. I looked through these websites and web pages because I wanted to be able to connect the practice of knowledge production about AD in the lab and the use of animal models within those practices to their broader context.

3.6 Interviews

I did eight formal interviews with scientists, postdoctoral fellows and PhD students who were working with AD and misfolding proteins in the fly lab and other laboratories across the complex. I knew two of my informants through personal connections. Two others I met through my laboratory work. The rest I searched for online: I ran a random search on the university website to find people who were researching AD and the A-beta hypothesis. I looked across all disciplines and contacted these scientists. Some had already left the university. Some were not available for various reasons, but four responded positively, and those are my other informants.

I often carried out the interviews in my informants' offices at their request. I had one interview in a seminar room that my interviewee had kindly arranged so that we would have more privacy. I sent each interviewee the main questions before the interview, so that they would have an idea what to expect from me. We would often start with me introducing myself and my project to my informants, which appeared to be very interesting to many of them. They were often curious to hear how feminism is related to laboratory work, and I enjoyed explaining it to them, because it clarified for me what was feminist about my project each time (see chapter 2). Next I would ask my questions. The main questions were general: "What is Alzheimer's to you?" or "How do you understand Alzheimer's?" Then I would ask them to tell me about their own projects, how they made sense of AD and how they designed their projects and carried them out. Lastly, I would ask about their animal or organism model of choice and the technologies they were using. On some occasions, we would even talk about budget, economy and funding, national politics of health, and research and ethics.

I made notes at the same time as I recorded the interviews. The interviews varied in length between 45 minutes and 2 hours. I would ask for permission to record the session, and luckily for me, all my informants agreed. In my analysis, however, I have changed the names of my informants to keep their identities hidden. At

the end of my interviews, my informants kindly gave me a tour of their laboratories, showing me devices, pictures and graphs while explaining them to me. My informants were generous and patient with me and my naïve questions regarding being a social scientist in the laboratory. Aside from the formal interviews, I also had many chats with the fly lab crew. Though these conversations were not interviews, I recorded them so that I could go back to them later, and I have used them in my analysis. I had the verbal consent of the person I was talking to each time I recorded the chats. I was so worried that I would miss something due to my limited knowledge that I religiously recorded every conversation I had. In my interviews and informal conversations, I looked for stories rather than coding them. I looked for stories in which my informants talked about human and animal relationalities in the context of AD laboratory work. I also looked for stories about everyday practices in which death appears as the main theme. After all, as Haraway suggests, science is a narrative and a mode of storytelling itself—“stories with a particular aesthetic, realism, and a particular politics” (1989, 4). As I was looking at, analyzing and writing about my transcriptions, I was trying to tell the story of death, transgenic fruit flies and AD in the laboratory.

3.7 Writing and thick description

Participant-observation research is messy and chaotic. I ended up with loads of unorganized notes, many pages of interview transcriptions and a messy diary in which my experiences, feelings, questions and narrations regarding the laboratory work were written in ways that I sometimes could not read or recall, though they lay before me. This is to say that ethnography is not only about doing participant observation or conducting interviews but also about text production and the produced text. As Tedlock argues, “ethnography is both a product and a process” (1991, 72). It is a process not only because the researcher is engaged in a long-term undertaking of participant observation and data collection but because as one starts to narrate, describe and analyze that which has been collected as research data,

one is still in the process of doing research. Doing research and producing knowledge in this sense is as much about the process of participant observation and interviews as it is about intellectually making sense of and narrating such material. The process of writing as a constitutive part of ethnography is what Tedlock refers to as “narrative ethnography”, in contrast to “ethnographic memoir” (Tedlock 1991, 77). Whereas in the latter, the researcher self is not obvious, in the former, the researcher gives space to not only experience but also “ethnographic data, epistemological reflections on fieldwork participation, and cultural analysis” (77).

Thick descriptions combined with in-depth analysis compose a method that generates text out of the chaotic mess generated from participant observation (Winthrop 1991, 98). It is a method for doing narrative ethnography. Anthropologist Clifford Geertz’s concept of “thick description” has been one of the most influential methods in anthropology for discussing participant observation as something interactive, in which the researcher is embedded and interacting with the field as well as intellectually reflecting on his experiences (quoted in Ponterotto 2006, 538). Tedlock (2011) argues that thick description involves avoiding the passive third-person voice of laboratory reports, which Haraway refers to as playing the “modest witness” (1997), and instead paying more attention to the embodied practices, voices and first-hand experiences of doing research. Thick description does not imply doing a “chronological diary” (Tedlock 2011) but includes emotions, passions, and politics in to the writing—to not only witness but acknowledge the *intra-active*⁵ effects of doing research in which the researcher is as much a part of the study she conducts as its object. This is what I have been so far trying to portray by explaining the processes through which I became a researcher as an embodied partial process during my fieldwork, my research changed over time and my research questions formed as I followed my gut feelings and disgust. Thick descriptions are dense narratives that try to portray

⁵Barad (2007) argues that intra-action is different from interaction. While in interaction, entities are understood as separate that come together and reshape one another, in intra-action, she argues that there are no predefined boundaries but that object, subject and phenomenon become together and make each other up (please see chapter 2 for more discussion on intra-action).

complexities, contradictions and multiple realities. Ethnography is not only keeping diaries, transcribing texts and doing interviews but the form of intellectual effort that the researcher puts into the text as thick description.

Without being too familiar with the theoretical concept of thick description, I was enacting it as I was writing and keeping my diary. I tried to write about surprises, unexpected turns of events, failure, smells and intense feelings as much as about routines, cultural and technological rituals and “style of reasoning” (Hacking 2002, 3–4). In the lab, I did not have much time to write when I was working with *Drosophila*. Every now and then I could pause to make a small reminder note, but often the lengthy writings would come afterward. I had my own ritual of taking a break after each laboratory visit, sitting in the university student coffee shop and writing the story of the day. I would write about what I did, what I saw, how many transgenic fruit flies I killed, how I felt nausea and the temperature of the incubators as well as my encounters with other scientists, dialogues, greetings or question-and-answer rounds. I also wrote about what I did not understand. I wrote about processes through which AD knowledge is produced, the very processes of which transgenic fruit flies’ bodies became an intrinsic part; I wrote about it all, filling my diary. In other words, as I wrote and rewrote, I realized it was not AD I was writing about in particular. I was not writing a thesis about AD biochemistry as such. Rather, I was writing about how scientists come to produce knowledge about AD biochemistry. I was writing about the ways in which knowledge about AD is produced, through human and nonhuman entanglements. I was writing about how different animal models are part of such knowledge production and how that matters, not specifically or solely from a natural sciences perspective but from a feminist ethics point of view.

Last but not least, in my thesis I used thick description as a method of writing about feminist concerns. I found thick description particularly interesting because, as feminist ethnographer Patricia McNamara (2009) argues, it is in line with feminist agendas and storytelling practices as an unconventional telling of scientific narratives. McNamara argues that storytelling has been historically

associated with femininity. Women have always carried culture with them through folklore and stories across time and space. However, women's voices as such have often been silenced and disqualified as nonobjective, nonscientific and emotional—and also as “only” stories, not facts. Therefore, as McNamara argues, ethnography and thick description are storytelling practices, and as such, thick description is a mode of scientific knowledge production that is an alternative to the masculine disembodied writings of scientific facts. As such, thick description is political writing; it is a claim to alternative modes of knowledge. Thick description is a way to access invisible knowledge⁶.

3.8 Conclusion

In this chapter, I presented the empirical material, methods and methodological tools that I have used in collecting data about AD, as well as the analytical tools and methods I used in analyzing the collected material and in my writing techniques. I wrote about making my way into my fieldwork laboratory and how this changed my research project into a study of knowledge-production practices about AD in the lab. I also explained how I collected information through several interviews and informal conversations, as well as through reading scientific reports and articles.

I explained that I did participant observation in the lab in which I was not only observing the scientists but involved in the project as a technician. As such, I acknowledge that my role as the research subject is a crucial one on which to carefully reflect. In order to do so, I drew on Haraway's (1988) concept of situated knowledge, in which the researcher's situatedness shapes the boundaries of the researched object and determines the modes of observation. It is important that researchers attend to their situatedness through accounting for their “sitting”, such as historicity and political selves, and “sighting”, the

⁶Nonetheless, as McNamara argues, even with the benefit of thick description, women's voices are still unheard, predominantly within social sciences and anthropological studies, and therefore not only can feminism benefit from thick description but ethnography can benefit feminist theories.

material and discursive technologies they use to produce knowledge (Lykke 2010a, 152). In other words, the only way to achieve objectivity is through using one's subjectivity.

Moreover, I highlighted the importance of embodiment in doing sciences by discussing my relation to the fruit flies in the lab. I argued that I had to become fly-sensitive, which was an embodied position of doing life sciences: a position in which touch, scent and vision become constitutive parts of produced facts in the laboratory. I also mentioned the intensity I experienced working with the transgenic fruit flies—that of disgust. Rather than shying away from it, however, I decided to stay with the moments of intensity, “offensive”-ness, stomach twisting and “sensuous proximity” (Ahmed 2013) as a tool to code my material for analyses. I also mentioned that I used storytelling and thick description as a feminist way of writing about AD.

Thick description is not the intellectual property and production of the mind of the researcher in isolation. Rather, it is an entangled process through which researcher subject, object and research processes themselves are constantly made and unmade in relation. Let me expand on this assertion: as I have shown so far, my study is situated within the scope of my participant observation in one biochemistry laboratory in Sweden. I do not single out AD as a fixed, singular and detached object in a vacuum. I do not argue that the story I tell in my thesis defines AD. Rather, I argue that AD is always already multiple and a matter of becoming in relation. For instance, in my project, AD is about the entangled relations between biochemistry, imaging technologies and molecular agents; misfolding proteins and transgenic fruit flies; feminist theories and my own position as a feminist participant observer in the laboratory. The AD I write about in this project is then locally particular, onto-epistemologically (Barad 2007) precise yet different from—for instance—AD in the lab across the hall. AD in this project is made up of the moments in which it is becoming what it is in intra-action (Barad 2007). As such, AD ontology is always already a matter of situatedness, simultaneous inclusions and exclusions, and “onto-epistemology” (Barad 2007). Therefore, as practices of mattering always exclude other possibilities of mattering, onto-epistemological

practices are always already entangled with the question of ethics in the lab⁷—or, as Barad writes, scientific practices are always already ethico-onto-epistemological (see chapter 2 where I discuss this theory).

To recap, engaging with AD ethico-onto-epistemologically implies two main points in my thesis: I am interested in practices, as in, I am interested in the ongoing knowledge production and materializing practices out of which, and with which, AD becomes known or knowable and gets materialized as it is in the laboratory. My thesis is theoretically in debt to the body of literature that engages with knowledge-production practices as performative, situated practices (Barad 2007; Mol 2002). Second, I understand AD as a matter of “agential realism” (Barad 2007), meaning that AD comes to matter in constant shape-shifting material-discursive intra-actions. As such, AD is not only materially discursive but also the subject matter of multiple modes of knowledge production.

⁷For instance, doing AD in this lab is always entangled with the exploitation of animal models and therefore in need of ethical conceptualization. I will engage with the question of ethics in the third chapter.

Molecularizing Alzheimer's Disease, Performing Death

What is Alzheimer's disease (AD)? I started every interview I conducted with this question. Interestingly, none of my informants began with listing Alzheimer's clinical symptoms such as memory loss or hallucination. Such patient-centric readings of AD were irrelevant to the context of the laboratories I visited. Indeed, at best, the biggest animal model in these labs was mice. As my informant Karin said, in the lab, measuring memory loss may be doable to some extent using a mouse model. But within the scope of our limited knowledge and measurement possibilities, it is not as common to measure memory loss in flies or a cell model¹. In answering the question "What is AD?" all of my informants jumped into discussion of the basic sciences and molecular biology: genes, proteins, enzymes, neurons and molecular agents. In these labs, AD was thought about, made and understood as the fundamental molecular processes of the body—as proteins aggregating, organizing themselves, folding and misfolding (see, e.g., Göransson et al. 2012; Helmfors et al. 2015).

The molecular understanding of AD is not a new phenomenon. AD has been mostly discussed in terms of molecular pathogenesis and

¹There are some experiments that measure memory loss in flies, Karin told me, although the understanding of memory in flies and mice is not the same as it is in humans. The discussion of memory, however, is not within the scope of my thesis and therefore I leave it here.

components in laboratories for over one hundred years, in much the same fashion as psychiatrist and neuropathologist Alois Alzheimer's note about the disease does in the following:

[I]nside an apparently normal-looking cell, one or more single fibers could be observed that became prominent through their striking thickness and specific impregnability. At a more advanced stage, many fibrils, arranged parallel, showed the same changes. Then they accumulated, forming dense bundles, and gradually advanced to the surface of the cell. Eventually the nucleus and cytoplasm disappeared, and only a tangled bundle of fibrils indicated the site where once the neuron had been located. As these fibrils can be stained with dyes different from the normal neurofibrils, a chemical transformation of the fibril substance must have taken place. This might be the reason why the fibrils survived the destruction of the cell.

— quoted in Maurer et al. 2000, 20

The very understanding of AD has gone molecular, and it has been modeled, simulated, acted upon and imaged in the lab on the molecular scale, often in nonhuman bodies. In other words, practices of knowledge making about diseases such as AD trespass not only the boundaries of the imagined “molecular body” (see Lock 2013; Rose 2007), “mechanical body” (see, e.g., Waldby 2000), biology and technology (Waldby 2000), but also those of the species (Sharp 2011), through which new forms of life and of dying are performed. AD transgresses the boundaries of medicine and life sciences: as a predominantly a minor clinical (human) disease, it has been transformed into *the* science question today, and it has gone through a social and political process Nikolas Rose (2007) refers to as molecularization (see chapter 2). In other words, molecular practices of knowledge production about AD have detached the disease from (human) bodies (enacted partially in model organisms), isolated the disease as genes or proteins (depending on whether it is understood as a genetic or protein disease) and fetishized it in molecular components or

structures such as A-beta plaques or the tau tangles², which in return gives shape to how AD is understood and acted upon at large (e.g., in clinics, popular culture and life sciences).

In this chapter, I explore the laboratory realities of AD and its relation to life and death while being molecularized in practices such as modeling and imaging. Indeed, what is interesting to me is how the molecularization of AD in the lab—namely, breaking the AD neurodegeneration processes in humans into measurable, replicable, isolated and image(in)able molecular components in model organisms—has always been heavily situated in death, dying matter and dying processes on the one hand and animating new forms of life, such as transgenic models and proteins to embody such processes, on the other hand. I focus in particular on imaging practices because, as I discussed in chapter 2, imaging technologies are one of the main characteristics of molecularization processes and a pillar of life sciences (see, e.g., Franklin et al. 2000). As cultural studies scholars Marita Sturken and Lisa Cartwright write, there is to some extent a historical relation between seeing and knowing within medicine and life sciences: “To see is to know” (2009, 356). Images within biomedicine have often been understood as evidence captured by presumed objective technoscientific means such as camera or X-ray, which makes the invisible (e.g., the interior of the body, or a molecular component of the body) see-able and therefore know-able. In these scientific traditions, “vision is understood as a primary avenue to knowledge, and sight takes precedence over the other senses as a primary tool in the analysis and ordering of living things” (370). This vision is, as Donna Haraway (1989, 1992) critically reflects, often

²One of the strongest threads in Alzheimer's studies revolves around misfolding proteins since the days of Alois Alzheimer (Braak and Braak 2000). Proteins play a vital role in human bodies. Sometimes, for not fully known reasons, proteins get cleaved on the wrong amino-acid sequence by the cleaving enzymes and accumulate in the form of misfolding proteins that causes diseases or dysfunctions in the body. AD has been associated with two groups of such misfolding proteins called amyloid beta (A β or A-beta) and tau protein (Göransson 2012; Göransson et al. 2012; Whitehouse et al. 2000). When a body is younger, it circulates the amyloid peptide deposit, whereas as the body ages, it pollutes itself in overproduction of A-beta peptides while at the same time losing the ability to circulate the deposits as efficiently as in its younger years (Sadowski and Wisniewski 2004).

understood as human vision, which makes knowledge and knowing an attribute of the human only, disqualifying and dismissing the Other's vision while celebrating the knowledge produced by white upper middle class man. I discussed the problems of this approach toward knowledge in chapter 3. In this chapter, I wish to stay with the imaging practices through which knowledge production can be understood differently—for instance, as a relational doing that exceeds the human subject. I stay with imaging because, according to Sturken and Cartwright (2009), the relation between visualization of the invisible by “objective” technoscientific means and the construction of scientific facts is a legacy that is still evident within contemporary biomedicine and life sciences. Such a reliance on seeing and knowing within sciences is problematic because, as feminist philosopher Rosi Braidotti argues, “there is an inevitable slippage from the visible to the mirage of absolute transparency, as if the light of reason could extend into the deepest and murkiest depths of the human organism. As if truth consisted simply in making something visible” (1994). In other words, overemphasis on the visible may lead to a mistaken conflation of what is seen with the absolute truth.

As I discussed in chapter 2, through imaging practices in life sciences, diseases and bodies as well as *life itself* become a visual register. Life itself, the captured “essence” of life, which cannot be encapsulated, has become a target for life sciences to pin down and image by technoscientific means. The very attempt to capture that which cannot be captured disturbs the natural/cultural processes of life and disrupts its liveliness, freezing it in order to capture it. In such attempts at understanding and imaging life, life has been constantly reproduced, observed, modeled and animated in ways linked to the contemporary cultural imaginaries of what life can be, and as such, these attempts enact and animate novel modes of living and forms of life (Franklin et al. 2000; Keltly and Landecker 2004). The emergence of high-tech imaging possibilities (such as the PET scan³) and novel molecular agents and dyes are also a crucial part of Alzheimer's research. In the time I was doing my fieldwork, many scientists hinted

³Positron emission tomography is an imaging technique that is used to inspect the metabolic processes in the body.

at the new power imbued in novel scientific imaging technologies such as the radioligand⁴, and antibodies and molecular agents that would bind to the A-beta plaques and glow under the fluorescent microscope. Proteins captured by imaging technologies often appear colorful—different colors and color densities communicate to scientists the stage of protein accumulation, its kind and toxicity, as well as neural death, which I will discuss in the rest of this chapter.

Furthermore, in this chapter I also investigate whether, through imaging and images of AD on the molecular level, death is also produced, observed, modeled and *animated* in ways that are linked to the contemporary scientific discourse of what an AD-related death can be. I ask what forms of death and novel modes of dying have been imaged and animated in the lab. I wonder about the ways in which death is enacted and “made and born” (Franklin 2006, 171), for instance, in the form of transgenic flies that are genetically made and born to die of AD. As scientists are reshuffling proteins and genes—linking human and nonhuman, lives and deaths, suffering and cure and as such engendering dying in new ways in the lab—I ask whether death, within the material and discursive realities of AD molecularization in the lab, is enacted in relation to nonhumans (and their death) rather than to human death. Last but not least, I understand the molecularization of AD as *matters of practice*—a concept I discussed in chapter 2. Matters of practice highlight nonhuman *doing* and matter’s “agentiality” (Barad 2007) as a constitutive part of AD molecularization. Matters of practice as a concept stresses the enactment of molecular AD as always a “posthumanist performativity” (Barad 2007). As such, using the concept of matters of practice, I inquire into whether the molecularization of AD in the lab involves practices of knowledge production through which AD and death are *performed by human and nonhuman* actors as they are animated through imaging practices.

⁴This is a radioactive biochemical substance that is used in experimental research. The substance binds to the respective molecules which is then detectable by PET-scan.

4.1

Alzheimer's disease molecularized: On partial enactments and the laboratory

Not only have AD's "onto-epistemology" (Barad 2007), meaning and modes of knowing changed continuously over the past hundred years, it is still a *science in the making* (see chapter 1). In other words, AD is still heavily researched within the contemporary life sciences, as there is still much to learn about its etiology (the origin of the disease), and as there are multiple accounts and practices of meaning making about AD within natural sciences. Among the contemporary networks of researchers who work with AD, there are many theories about the factors that are involved in AD progression and causation such as trauma, lifestyle, cardiovascular disease, environmental factors, genetics and more (Sadowski and Wisniewski 2004). Even within life sciences, AD, which is predominantly understood as a molecular phenomenon, has been enacted as multiple (Mol 2002) in different science labs, as I explain in the following paragraphs.

Olof was one of the scientists I interviewed during my fieldwork, and he was engaged in a study about AD from a biochemical perspective. During the interview, he explained to me that for decades AD in the lab has been understood in relation to its molecular specificities. He told me that, in the lab, AD is a molecular phenomenon and its mechanism is well known on the molecular level. He explained that scientists know exactly which proteins and enzymes are involved in producing the misfolding A-beta plaques and tau tangles, which are the neuropathological hallmarks of the disease. However, he continued, AD's etiology is still a mystery, and it is the understanding of its etiology that drives contemporary laboratory research on the disease. The A-beta plaques from the A-beta protein and the tau tangles from tau protein, as AD's two dominant molecular accounts, divide the scientists into two different yet related collectives (Lock 2013). Most of the laboratories focus on either both or one of these proteins, which in return enacts AD in partial yet multiple ways. In order to study AD biochemistry and molecular function, scientists molecularize the disease as they reduce the procedural phenomenon, namely AD, into isolated bits and pieces, depending on their hypothesis (e.g., whether

they find A-beta peptides or tau tangles to be a better target group for their scientific inquiries). I followed scientists who were involved with A-beta protein sciences.

I have to mention that, even though A-beta plaques have become an influential part of AD sciences, some surrounding uncertainties trouble scientists. Namely, plaques could be the brain's defense mechanism for depositing the toxic proteins, and therefore the proteins themselves might not be the right target for therapeutic measures (Brorsson et al. 2010; Göransson 2012). Moreover, plaques, which can only be detected postmortem, do not necessarily correspond with AD onset in the patient. A "healthy"⁵ patient might express a considerable amount of plaques in the brain autopsy yet might never have been diagnosed with clinical AD, whereas a clinically diagnosed AD patient might not express as great an amount of plaques in the brain postmortem (Riley et al. 2002). Nonetheless, the A-beta peptide hypothesis is still salient as one of the most promising ways to solve the mystery of AD.

Moreover, the molecular categorization of neurodegenerative conditions may separate diseases which were previously categorized together based on their clinical symptoms. Some diseases that are clinically the same, like the cases of Auguste (plaques and tangles AD) and Johann F. (plaques only), as I discussed in chapter 1, are proven to have different molecular morphologies, which problematizes such clinical categorizations. Moreover, new molecular morphologies create new categories of disease that might or might not share clinical symptoms but that share neuropathological specificities⁶ (Lock 2013).

⁵By "healthy" I mean not clinically diagnosed with AD. Of course, the person might be suffering from other diseases which makes them "unhealthy" in a different context. I have to mention here that the imaginary of a healthy body is a fraud—an unrealistic fabrication which has already been criticized by many feminist scholars (see, e.g., Shildrick 1997). Moreover, as has been also argued by others, within the capitalist and market-oriented realities of contemporary medicine and pharmaceutical industries, it is profitable not only to create new illnesses for prospected drugs (see, e.g., Johnson and Åsberg 2012) but also to diagnose patients with lifelong diseases which guarantee a lifelong consumption and profit (Dumit 2012).

⁶For instance, according to Whitehouse et al. (2000), both tangles and plaques have been found solo in other neurological conditions. Metachromatic leukodystrophy (MLD) also shows tangles in the brain and similar clinical symptoms in the patient, and by the standards of medicine today Auguste might have been diagnosed as having

Amyloid beta plaques are also the hallmark of other neurodegenerative disorders such as Parkinson's disease and Lewy body dementia⁷ (Edison et al. 2008; Koo et al. 1999). This is to say that often, on the molecular level, it is not necessarily AD that is being studied but partial molecular conditions, namely misfolding amyloid proteins or tau tangles.

Furthermore, the experiments in the lab of my fieldwork are done on animal models that have, as my informant Karin notes in the following interview excerpt, a less complicated brain than humans. Even though AD is a neurodegenerative disease, the expression of the misfolding A-beta proteins in animal models is not always enacted in the animal's brain. For instance, sometimes A-beta peptide expression in the flies occurred in their nervous system and sometimes their eyes. There are different levels of difficulty and asymmetry here, mainly surrounding how the simple fly brain stands in for a human brain with much higher complexity, which as scientists acknowledged in the lab, can affect the experiments in surprising ways. Another notable issue is that AD in humans is a neurological condition that happens in the brain over years. However, the life span of a fly would not allow for such long periods of protein aggregation. Karin explained this to me.

KARIN: The human brain is more complex, so there are other things going on [in the brain]. We have the formation of tau tangles in humans intracellularly; I don't have it in the flies, so that is a factor I can't relate to. I can't compare anything between humans and flies in terms of that.

TARA: And it is not possible to do that?

KARIN: People have tried but no, I think, so far. People did try this much earlier when the first fly model came out, with AD. They saw that the A-beta peptide is aggregating and causing plaques. The next step was of course to coexpress this [the A-beta plaques] with the tau protein but they couldn't see any effect of that [in

MLD rather than AD.

⁷ However, the amyloid load is different in between these disease and can be measured (Edison et al. 2008).

the flies].

TARA: So, it [tau tangles] is produced but there is no effect [in the flies]?

KARIN: The toxicity wasn't. The flies were not sicker and they didn't become healthier either.

TARA: How about the mouse model?

KARIN: It seems actually that the mice are not so much affected [by A-beta]. So we have been speculating. If we understand why the aggregation of the A-beta peptide doesn't seem to affect the neurons in the mice, what are the factors that protect the mouse brain? We might have the answer to the disease. So the mice are very resistant to AD which is very strange.

As my informant explained, the AD that is simulated in animals is not compatible with that in humans in many ways. While the A-beta affects flies, it does not affect mice in the same way. Indeed, the neural pathways in mouse brains somehow regenerate in new ways that prevent the mice from getting as sick as humans do. On the other hand, even though the A-beta plaques show similar toxicity in flies as they do in humans, the tau protein seems to lack the effect on flies that it has on humans or mice. This is to say that, as my informant also acknowledges, it is not AD that they are modeling in the lab but A-beta molecular functions. Nevertheless, despite all the differences, if researchers can understand the molecular functions of neurodegeneration, they might be able to control AD progression. As Karin said, even though mice are somewhat resistant to AD, they are still meaningful models, for if scientists understand what it is that protects them from A-beta they may be able to get closer to solving the mystery of AD on the molecular level. As such, these animals remain useful molecular engines for scientific inquiries within the context of AD.

Despite all the uncertainties and complexities of studying A-beta misfolding proteins related to AD in animal models, my fieldwork laboratory was situated within the A-beta hypothesis and specifically experimenting with transgenic fruit flies. Another laboratory I visited was also working with A-beta misfolding proteins, but their experi-

ments involved either the mouse model or A-beta proteins produced via *E. coli*⁸. The fly and mice labs had different research approaches. In the fly lab, scientists reverse engineered the accumulation *processes* in order to understand the *toxic mechanism of neurodegeneration* and to measure the toxicity of proteins in different stages of protein aggregation. The process itself was at stake. For instance, scientists kept a *death diary* to chart transgenic flies' dying curves, carefully documenting the number of flies that died in each fly culture and their cause of death (e.g., overexpression of AD-related genes and A-beta proteins or simply suffocating in the food). I will come back to imaging practices of such neurodegeneration and toxic processes later in this chapter. What matters here is scientists were visualizing, documenting and measuring the degeneration processes over a time period and it was such time-consuming procedural data collection that in combination with the images it would constitute meaningful results about AD in the fly lab. The relation between the images and practices and processes of imaging is important for me, and I discuss it later in this chapter.

Anna and Helen, other informants of mine, were protein chemists in the mouse lab, and they were interested in exploring and imaging protein *species and their morphologies*. Anna explained that in AD, amyloid proteins develop in the brain years before the symptoms can be diagnosed, pointing to the fact that degeneration of the neurons is a gradual process. As she explained, within the years the process takes, proteins in the brain accumulate in different ways and into different species until they mature in the form of A-beta plaques. In this process of protein aggregation, different *protein species* develop: monomeric single proteins, oligomers, fibrils and plaques. As she described, despite their common genealogy, these are different A-beta species—they look different; they *behave* differently; and, most importantly, their effect on the neurons is suspected to be different. For instance, as several of my informants in both labs mentioned, there is a hypothesis that A-beta proteins are most *toxic* in their prefibril stage, and before they form plaques; it is thought that they damage

⁸*Escherichia coli* (*E. coli*) is a bacterium used in experimental biology and in the lab as a model organism through which scientists grow proteins.

and kill neurons and neural pathways in this stage⁹. Whereas in the fly lab it was the gradual process of aggregation that was the target of investigation, in the mouse lab it was how these proteins appear at particular frozen moments in their lifetime.

In the mouse lab, even though scientists had to produce images, they first had to make proteins over time, via either *E. coli*, injecting proteins in the mouse brain or genetically modifying the mouse to produce the desired proteins. What they were interpreting as their result was the moment of visualization in which they could see how those proteins appeared. For instance, they had to train the *E. coli* to produce their desired proteins, to purify the *E. coli*, to detect and separate A-beta proteins from the bacteria. They had to try several antibodies and fluorescent molecules which bound to the proteins before they could image the protein morphologies. Nonetheless, their aim was *to see* multiple A-beta proteins' morphologies, and therefore, as the proteins aggregated and folded into different species, researchers had to stop the process of aggregation to image these different stages. Those moments of imaging and the captured images would then be interpreted as scientific data.

In the fly lab, the focus was on the whole chemical process through which these proteins were accumulating, whereas in the mouse lab the focus was on the morphology of proteins in different stages of accumulation. Even though such epistemological differences resulted in multiple modes of doing AD science, whichever theoretical assumption was in place, and whichever animal model was used in experiments, AD meaning making in these labs was bound to imaging practices. In other words, similar to Sturken and Cartwright's (2009) argument about the role of images as the visual proof of the invisible processes in the body and therefore one of the main parts of life sciences, scientists in the mouse and fly labs needed *to see* the proteins in order *to know*. Whether to know the proteins from which toxicity originated or to know protein species and their morphologies,

⁹Anna as well as Karin explained that protein aggregates in their pre-fibril stages are still fluid enough to be manipulated or even, hypothetically, dissolved. In other words, in the pre-fibril stages of protein formation it may be possible to influence and control the deadly protein bindings and prevent cell death, should the scientists develop the right molecular agent and detection techniques.

scientists needed the visual evidence that indicated that the protein under the microscope was an A-beta protein. Through these imaging practices and with the help of molecular probes in the lab, A-beta proteins, which are invisible to the naked eye, would become a visual register, a “visible matter” (Waldby 2000), while simultaneously these images were taken as material and visual evidence indicating that, for example, the resulting toxicity in the model organism was due to an overexpression of A-beta accumulation. In other words, even though transgenic flies, mice and *E. coli* were the models in these labs, the “work object”¹⁰ (Casper 1998) was the misfolding A-beta protein, enzymes and toxic processes of aggregation and protein morphologies rather than the models themselves. In this context, the molecularization of AD entails making AD by reverse engineering the disease process on the molecular level, through genetic manipulation and protein inducement in animal models that can simulate the disease in ways that are similar to AD development in the human body.

To recap, in these labs, AD molecularization has two main characteristics: *visualization* or *imaging* of the molecular components, morphologies and binding processes that are associated with AD neurodegeneration and neural death such as A-beta peptide; and animating this molecular hypothesis by making living models to replicate the degeneration processes. I will discuss these two components, namely modeling and imaging, in the rest of this chapter as I explore the relation between imaging practices as well as animating AD, life and death as entangled processes.

4.2

Visualizing the molecular component: Animating life through death

Helen, one of my informants, was working with *E. coli* to grow A-beta peptides. In an interview, she told me that the A-beta protein is a difficult protein to work with and to image. She said,

¹⁰According to STS scholar Monica J. Casper, a work object is “any material entity around which people make meaning and organize their work practices” (1998)

When you work with AD-related proteins such as the A-beta protein, which is a protein or a peptide that is very prone to aggregate, you have to constantly work fast and you have to work in really good conditions so that it will not aggregate [she needed single monomeric A-beta misfolding proteins for the imaging and therefore needed to control the protein folding process so that the misfolding proteins would not aggregate further into A-beta plaques]. A-beta is a very difficult protein because it is irregular; you cannot be really sure how it is going to behave. Some proteins are very nice and they behave the same way and you can use the same settings to get the same result. But with A-beta, you are using the same setting but you are getting different results. Also, if you are not fast enough, it will aggregate and you don't want that because you want monomeric peptides.

Helen's explanation of A-beta's irregular aggregation and its tendency to accumulate quickly, making imaging and experimenting a challenge in the lab, points to the limits of natural sciences and the entanglement of life and death within life sciences in ways similar to those Natasha Myers writes about. In her book *Rendering Life Molecular: Models, Modelers, and Excitable Matter* (2015), Myers draw on Foucault in order to point out the impossibility of capturing life and its essence in the lab and through technologically mediated practices of imaging such as crystallography. As she argues, despite a historical quest in life sciences to capture life (in terms of, e.g., genes or proteins), life escapes capturing because in order to image life its very vitality needs to be disrupted. It is in this moment of disruption that life can be visualized, but it then, ironically, loses its liveliness. The same tension is also visible in Helen's argument about the challenges of imaging A-beta peptides. As Helen explained, these images are meant to represent the misfolding proteins, their shape and the different stages of aggregation, which is a lively process. In fact, the A-beta misfolding aggregation is such a lively and unruly process that the essence of time is an ingredient in the imaging step. If one is not fast enough, the protein will aggregate and the monomeric protein for imaging

will be lost, Helen said. Helen's explanation of A-beta aggregation points toward the liveliness of proteins, their irregularity and their role as "trickster" (Haraway 1991), which makes them difficult to work with. If a scientist does not manage to image proteins in the exact right moment, life will pass by, and proteins will misfold and aggregate in undesirable forms. Helen explained that to image this lively process, she had to control the life span of the proteins by constantly controlling their environment or separating the monomeric A-beta proteins. It seemed that in order to image such a lively process, Helen had to constantly disrupt its liveliness, to prevent "life" from progressing; she had to stop the accumulation of the A-beta into moments that could be frozen and captured as images, which were ironically representing the accumulation process and the life of the protein. The liveliness of proteins, however, is less of a problem in the fly and mouse models.

FIELD NOTE SEPTEMBER, 2012: *The first time I saw the images I was blown away. They were beautiful, like artworks: a series of expressionist paintings full of lines and dots, exploded by intense colors. After almost a year of working with the flies, I was expecting to be grossed out by them yet again. What I expected was to look at images of the flies in great resolution. I was expecting to see glowing flies or to see pictures of flies with glowing eyes or glowing central nervous systems. What I saw though was different. A black canvas, a pitch-dark background, like the night sky full of glowing stars. The stars, however, at parts were concentrated, forming a foam-ish density that was colored differently; like a newly born galaxy giving birth to life, a galaxy that is full of stories, full of untold tales to be told. On the picture, there were several galaxies. Some far from one another. Others closer to each other. Some bigger, some smaller. Some more dense, some stretched over and taking more space. Often, they were glowing with different shades of the same color, like green: dark green like a deep forest green, one that is the point of no return. Green like Kelly green telling stories of a vast ancient land inviting you in for a journey. Green like spring grass green, as if you could almost smell the musky scent of the nature blooming, a green which was inviting you for a nice walk under the sun. The picture I was looking at was indeed telling the story of life, never-ending strolls, and a point of no return. It was the story of the newly*

born, slowly blooming proteins, coming together in bundles and getting stronger and stronger to the point of cell destruction and neuron death. It was a picture in need of an expert's keen eye to interpret such artistic pieces in meaningful ways. I was not one. I asked my informant, Karin, about the pictures and what stories they told; I wondered, what is the story of the deep forest green, Kelly green and the spring green? She said "We squash the flies [on a small board] and then separate all proteins that are in the head and then we can specifically detect the A-beta protein, using antibodies that bind with these A-beta peptides." I asked, "Is this antibody the one that glows?" She said, "No. we use antibodies against the beta peptide and then we use an antibody against that antibody and the second antibody is attached to a probe that is detectable by a colorimetric assay. It is a standard procedure when you want to detect a specific protein." She said that the more advanced aggregates give a denser and bigger green color. The darker green spots show plaques and clusters which means that the cells are already dead. I wondered how colorful death can be. What is the color of death? And how many flies shall die for such a piece of art to get materialized? I couldn't help but think of all the flies' body parts on the plate, entangled more than ever in a pile without a shape, without boundaries, without individuality. I couldn't help myself but think of their body parts mixed up in a pile of goo, soaked and stained with the antibodies ready to glow. Could it be that the story of the green forest, Kelly's green story and the spring grass green story was then the story of scientific practices, molecular bindings and death?

Figure 4.1: Images of A-beta peptide taken by Karin and Helen in the lab

As Karin explained, in order to visualize A-beta and to create the green shades of A-beta species, she needed to squash many flies which she had bred to express the A-beta aggregates. In order to image the proteins that were accumulating in the body of the flies, Karin had to stop the aggregation process by killing the flies to image them. The proteins that were visualized represented the life cycle and different stages of aggregation of the A-beta protein, with each stage represented in the image by a different shade of green. Whether the monomeric peptide—which is the early stage of A-beta aggregation and glows like the spring grass green—or the plaques—which are the final stages of aggregation and glow in the image as a deep forest green—the image was indeed the visual register of *dead protein specimens* extracted from the squashed bodies of the flies, yet ironically representing the life of the A-beta protein. In the mouse lab, similar to in the fly model, Anna had to disrupt the liveliness of the proteins in order to image them. She said,

A good thing about a dead animal is that you can slice the brain and you can use different types of imaging agents on constitutive sections so you can take sections from it and place them right beside each other and then image them with different techniques. You can see this exact same structure in the brain but with different techniques. Also, if you work with a dead animal you can use one mouse for two hundred experiments.

In fact, the lifelessness of the extracted protein from the dead mouse brain was a promising tool for Anna to experiment with different kinds of imaging techniques on the same sample in order to strengthen her results. Both Karin and Anna not only killed the model animals to image the A-beta protein in their bodies, but also ceased the liveliness of these proteins into instrumental specimens that could be used over and over for multiple experiments.

In these images, what is at stake is how the imaging technologies interact with dead specimens in order to capture life—that is, to understand the aggregation of the proteins, their processes and morphologies as they occur in a living body. Science, technology and

society (STS) scholar Kim Sawchuk (2012) argues that with the introduction of the camera and photography, anatomists and physicians turned to cameras to provide a lifelike image of bodily organs for educational reasons such as documentation for medical atlases. As such, often dead organs were photographed in order to do justice to *reality* and to capture the *real and lifelike essence* of the represented organ as living. The problem was that the camera was too precise and it would show the decaying characteristics of the dead organ instead of providing a lifelike image. Therefore, illustrations based on these photos depicted the organs as more “lifelike”, and it was these that were integrated into the anatomical atlas. A paradox is embedded in these images, as Sawchuk argues. These images, according to her, embody the historical “central paradox of anatomy” (145)—that of obtaining information about living processes by exploring, animating and dissecting dead bodies. Another good example of this paradox is the iconic image of “life before birth,” captured by Swedish photographer Lennart Nilsson and published in *Life* magazine in 1965. As many feminist cultural studies scholars such as Nina Lykke and Mette Bryld (2000) and Sarah Franklin, Celia Lury and Jackie Stacy (2000) write, this image—which became one of the iconic images of life itself in the twentieth century—was ironically captured from a dead embryo.

Images in the lab also link life and death in paradoxical ways. In order to make the green shades of A-beta captured on the images, scientists in the lab had to, permanently (as in the fly and mouse models) or momentarily (as with *E. coli* and proteins) disrupt and freeze the liveliness of protein aggregation processes. To know A-beta morphologies and to measure their toxicity, scientists needed to see glowing proteins visualized through imaging techniques. To produce these images, through which they could make scientific facts about protein aggregation processes, its function and morphologies, the very liveliness of the proteins had to be frozen in the state of death. These images not only had in them the novel molecular technologies that made it possible to see the invisible but also linked the dead and the living, death and life, protein life cycles, neural death, dead mice and flies and the stories they told about AD as they turned and glowed

different shades of green captured on the computer screen.

4.3

Making Alzheimer's disease: animating theories about neural death

Sawchuk (2012) argues that what animates the anatomical pictures in the first *Grant's Atlas of Anatomy* was not the photo taken by the camera but the *labor* the illustrators put into reanimating those photos through sketches, for the reasons mentioned earlier regarding photographing dead organs. Following Foucault, she argues that the labor illustrators put into these illustrations “makes the dead, and death, palatable to the living” and “resuscitate[s] the dead tissues of specimen, often housed in a jar” (145). The animation of the organs in these images is then the mutual intra-active processes of automation (the camera capturing the photo) and the artist's labor. As such, Sawchuk argues that like these images, the concept of animation also embodies this paradox, as it “impl[ies] the imparting of movement and life, yet necessarily recalls the opposite, static, and death” (145). What matters to me in this argument is the relation between imaging technologies and the labor of the illustrators that, together, enact and animate lifelike images of bodily organs, embodying the paradoxical relation between death and life. However, as I will discuss in the rest of this section, scientists in the lab were not illustrating the lifelike images of neural death on the paper or only visualizing them through computer simulations. Instead, the labor of animation in the lab was a matter of practices through which scientists animated theories of death and life as they created new forms of life and modes of dying through breeding transgenic fruit flies.

Upon my arrival in the lab, it felt as though I was entering an assembly line in a transgenic fruit fly factory. I was given six vials with a sticker on each, indicating a five-digit number representing the kind of the transgenic fly that was living, reproducing and dying in that vial. These flies were ordered from a giant fly stock laboratory in United States. Five of the cultures (each vial hosted one fly culture), were modified to have one or two of the proteins and enzymes that

are associated with AD in humans¹¹. One of the vials hosted a culture in which flies were genetically modified to express particular visible bodily modifications such as curly wings or irregular facet eyes, which are distorted¹². These bodily features would be used later to mark the bodies of the flies for experimental purposes.

I received these six cultures in a tray similar to an egg carton with small pits for the vials to stand in. The tray had the capacity of ten (columns) times ten (rows). "These are going to be your companions for the next months to come", said my laboratory supervisor as she handed me the tray. Each vial sat in a column on the tray with a replica of itself sitting in the row behind. The second row vials were the backup stock. Each column represented one particular genetic combination associated with AD. When I began my fieldwork, twelve vials sat in the tray, two in each column, with the flies inside them. *I started my work with only twelve vials*. Each vial was coded and branded as a phenotype with a distinct color of sticker: blue, red, yellow, green, purple and white. My first task was to breed more of the same stocks—to expand the number of the flies so that we would have enough for the experiment.

Day after day for months, I would enter the lab, take the original vials, and flip them into new vials. Then I would put back the original vial in its spot on the tray, label the new vial and put it on the next available row behind the original vial on the column to which it belonged. I would leave the tray for a day or two before going to the lab again, during which time the eggs in the original vial would hatch, and the larvae and pupae would metamorphose into adult flies. Then I would repeat the same routine: flip the flies into a new vial,

¹¹The first vial was 33795: flies which express the 695 amino acid isoform of human APP on the chromosome, a protein that is known to be the bigger protein from which misfolding A-beta proteins are cleaved. The second was 33796: flies which express the 695 amino acid isoform of human APP on chromosome 3. This is a similar protein to the first culture, but the difference was that the protein was genetically modified on a different chromosome, so while the protein was in the same the place it was developed to be different. The third culture was 33804: flies which express human BACE1, an enzyme known to cleave APP and contribute to the production of the A-beta peptide. The fourth culture was 33797: flies inhabiting a combination of APP protein and BACE1 on chromosome 3. The sixth culture was 33798: flies with the combination of APP and BACE1 on chromosome 2.

¹²This culture was the sixth culture and was known as DB:DB.

put a sticker on it, put in on the next empty row where it belonged and put back the original vial to wait for more eggs to hatch and more flies to be born. Eventually I had to throw out the original vial because as more and more generations of larvae and pupae were born in it, the food started getting mushy and the environment of the vial became toxic and unhealthy for the flies. Therefore, every three or four weeks I would throw out the original vial and the next one on the column would become the new resource for my breeding rituals. Moreover, in order to keep the backup vials and the flies in them healthy, every couple of weeks I would flip all the backup flies into new vials, throwing the old vials in the waste bin. The empty spots on the fly tray soon were filled by vials with flies buzzing in them like miniature tornados; you could almost hear the humming sound of their wings constantly stirring the air. It took me couple of weeks before I had a full tray of backup flies. At that point, flies were reproducing constantly on a large scale, because I had bred hundreds of flies living in these sixty vials, so that I had to constantly dispose of fly vials or it would have gotten out of control. At that point, flies were reproducing beyond my experimental needs, and therefore the extra flies were unnecessary to keep. As soon as I had my full tray of flies it was time for the next round of breeding: crossbreeding the vials. I had *sixty* vials.

I took a new empty tray as I started up with new generations. The aim was to experiment on, via crossbreeding, the toxicity of the protein and enzyme *combination* in the flies. Yet again, I began with the assembly line. While I kept my stash of flies in the first tray up and running, I started to build up and stash the second fly tray, that of the crossbreeds. In principle I was crossbreeding fly cultures. In practice I was performing the same rituals as in the first few months plus one new task, that of collecting and mixing males and females from different vials in order to breed them together. Aside from this one difference, the rest of my daily practice was identical: flip the flies into a new fresh vial, put a sticker on the vial and write the genetic combination of the flies on the sticker. Once I did the first round of crossbreeding, I had a fly tray just like the first one I received upon my arrival in the lab. There, on the first row of the empty tray, sat

ten new vials hosting the first generation of the crossbred offspring. Then I had to create backup flies, as in the previous round. As the flies reproduced over and over until they died, a new generation of sick and dying flies started to grow in number. The vials filled the second fly tray until one day I needed a third one. And then a fourth one. I remember the day when I looked up and there they were: trays of flies mounted on the two rows of shelves in the lab. There were trays of flies on each corner of the tables in the lab, and in the incubators in the other room. In the bigger laboratory upstairs, my lab supervisor and her colleagues kept more fly trays because there was more space there than in the small lab where I worked.

Christopher Kelty and Hannah Landecker make reference to the movie *Fight Club* (1999), directed by David Fincher, arguing that the first shot of the movie, which is a virtual travel through the actor's brain, is not a simulation of something, nor an illustration of a real object (2004, 32). The imaged neurons shown on the screen were actually grown via L-System. Kelty and Landecker start their argument by quoting Kevin Mack, the computer graphics specialist, who together with Katherine Jones, a medical illustrator, created the scene. Mack says,

The most interesting aspect of what we did, was the fact that we *grew* the neurons. Rather than having artists spend months modeling these very complex organic forms, we used L-Systems to grow them. L-Systems are a formal grammar for defining branching structures, primarily for defining the structure of plants, it was come up with by a botanist named Aristid Lindenmayer, and it was cool because we were actually growing a brain and while it wasn't a functional brain, you know, that's just the next step.

— quoted in Kelty and Landecker 2004, 31

Kelty and Landecker (2004) argue that Mack mistakenly believes that what appears on the screen is not a representation but the real thing, namely the brain, because it is a lifelike image. Even though he is aware that the animation is not a functional brain, he still believes that it is something alive, as he takes “the product of

his animation software for the real biological brain it is meant to represent [the real brain]" (Kelty and Landecker 2004, 31) due to the resemblance. As Kelty and Landecker ponder the reasons for such a mistake, they come to argue that often what is animated through such processes is the biological metaphor mistakenly embraced as real for its realism, or for its "apparent like-ness to some biological object or process" (32). Therefore, they argue that it is important to understand and investigate, in such an animation, not the state of likeness between the objects or processes and that which is animated; the stake is not in the lifelike images. What matters is the relation between images and knowledge through which biological objects or processes are animated. In other words, "in these images the 'life' [is] constantly produced by practices of theory, observation, modeling, and representation in life science [...]. This image of the brain is neither a magnification nor an illustration, but a complete *de novo* construction of an image 'grown' from an analytic theory of botany, cellularity, and time. It is not a simulation of cells; it is an animation of a *theory* of cellular life" (32). The way I read their work is that theories about life have been animated to represent processes of living as it is scientifically imagined. In other words, how scientific imaginaries about life actually come to life and are animated as living processes becomes the point of investigation. Today, visualization of life and diseases is not only about seeing and knowing, as Sturken and Cartwright (2009) suggest, nor is it about illustrating lifelike images of dead organs, as Sawchuk (2012) writes, but about making, materializing and animating what is known about life and diseases within life science in order to image it.

To go back to the fly lab and read my material together with Kelty and Landecker's (2004) understanding of animation of theories about life, I believe that to understand A-beta, APP and the enzymes' function in the body, what I did in the lab as I bred transgenic flies was to animate not A-beta, APP or the enzymes but that which was known about these molecular components within the context of AD science. The difference between the animation theories of AD in the flies and that of Mack's brain is that these theories about AD were not virtually enacted and grown but materially made and grown, as

flies were born with that which was thought to be AD in the lab, and they lived such processes and died of them. In other words, I was not animating lifelike AD by breeding the flies; what was enacted in the labs was partial AD and the molecular components and processes thought to be relevant to AD. I was breeding flies to represent neurodegeneration *theories* as they were thought to be taking place in the human body. In other words, in breeding flies in the lab, not only theories about AD and A-beta protein were animated in the form of living flies but also theories about neural death and degeneration came to life. I will explain this combination in more detail below.

All the flies in the vials would live for a shorter time than would healthy flies because they were sick¹³. However, through crossbreeding it could become clear which combination would be even deadlier than the genetic combination with which they were already modified. It was as if scientists were playing a genetic puzzle by breeding different cultures of flies. For instance, they bred flies with the bigger APP proteins from which A-beta protein is cleaved. In other cultures, scientists bred flies with only one of the enzymes known to cleave APP, causing the formation of A-beta peptide such as BACE1. At other points, scientists would mix these elements together and breed flies that for instance would have both APP and the related enzymes. Because many different biochemical elements are constitutive of A-beta peptides, scientists in the lab were crossbreeding the flies constantly in different ways to get multiple assemblages in order to see which protein combination, or even which protein, was more toxic and deadlier to the flies. Through genetically moving around one component at a time via crossbreeding, scientists were drawing scenarios of neurodegeneration and animating them in the flies, trying to see which fly culture would die faster. The puzzle was to find the deadliest genetic combination, based on that which was already known about neurodegeneration in AD, and to bring it to

¹³ In this context, sickness is associated with an AD-like disease that the flies were genetically modified to express in different ways. After modification, these flies showed physical and behavioral symptoms that were interpreted by the scientist as the symptoms of the disease they were carrying.

life through breeding vials and generations of transgenic flies, each embodying different understandings and hypotheses about neural death, in order to measure it. Cultures that would die faster then represented the toxic protein assemblages and would be imaged for visual evidence.

As such, theories about human disease and neurodegeneration were made to come alive in the fly bodies—flies that then would die in order to be analyzed and to give information about AD and neurodegeneration. I started my experiments with six fly cultures. Each fly culture embodied (and was genetically modified to express) singular molecular processes that were theoretically thought to be causing neurodegeneration in AD. Each culture was then crossbred with other cultures to test hypotheses about neural death in combination. Generation after generation of flies were made and *grown to animate theoretical hypotheses about death*. At points, BACE1 was thought to be the cause of neural death so scientists would only bred flies genetically modified to express BACE1. To experiment the accuracy of the hypothesis, new generations of flies were made and born to embody this scientific hypothesis about death—to embody BACE1. It was only after they were bred that they could be killed and proteins could be extracted from their bodies—proteins that would glow green confirming A-beta—related neural death. In the flies in the lab, death is not a moment of the loss of a life but the re-creation of the theoretical processes of dying from overexpression of BACE1 or APP. In other words, these flies are *made-to-live-an-AD-related-death*. Whether death is thought to be related to overexpression of APP or whether it is the overload of BACE1, the flies are accordingly, genetically made to animate such scenarios of death and live it to the point of actually dying of it. As they age with AD, and as BACE1 or APP takes over their bodies and kills neurons over time, these flies live a toxic mechanism associated with AD, allowing scientists to study their *gradual death*.

The production of flies, as I have explained so far, shows another aspect of the paradox of animation. I referred to Sawchuk (2012) and her argument that, within medicine, information about living organs and processes is often animated through illustrations of dead bodies

Figure 4.2: One of the four tables in the lab with the shelves and fly trays on them.

and organs. Breeding the flies shows the other side of this coin, which is bringing death and dying to life in order to gain information about them. Breeding the flies to embody theories about neural death shows how scientific knowledge about death, toxic processes and neurodegeneration is animated and brought to life for knowledge production purposes. In other words, flies' breeding practices are not an exact replica of Sawchuk's dead specimens and organs. Nor are they the same as the imaging practices, mentioned earlier, in which flies and mice were killed and imaged in order to produce information about A-beta. Fly breeding practices in the lab, however, are similar to the opening scene of the brain in *Fight Club*: not virtually made and grown but organically bred and lived. In other words, their bodies are actually made through genetic manipulation and crossbreeding in order to animate new modes of life as well as new forms of death. Theories about death are brought into life and lived by the flies.

Looking at the shelves around me and counting the vials hosting thousands of genetically modified, sick flies, I realized that death was not only the rotting smell sneaking out of the waste bin, abstract in the air, that made my nose wrinkle. Death was not only the dead

bodies of the flies piling up in the vials. Death was not simply the growing number of the flies dying during and for the purpose of the experiments. Death was not only the small, culturally insignificant bodies of new generations of transgenic flies, which were dying from a disease. Death also encompassed the growing number of the flies bred to live those deadly neurodegeneration processes, stored in carefully labeled vials in large numbers, buzzing around with their strange eyes—eyes bred to be red, eyes that were genetically marked and distorted. Death was the procedural process of living and dying enacted through the materialization of multiple scientific hypotheses about what an AD-related neural death can be. Kelty and Landecker argue that imaging life involves animation insofar as life is “constantly produced by practices of theory, observation, modeling, and representation in life sciences and as such they are ‘set in motion’” (2004, 32). However, in the lab of my fieldwork, the everyday practice was to animate theories of cellular death, which could be visualized through active processes of molecular binding and molecular imaging. In the lab, researchers genetically modeled and made lifelike processes of neurodegeneration and neural death associated with AD in humans, not only simulated and illustrated through the flies but enacted in material ways such as in BACE1 or APP fly cultures. Animating in this sense involves the making and marking of fruit fly bodies, as well as genetically rewriting theories about neural death, which were expressed in the flies in the form of bodily morphologies.

Last but not least, animation in the lab also literally involved making a documentary of these dying processes, as scientist videotaped the flies over periods of weeks and months.

FIELD NOTE NOVEMBER, 2012: *Apparently the healthy flies like to fly almost all the time. They are fast in their movements and they like to fly up to the cork of the tube and hang out there, flying in circles, sitting on the cork and jumping up and down. If they fell down or flew down to the bottom of the tube, they often immediately would take off again to the top of the tube. When looking at the fly tubes in the lab, there is often a cloud of flies pulsating near the cork as if they are all pushing against it to break free. They are like a mass not only because there are too*

many of them but often the healthy flies like to fly together and keep each other company. They also have a certain pattern of movement across the space. It is different with the AD flies. I could see the difference on a daily basis without any technological assistance. I mean, it was so obvious, the difference, that it could be perceived by the naked eye. In the beginning of my experiment, when the flies were not yet sick, because the accumulation processes were still in their early stages, it was a nightmare to flip the tubes. Every time one or two of the flies would get away, flying out of the tube. No matter how fast I flipped the tube, they were faster. After some days though, I could see the flies moving slower and slower and eventually, in their final days, they were just sitting down at the bottom of the tubes, barely moving, not to mention flying. Not only had their moving habits and speed changed but also they were becoming more and more isolated from one another, each sitting with a noticeable distance from another, moving slowly to one side or another. Last was their pattern of movement which became more obvious after the iFly software calculation. Apparently, the flies with the more advanced toxicity in their body move in an unruly manner in circles or zigzag between point A and point B. A healthy fly often takes off from point A to point B directly.

There was a small box on the table next to the computer in the second room, which was a 3D camera. In the middle of the box, two mirrors faced one another in the shape of a V. The V faced the camera. The camera lens and the mirrors formed a triangle. Toward the top of this triangle, close to the camera lens, was a small round opening. I had to put the tubes in the opening and videotape their contents for one minute and thirty seconds. The camera was connected to a computer next to it. I could command and control the videotaping device, and I had to save the results on the computer. A program called iFly was installed on this computer. The iFly tracking system uses a single camera to capture the trajectory of up to twenty flies' movements while simultaneously providing statistical analyses of the movements in order to measure the locomotor changes in the flies that are the result of different stimuli (see, e.g., Kohlhoff et al. 2011). For instance, I would record the crossbred flies, and as I saved the movie on the computer, the iFly would automatically transcribe and measure the flies' movement patterns, speed, and velocity into

numbers that would later be translated into graphs. Each graph would show the death curve of each culture on its own and in comparison to the others. In these practices, the dying bodies of the flies were translated and transformed into calculable numbers and logistic graphs once the computer reduced their movements into measurable codes. Movement historically has been associated with life and animation, as media and cultural studies scholar Jackie Stacy and STS scholar Lucy Suchman (2012) argue. Therefore, thinking with animation, movement and digital recording practices, it is clear that neurodegeneration is animated in these practices as a matter of movement—namely, the flies’ movement patterns and velocity.

4.4

Making Alzheimer’s disease: On imaging and intra-animacy

As Haraway (1989) argues, science is a narrative as much as it is material; it is a storytelling practice, as scientists narrate the results and processes of fact making. Science is, as such, as much fiction as fact. It is within such an understanding of science and its entanglement with language, culture and politics that Haraway urges feminists to take scientific metaphors seriously, for it is through such metaphors that worlds around scientific facts are made (im)possible. Interestingly, in my interviews with scientists, they talked about molecular agents such as proteins and antibodies using particular phrases and metaphors: discussing their experiments, they constantly used verbs such as “behaving”, “reading”, “recognizing” and “acting out” to explain proteins’ properties. For instance, when explaining the molecular binding processes, Anna said,

[You use antibodies] if you want to know which proteins are involved. [Often] you have a guess like A-beta, and there are antibodies against these proteins. This is how antibodies work, if you get an infection so your antibody starts detecting that there is something foreign and then it [the foreign entity] will be eaten alive by the cells in your body. But

you can also use this to generate antibodies against specific proteins and these antibodies you can then use. So if you have, [let's say], *apple protein* and then you have the *antibody against the apple protein* and if they meet *the table* they won't recognize each other and they won't bind and if they meet *the paper* they won't bind either but if they meet *the apple* they will recognize and bind and then you can detect this antibody. What is important is that they can read one another.

She laughed as she blinked, making a joke and saying, "They have their secret language". It was not only Anna who used adjectives culturally associated with a human subject to explain happenings on the molecular level. For instance, she referred to the molecules' "secret language", as in their ability to recognize or read each other. Helen also used this kind of language while trying to simplify the complex molecular phenomenon for me, with my lack of background in biology or chemistry (not to mention molecular biology and protein chemistry). In our interview, she used the term "protein behavior" several times before I asked her what she meant by that term. This is how she responded.

HELEN: For example, some proteins like to be in the tetrameric form, some proteins like to aggregate. In this sense, certain proteins have certain properties. They all have the environment they want to be in. It [protein behavior] is an expression that we use a lot. What you are actually saying is that "the specific properties of this protein are this" when you say the "protein is behaving".

TARA: You said, depending on how proteins behave, the experiment can be challenging. Can you explain a bit more what you mean by that?

HELEN: For the A-beta the behavior is very difficult because it is irregular, you cannot be really sure how it is behaving. Some proteins are very nice and they behave the same way and you can use the same settings. But with A-beta, you are using the same setting but you are getting different results. So it is difficult to work with it, sometimes you get nothing from purifying it.

Not all the time. But sometimes during the process, you do all the steps and when you come to the part that you expect to have the protein you may have nothing.

One way of interpreting Helen and Anna's mode of talking about A-beta proteins and molecular agents—using language such as “detecting”, “behaving”, “recognizing”, or “speaking”—could be in line with Myers's (2015) discussion on animating. As Myers argues, often protein modelers anthropomorphize proteins: they attribute human characteristics and agency to the proteins and animate them with humanlike behaviors. The problem, she suggests, is that animating and anthropomorphizing the proteins may confuse the nonexpert audience, projecting creationist or false evolutionary ideas on to them about intentionality and the survival of the fittest. In other words, Myers writes, within neo-Darwinian evolutionary views, unlike the popular take on evolution, the organism that survives is not a conscious actor, one that adapts itself to the environmental changes; “it is not the organism that changes their genome (nor some god designing it). The animal is not the active agent of mutation who intentionally transforms the genes. In neo-Darwinian theory, it is argued that what happens in natural selection is that in its interaction with the environment, the randomly mutating genome in the body of the organism opens up opportunities for it to ‘exploit’ specific environments” (192). This mutation is a random relational becoming of the body and the environment. Myers brings in the example of giraffes, arguing that only those whose genes “endow them with long necks” survived as they could reach the high branches for food and pass their genes to the next generation (192). In other words, the protein mutations and cellular functions happen through “random mutations in DNA”, and as such “organisms are the effects not the agents of evolutionary novelty” (191–92).

To go back to the lab and thinking with Myers, one can argue that animating proteins through anthropomorphizing them for educational purposes (as occurred when Helen and Anna were trying to explain their experiments to me) may suggest that the proteins have desire and agency, and communicate false ideas about their intentionality.

For instance, Helen mentioning that the proteins *like* a particular environment or *like* to bind in certain ways may give the wrong impression that proteins have desires. As Myers writes, "to suggest that proteins have any agency in directing their own actions within cells is just as blasphemous as suggesting giraffes grow long necks in order to reach into the trees" (2015, 192). Myers argues, and Helen also expresses in the excerpt above, that scientists are well aware of such evolutionary randomness in living organisms. In other words, my informant Helen did not intend to argue that the proteins have a conscious desire when she said, "they all have the environment they want to be in". She quickly reminded me that when she uses such phrases regarding protein behavior, she is referring to the "specific properties of that particular protein" that is extracted from several experiments under replicable circumstance. Both Helen and Anna, despite animating proteins and molecular agents in their explanations, were careful to remind me of the randomness and that what happens on the molecular level is different from the human world and human characteristics.

Yet, despite the risk that such anthropomorphization of proteins entails, as Myers also mentions, it is an effective educational tool. My suggestion is that maybe the problem is not necessarily about anthropomorphization of the proteins as one animates them but the cultural understanding of certain behaviors as strictly human traits. In other words, Myers's critiques of anthropomorphization of the molecular processes stand as long as certain practices, such as speaking, recognition, desire or language, are understood as bound to a rational human subject. What if humanistic characteristics such as desire (Grosz 1995), agency (Barad 2007) and language (Kirby 2008) are not human at all? I wonder if a shift of lens from understanding such animating characteristic as anthropomorphizing into renegotiating of the characteristics themselves may be rewarding here. If so, it may not be far-fetched to say that proteins and molecular agents appear to have preferences and desires—thinking with Grosz (1995), there may be a visceral and affective relational intensification and connection occurring within these agents. In this sense, proteins' desire is the affective ability to attract or repel each other in a social setting called

the petri dish¹⁴.

FIELD NOTE NOVEMBER 2012: *Today, I spent many hours with Anna. It was very interesting because I get to see mouse brain tissue. There on her desk lay a weird-looking device which reminded me of an ice cube tray: a square-shaped flat tray with small deep holes in it in rows, called microtiter plates. In each one of the tiny pits was a slice of a mouse brain tissue, floating in fluid. Anna told me that they receive the brain in one piece and then they use a device which functions like a ham slicer in the supermarkets, with which they can slice the brain in very thin ten micrometer sections. There they were, the ten micrometer sections floating and waiting for the antibodies poured on them to bind to the A-beta proteins that they supposedly had. They were floating because, as she told me, the molecules needed to bind on both sides of the tissue. Once they were ready, Anna had to image them. She took me into a different room. As we entered I saw one giant microscope and a huge computer of some sort. There was a loud humming noise in the background which appeared to be an air conditioner to cool the room so the devices would not be damaged. We talked, loudly, through the humming sound. She showed me images of the brain tissues. The results were fabulous. Some of the pictures were blue. Others were red. The blue one was dense, compressed and packed, like someone had dropped the bucket of paint and the liquid was splashed on the canvas with a dense core where most of the paint had landed. The red ones were smaller and more transparent. More like as if someone had dipped the brush into the paint and splashed it onto the canvas. I asked, so what do these colors mean and how do you make sense of them? She said, these are different stages of A-beta formation. In the younger brain the proteins are less advanced; the red color is the younger brain, the early protein stages. The older they get, they become more advanced and denser, more like plaques. Those are the blue ones.*

I thought, it is then this binding that is materialized in the form of blue or red clusters in the images? These images reminded me of the green images in Anna's lab. They reminded me of metaphors Anna used to explain such molecular binding processes, as she told me the story of apple, table, paper, and their secret language through which they recognize one another and

¹⁴I would like to thank my supervisor Cecilia Åsberg for suggesting the petri dish as a social setting in which proteins have preferences and affective abilities.

bind together. I wondered what kind of a language do the apple, table, or paper talk? I wondered if AD is a story about apple language and molecular bindings, which Anna was only retelling after it was already told, after it was already done, after it had already been spoken—only after the apple and the molecules had already been bound?

As much as protein morphologies in the lab are visual images, as each image represents one protein species, they are also about material biochemical transformation and transspecies¹⁵ meeting, mutual connection and coupling, once one thinks about species in a broader way: that of protein, molecular and antibody species. These images are about transspecies¹⁶ dialogues—that of speaking the apple language that Anna spoke about as a metaphor in the excerpt above when she was simplifying her explanation of the communication between the molecular agents, antibodies and proteins. The images are about recognition and binding as if the proteins, antibodies and molecular agents have their own secret language with which they communicate to one another.

As feminist philosopher Vicki Kirby (2008) writes, if one thinks with natural science, one realizes that language is not limited to culture or humans (and maybe a few animals). Rather, “the stuff of body appears as codes, signs, signatures, language systems, and mathematical algorithms” that make it more obvious that, as she writes, inspired by Derrida, “the puzzle of language” in natural sciences and biology is as evident as it is in literature and philosophy (218). This is to say that the literalism, the reduction of life and death to codes and information is itself a complicated, transspecies, material affair. Language here is understood as material rather than purely discursive. Language includes material forces through which neurons are fired, bacteria encrypt and proteins bind; it entails the materiality of life itself as much as it indicates that life itself “is creative encryption” (219). Language then becomes performative. It

¹⁵It is transspecies because human and nonhuman genes and proteins pass the threshold of the transgenic mouse and fly bodies.

¹⁶As proteins and genes pass through the boundaries of species and engender transspecies critters, the bodies of the flies and mice resist, accommodate and as such enter a transspecies dialogue with human disease.

is a (nonhuman) *doing*. As such, when Anna is animating proteins and antibodies as she talks about them speaking the apple language or recognizing one another, not the intentionality of the molecules but their agentiality and posthumanist performativity that are at stake.

The molecularization of AD, as a matter of protein morphologies, also involves materializing temporality—a nonhuman temporality, that of the proteins' progression and the simultaneous decay and death of the neurons; one is born and becoming mature as the other fades away and dies. As such, the plaques in the mouse brain tissue are configurations and biochemical transformations that not only hint at the death of neurons but *are* the death of neurons in a material sense. Crucially, death as well as AD is performed in practices of the molecularization of AD. In other words, while plaques signal an already dead neuron, monomeric single proteins signal the beginning of the degeneration process, which theoretically could be stopped, had the proper treatment and effective molecular agents been developed. The stage at which oligomers occur is suspected to be the most toxic. At this stage, the degeneration is thought to be taking place most strongly; neurons are dying quickly. In other words, while plaques (the blue images) are the embodiment of (neural) death, a death which has already happened, oligomers (the red images) signify the very process of dying itself and a possibility of preventing neuron death. As Anna explained, while the blue color testifies to a dense material substance, namely plaques, the earlier oligomer stage appears on her slides as red, where the material substance is less dense.

To summarize, in the mouse lab, AD is enacted in terms of protein morphologies, as proteins are purified, made and imaged. It is also enacted in terms of death. Thinking with matters of practices, *death itself*, while isolated and reduced to fixed codes and information (e.g., oligomeric toxic proteins), becomes a temporal, procedural protein-related death as much as a material transspecies encryption performed by nonhumans. Through making and imaging different stage of A-beta protein misfolding and their morphologies, different stages in the gradual process of neurodegeneration and neural death are also performed. In other words, to take practices seriously, to discuss the molecularization of AD in terms of material-discursive practices,

requires not only expanding the human-centric understanding of AD but also revisiting the meaning and materiality of practices themselves as something bound not to the human subject but to a posthumanist performativity.

Myers (2015) suggests the term “intra-animacy” to highlight that visualization of protein via crystallography is an intra-active process. Using Barad’s concept of intra-action (see chapter 2), Myers offers examples from laboratory work to show that it is not only human subjects that animate protein models and work with proteins—the scientists themselves have been animated as they develop a feeling for the proteins (see chapter 3). As they learn how to intra-act and work with the proteins, scientists are animated as much as the protein models are. Myers refers to this process as intra-animacy in order to highlight the mutual becoming of the modeler and the model through the animation processes and visualization of proteins in the lab. In this part of the chapter, I tried to add another aspect to Myers’s intra-animacy, as I was trying to show that proteins are not only enacting the modeler, as Myers writes, but also materially performative of the images themselves. I aimed to argue for posthumanist performativity as a constitutive part of images. As such, to take the agency of the nonhuman seriously, intra-animacy also renegotiates the meanings of imaging as dynamic intra-active process of becoming through which not only AD but also death are performed.

4.5 Conclusion

*Who shall conceive the horror of
my secret toil, as I dabbled in the
unhallowed damp of the grave,
or tortured the living animal to
animate lifeless clay?*

— Shelley [1831] 1980, 54

As Catherine Waldby (2002) writes, Mary Shelley’s *Frankenstein* has

been the inspiration for many articles written within the humanities, social sciences and bioethics, pondering the promises or destructive potentials of science and technologies that meddle with life such as in vitro fertilization or DNA technologies. However, Frankenstein is often understood and related to within such analyses as a figuration representing “technology out of control” (Waldby 2000, 29). Waldby argues that what is monstrous about such a figuration is that it threatens Western ideas about human integrity and purity, as it crosses the boundaries of life and death, technological and organic, human and nonhuman. Moreover, Waldby suggests, inspired by nineteenth-century scientific experiments with life and vitality, that Frankenstein is a monstrous figuration because it embodies certain techniques of vitality and the scientific ability to engineer living systems, renegotiating life as a divine transcendental force into vital bits and pieces that can be made by humans. Last but not least, the monstrosity of Frankenstein stems from the fact that it is no longer fiction: it represents the human body within the contemporary era of information and bioinformatics. She writes, “the monstrosity of the creature’s body implies the monstrosity of our own” (Waldby 2002, 29), which is immensely entangled with technologies and biomedicine. However, whereas Waldby stays with the figuration of Frankenstein to discuss the “subjectivity of the scientific object” and the techno-organic body, in this chapter I discussed the material-discursive becoming of such monstrous bodies in the lab. I wrote about the enactment of life and death within AD laboratory practices through which not only vitality or life has been enacted in multiple ways but so has death. Practices in the lab not only envision and animate life on the molecular level but also molecularize and animate death and processes of dying on the molecular or neural level.

I argued that imaging is not only to image organs and body regions, as in the *Grant’s Atlas of Anatomy* that Sawchuk (2012) writes about. It is not only to image and break the body into image-able molecular and cellular structures but to make and animate such bodies and life on the molecular level with the purpose of being imaged. I drew on Kelty and Landecker (2004) in order to argue that animation in the lab brought to life that which is thought about death. Transgenic

fruit flies were made to live an AD-related death and as such animate theories of cellular death. In this case, the monstrosity was not only trespassing the boundaries of life and death in *Frankenstein*, which involved using dead people's body parts as technological probes in assembling and animating life. Rather, the monstrosity involved animating that which was thought to be death and bringing it to life. Neurodegeneration processes and theories about protein toxicity were animated in the flies as they lived it and suffered from it in order to generate knowledge about human bodies and disease. As Landecker writes, "this is a shift not just in what is thought or said about death but in what it is possible to *do* with death" (2003, 26. *Italics in original*). Death, in the lab, was literally, organically and materially made and animated in order to be imaged.

However, as I discussed in this chapter, animating death, life and AD is not a humanistic trait. Thinking with practices of imaging and the materiality of life and death, I came to argue that death becomes a nonhuman process of becoming and chemical transformation. Death becomes relational, multiple and a posthumanist performativity. Death becomes something that is animated in meaningful ways in relation to scientific hypotheses, the temporality of death and biological (im)possibilities. As such, animation is not an attribute of a subject or something that can be given to an object. Instead, it lies in the entanglement of human and fly bodies, scientific hypotheses about death and dying, and the practice of breeding flies for imaging purposes. I borrowed Myers's (2015) concept of intra-animacy to argue that animating AD in the lab is a posthumanist agential performativity.

I explored the relation between animation, knowledge and material-discursive becoming of processes related to AD. Death as such loses its abstraction and becomes a material-discursive practice through which it is performed not only in terms of dying flies but also the toxic proteins with which these flies are saturated. Death becomes a visible matter, something "more than a null quantity; it has gained a substantial and significant existence in its own right" (Landecker 2003, 25). It becomes the practices of isolating, manipulating, recombining and identifying not life but moments and components of death and

processes of dying. As a result, not only new forms of life but also new dying bodies and modes of death are enacted across the boundaries of species. Neural death is in these practices associated with “visual morphology, a spectacle that [is] then taken to signal the presence of an unknown but presumably repetitive, inherently uniform cellular process” within science (Landecker 2003, 29).

Last but not least, I showed that in the lab, AD is not much about memory loss in human subjects or the hallucinations, dis/orientation or neurodegeneration that is associated with brain atrophy. Although such clinical pathologies are part of scientific practices, although many of the scientific trials are done to create more efficient ways of achieving AD clinical diagnoses, and although in many scientific labs the drive is to come up with a cure or preventive measures that can help patients, such clinical objectives are not what scientists *do* in their everyday scientific quest to unravel the mystery of AD. This focus highlights the fact that there is a huge distance between the appearance and imaginary of AD in popular culture, associated with a picture of a deteriorating human subject¹⁷, and laboratory practices of doing AD sciences on the molecular level. In the laboratories I visited, AD is all about molecular and biochemical processes. Although the scientific view on AD shares the deterioration and degeneration stories with popular culture, it is dying mice, flies, cells and neurons rather than humans that are central in the lab. In other words, the narratives and materiality of death are an enormous part of AD sciences, though it is nonhuman death that is created, done and performed. This is to say that with the emergence of biomolecular technologies such as molecular imaging, not only have “bodies” been scattered into tiny bits and pieces but life and death, “living matter” and “dying matter” have also been understood, acted upon and performed in novel ways. Nonetheless, the humanized bodies of animal models in the lab, such as fruit flies, remain monstrous—not necessarily because they threaten the purity of the imagined human subject and their body, as in *Frankenstein*. They remain monstrous in material and discursive relations, human and fly history, scientific possibilities and

¹⁷ Åsberg and Lum (2009, 2010) critically reflect on and problematize such cultural imaginaries.

bodily characteristics that enact them as a perfect model and therefore killable in the lab, which I will discuss in the next chapter.

Spectrum of Killability

It was a random day in the lab. I had to collect virgins to cross with six Alzheimer's (AD) subcultures. They were called virgins by the scientists because they were picked in the first eight hours of their hatching and before they had sexually matured. It was important to pick female virgins for the crossing so that scientists would know they were not impregnated by unwanted genes. I had already visited the lab the evening before and emptied the fly tubes so the new ones could hatch. There were about ten genetically modified fruit flies in each vial. I looked at them under the microscope and separated the females. I got one to three females from each vial. Next, I carefully pushed those selected with a brush into new vials and pushed the rest into the ethanol bin. For two weeks I had gone to the lab twice a day to perform the exact same ritual: collecting virgins, killing the rest and leaving the vial in which new transgenic fruit flies would hatch. In this way, I disposed of roughly 670 transgenic fruit flies during those two weeks.

That wasn't the biggest killing though. That happened a month later, when my main work assignment changed from finding the virgin fruit flies¹, to collecting A-beta/BACE female fruit flies² with

¹They were called virgin because they were collected in the first 8 hours of their life as adult flies and it is believed that during these 8 hours female flies would not mate. The reason we needed them "virgin" was to make sure that they would be mated with the desired flies that have the correct genetic modifications so that we could breed offspring needed for the experiment.

²A-beta or amyloid beta peptide is a misfolded protein that accumulates in the

the balancer.³ The genetic combination was so specific that only a few fruit flies would show all the right traits. I needed thirty virgins from each culture. I had five vials of each culture and six different cultures: thirty vials in total from which to pick virgins. The first day I emptied the tubes, I got over fifty fruit flies from each. I picked between five and eight fruit flies from each vial and threw the rest into the ethanol bin. That one evening, I killed over 1,200 fruit flies. I continued this ritual for two weeks. Even though the number of the hatched transgenic fruit flies was less than the first time, still, a lot of transgenic fruit flies died.

The project I was involved in was one of many projects in this small lab. We were four people engaged in collecting the “right transgenic fruit flies” and killing the rest—or, in other words, engaged in the daily practices of scientific experiments of this particular lab. We killed at least a hundred transgenic fruit flies per day, per person. I alone killed at least three thousand transgenic fruit flies in a month, for only one experiment. Had I killed a total of 36,000 flies, would I have continued working in the lab till the end of the year? I wondered, if I alone could kill 36,000 transgenic fruit flies in a year, how many fruit flies would we collectively kill in a year? If we all were working on only one experiment, four of us could have possibly killed 150,000 fruit flies in a year. However, others working in the lab were carrying out parallel experiments, sometimes three or more, and that made the number of dead fruit flies even higher. If I combine and multiply the yearly killings by the number of parallel experiments in the lab, I arrive at the hypothetical number of two million fruit flies killed per year. Two million fruit flies: that is the death rate of fruit flies in a small, humble university laboratory.

In 1910, American evolutionary biologist and embryologist Thomas Hunt Morgan started using transgenic fruit flies in his studies of heredity. In 1913, he established a fly lab at Columbia University

brain, and it is associated with AD. BACE is an enzyme that is responsible for cutting the A-beta protein in the wrong sequence and contributes to the A-beta misfolding protein accumulation.

³Balancers are tracing genes. There are two balancers expressed in fruit flies in the form of hair on the shoulders or curly wings. Once fruit flies express these features, it is easy to track which have the required genetic combination for a given experiment.

(Kohler 1994). His work with *Drosophila* established not only the role of chromosomes in heredity and the foundation of modern genetics but also *Drosophila* as a standard model organism in modern genetics. Although in the early years, he and his research group developed transgenic fruit flies for their personal genetic experiments, soon they were providing their samples to laboratories outside their university. Over the years, Morgan's original stock grew to over a hundred (his initial number). By 2012, it had grown into a giant *Drosophila* stock, with 44,904 cultures and 222,981 subcultures, funded by a number of governmental and private organizations, among them, notably, the National Institute of Health and National Science Foundation in the United States.⁴ If we, in a small university laboratory, had a death rate of two million *Drosophila* per year, how many transgenic fruit flies die to maintain a live stock that accommodates a minimum of 222,981 subcultures and 44,904 cultures? Because this giant *Drosophila* stock makes up only one of many providers of transgenic fruit flies across the world, how many billions of transgenic fruit flies are dying monthly, and yearly, within the life sciences and drug industry? And why should we care?

Within contemporary narratives of laboratory life and natural sciences, particularly in popular culture, the focus is often on celebrating novel forms of life and technologies of optimizing life. What is often left out of this productive, progressive discourse of the lively image of scientific breakthroughs is death. If mentioned, death is narrated in terms of "salvation narratives" (Haraway 1992), justified as collateral damage and a necessary evil in order to pursue the better good of "all"—in other words, those whose lives matter. This chapter shows that a big part of laboratory practices, perhaps even bigger than their aim to create life, is about the killing practices that come about with those processes of creation, manipulation and optimization. The death of mostly nonhuman animals such as mouse and fruit flies, and organisms such as cell lines and bacteria, in the lab is not only due to experimental practices such as sacrifices and dissections—death and killing are a constitutive part of the processes of creating life through breeding and keeping a living stock, as I showed in the previous

⁴ <http://flystocks.bio.indiana.edu/Inst/history.htm>

chapter. In this chapter, however, I aim to demonstrate that there is a *spectrum of killability* on which different animals and organisms become killable differently, depending on their biological specificities, sociocultural imaginaries, ethical dilemmas, the laboratory's style of reasoning and technical practicalities. More precisely, I analyze how particular biological entities such as fruit flies become nonanimal in relation, and therefore killable. I analyze killability, as a phenomenon and a state of becoming, through the Baradian lens of *agential cuts* (Barad 2007). I ask which material-discursive cuts are made inside and outside the lab that enact particular animal and biological organisms as killable within scientific practices? If killability is a phenomenon, a state of becoming in relation, is it possible that killability is a material-discursive spectrum?

In order to answer the questions above, I look at the three different labs that I contacted during my fieldwork. I examine three different models that are favored in these labs to show which cuts are made and which animal models are born as the desired AD animal model or test object.⁵ I ask whether an animal model becomes the (im)proper animal model and (not) killable differently through various experiments. Before I get to the labs, though, I wish to discuss the relation of humans and flies, through which flies have been constantly enacted as killable in different modes.

5.1 Messengers of death: From culture to medicine

While it is fly that spreads and carries disease to humans, it is also humans who spread and carry flies. Flies and human are reciprocal hitch-hikers. And, although flies can bring into our houses and onto our plates organisms that we would

⁵Inspired by Barad, I understand "object" to be ontologically inseparable from the agencies of observation. So, when I say "object" in this chapter, I mean it in its relationality and object as an agential realist phenomenon. The reason I stick with the word object is also to highlight how animals become objectified and exploited in moments that cuts are made and the animal models become living test tubes—or, in Barad's words, the apparatus—that contribute to knowledge production in the AD laboratory. The object then becomes exploitable in its agentiality once the cuts are made.

prefer to hold at a safe distance, the restriction of their range means that what they bring to us is mostly our own. Flies bring us disconcertingly to ourselves.

— Connor 2006, 17

*Am not I
A fly like thee?
Or art not thou
A man like me?*

— William Blake, "*The Fly*"

Steven Connor (2006), the modern literature and theory scholar, argues that flies⁶ are a more familiar companion to humans than any other companion species such as cats, dogs or rats. Flies have been spread across the globe mostly via (traveling) humans and human companions, such as horses. Up until now, and for centuries, flies have shared human habitats, because a crowd of human beings means a lot of food for flies. Agricultural societies and urban lifestyles not only increased and densified the production and consumption of organic foods and matter but also increased and concentrated the distribution of waste. In other words, wherever there is a group of humans, there is waste and decaying matter for flies (among other creatures) to feast on. A large amount of disposed agricultural crops and animal stock and waste is attractive to flies. The construction of waste disposal systems through gutters, drains and sewers mobilizes disposed bodily matter and daily household waste. Wars, epidemics and disasters create a large number of human and nonhuman decaying bodies. Flies such as house flies and stable flies usually lay eggs in piles of waste, fertilizers, dung or decaying matter⁷. When flies' maggots hatch, they

⁶Connor argues that the generalized term "flies" in the cultural sense often refers to flies such as the house fly, stable fly, tsetse fly, blow fly and similar flies; these are more familiar to human population for their feeding and breeding habits, which I discuss in this chapter.

⁷As I discuss later in this chapter, not all fly species feed on waste and decaying matter, and not all are associated with death and disease. But the imaginary of the fly

need moisture and protein to feed on until they pupate. It is not only the maggots that need decaying matter; adult flies are drawn to it, too. Among different kinds of flies (there are thousands of species), blowflies and flesh-flies are most likely to lay eggs on dead bodies, including human bodies (Connor 2006, 10). As Connor writes, flies and humans have been bound in a “husbandry of the kind that was folded around waste and decaying matter” (2006, 10). Indeed, one of the points of identification for humans with flies is death. As Connor writes, flies “bring us close to the most intimate fact of all, that of our own certain, personal death” (2006, 26), and even if we forget about them, “flies are with us to the very last moments when our body is decaying” (2006, 28). The American poet Emily Dickinson captures such an entangled mutual relation of death and life between flies and humans when she writes, “I heard a fly buzz when I died” (1945).

The association of flies with death and decaying matter designates flies as the messengers of death and disasters: a figuration which has been feared across cultures over time. For instance, fly-shaped amulets (with the body of a fly and a human head) were discovered in Egyptian tombs. These amulet were assumed to be a symbol of death and a passage of soul. As Connor writes, within ancient Egyptian culture, flies were associated with the flying soul that is leaving the body after death, and therefore they were feared⁸ (2006, 36). According to Connor, the French philosopher Jean Bodin wrote about how flies were seen as unholy and unclean because god was thought to limit the power of Satan to controlling preliminary and less developed creatures such as flies. Flies were also considered demonic because they were companions to witches.⁹ According to

as such, as a figuration of death and disease and decaying matter, is stronger within Western cultures.

⁸It is suspected that such a cultural association with the passing soul of a dead person is related to mummification: when dead bodies were kept for mummification, flies would lay eggs in the decaying matter. When the adult flies left the body, Egyptians would interpret it as the soul having left the body (2006, 35).

⁹Flies are so small that they could be used by demons and witches to come and go without being seen almost anywhere. Such an ability to move between spaces without being seen was how witches and demons were thought to move and take over (Connor 2006).

the ancient religious book of Avesta,¹⁰ an impurity would enter the dead body that was described as a fly-demon. Flies were constructed as demonic and ungodly figures that could inflict pain and death. Over the centuries and in biblical sources, the figure of Beelzebub or “Lord of the Flies”, who was imagined as a fallen angel, or a demon, was associated with not only death but also gluttony as in the seven deadly sins¹¹. Even in the lab, my informant told me that a fly is always drawn to sweetness, often it gets stuck in the food and dies in its pleasure. Furthermore, the Old Testament takes the deadly power of the fly from an interrelation between one body (fly) infecting another (usually human) to the relation between flies and nation. In other words, flies could also bring death to the nation, as they did for Egyptians in the plague of the flies in Exodus¹². However, as I show later in this chapter, it is humans who are bringing death to, if not a new nation, a new species—namely, transgenic fruit flies¹³.

Long before their role in transmitting diseases had been verified by scientific measures, flies were culturally associated with dirt, disease and death. As Connor (2006) writes, within Hebrew culture flies were associated with a skin condition later called leprosy, and Jews associated venereal diseases with flies. During the nineteenth century, bacteriological scientific developments had a hand in the construction of flies as “humanity’s great entomological antagonist” (2006, 103), being the carriers of typhoid, cholera, tuberculosis and polio, the major causes of death at in the mid- to late 1800s. Historian of medicine Naomi Rogers (1989) writes that insect theory mainly took off as an escape for describing epidemics that resist the usual modernist public health theories, which relied on cleanliness and

¹⁰ Avesta is an ancient Persian religious book of God.

¹¹ <https://en.wikipedia.org/wiki/Beelzebub>

¹² This is a reference to the ten plagues that were sent by God upon Egypt to both confirm Moses’s authority and show Egyptians the power of Moses’s God who was to be worshipped instead of the Egyptian gods. The fourth plague was flies.

¹³ There are different kinds of fruit flies but the ones that were used in the lab of my field work were from the family known as *Drosophila*, particularly the species known as *D. melanogaster*, which is heavily used in modern developmental biology. However, in the lab, scientists would interchangeably call them with any of the three terms, namely *Drosophila*, *D. melanogaster* and transgenic fruit flies, and I do so as well in my thesis. However, when I use the term *fruit flies* without the adjective transgenic then I refer to the wider family of fruit flies.

health as a matter of separation of spaces (based on, for instance, race and class) and species. She critically reflects on the assumption that “insects, potentially, could spread disease randomly; it was not the fault of middle-class parents with a paralyzed child if a germ-carrying fly had traveled from the worst parts of the city” (1989, 498). Once again, similar to in the religious narratives of demonic flies, flies were depicted as species to be feared in insect theory because they could travel between spaces without being seen, carrying microscopic germs and bacteria with them that would spread disease and death, not only to individuals but to nations in the form of epidemics.

If the association of flies with death and disease was mostly a matter of cultural symbolism and religious belief, after discoveries in bacteriology, such an entanglement became a point of social and medical anxiety. In other words, as Connor writes, from the 1890s until 1920, the imaginary of flies changed dramatically from them being harmless cohabitants (medically speaking) to a “subject of ruthless campaigns of extermination” (2006, 108). For instance, as the South African naturalist Frederick William Fitzsimmons book title *The House Fly: A Slayer of Men* shows, flies were thought to bring death to humans and therefore to be killed without mercy (quoted in Connor 2006). According to him, Fitzsimmons compared flies with deadly cobras, even saying that flies were deadlier. To Fitzsimmons, a war against flies was the moral and civic duty of all. With the rise of bacteriology, the association of flies with death, disease and disaster became “scientific reasoning” followed by public health campaigns and personal vendettas to kill the flies. Flies became killable as the embodiment of disease and dirt and as messengers of death to humans. The war against flies was stretched to the extreme when the Philadelphia Department of Public Health published a poster that read, “A fly is as deadly as a bomber”, evoking and feeding into the narratives of war, nations, death and flies in the midst of WWII.

In these discourses, not only do flies embody disease, dirt and death but they also embody social structures of class, nation and borders of belonging and, importantly, nonbelonging. As I discussed earlier in this chapter, flies are an intrinsic part of the modernist human. As such, they are also the Other to the human subject,

Figure 5.1: Poster for the Philadelphia Department of Public Health warning of potential health risks from exposure to flies. Created by Robert Muchley, between 1941 and 1943.

the “abject” (Kristeva 1982) to be feared and kept at a distance yet strangely reminding the self of its vulnerability and connectedness. Flies mock the boundaries of the promised clean and closed modern city and its divisions of class, race and ethnicity to separate the poor from the wealthy, the supposedly dirty and diseased from the sanitary and healthy. Flies mock humans’ hope for immortality promised by mighty modern science and novel technologies by bringing death and decay into the everyday life of humans, the home, the kitchen and the backyard, reminding humans about their own death yet to come.

A prominent example within contemporary imaginaries and pop-

ular culture, where imaginaries of flies are limited to the uncanny, abject and deadly figures to be feared is the movie *The Fly*, directed by David Cronenberg (1986). In this movie, an ambitious scientist, Seth Brundle, designs telepods with which he can teleport objects across time and space. In an attempt to teleport himself, things go wrong and a fly gets into the telepod. Brundle survives the teleport, but eventually he notices his major bodily transformations into a hybrid creature, which is neither human nor fly. The hybrid Brundle performance in the movie is close to the present imaginary of a fly: an aggressive, leaky creature that lives in his own filth. Fluids come out of his body and he vomits on his food and eats it. He has no control over his animalistic urges, and therefore he is dangerous. But above all, he is depicted as dangerous to humans as the fly takes over his humanity. Even in the age of advanced technology, the sneaky fly can cross the line and move into spaces of nonbelonging, namely the high-tech telepod, without being seen, and wreak havoc. The accident and the birth of the human-fly, however, testify to the uncertainties, leaky boundaries and fantasy of the isolated laboratory as much as to the nature and culture dichotomy when it comes to scientific experiments. Yet again, the dangerous, deadly fly has to be exterminated.

In her article "Nature's Queer Performativity", Karen Barad writes about the movie *The Blob*, directed by Irvin S. Yeaworth Jr., Russell S. Doughten Jr. (1958), in which she interprets the Blob as a figuration that reflects the fear of communism at the time and the fear of "being consumed by the Other" (2012a, 25), as the oozy creature in the movie moves and consumes everything in its way. She exposes a similar moral judgment in a newspaper article in 2009, reporting the discovery of a forty-foot slime mould colony "oozing along in the muck of a cow pasture outside Houston" (quoted in 2012a, 25) which as she interprets it, embodies yet again the "vivid literalization of the fear of being consumed by the Other in a xenophobic panic over the spread of foreign elements" (27). In other words, the newspaper article portrays social amoebas as creatures that accumulate and gather under the surface without being noticed until they consume everything in their way as if there is a clear line between them (objects) and us,

human subjects that the slime disturbs. This is the object and subject dichotomy that Barad problematizes with the concept of intra-action, drawing an ethical conclusion from it, which matters to me and which I discuss next. As she argues, the Blob—as a figuration that disturbs such dichotomies’ boundaries—embodies fear and produces “a combination of panic and neglect rather than compassion and reasoned response”, which results in “a willful sacrifice” of humans and nonhumans (27). Flies are a similar figuration to the Blob, as they also can multiply and move between spaces without being noticed, literally consuming not only resources but humans in death. As the byproduct of this relation between flies and humans, which folds around abjection and “leaky bodies and boundaries” (Shildrick 1997) between nature and culture—around death, consumption, disaster and disease—flies become killable, as they trigger fear and panic rather than compassion, a fear that generates action. They become a sacrifice and therefore killable for human survival. However, this relationship of willful sacrifice and killability is most evident within scientific practices, a situation which brings an interesting twist to the story of humans and flies. In other words, within contemporary natural sciences and laboratory practices, it is humans who bring death and disease to a particular fly species known as *Drosophila melanogaster*, otherwise known as transgenic fruit flies, as scientists and companies modify them to express a variety of diseases specific to humans such as AD. These flies are “made and born” (Franklin 2006) not only to become a model organism but also to die in large numbers in ways that are associated with their human kin.

5.2 Flies and otherworldly relations

D. melanogaster has become killable not only for its unique historical and cultural relation with humans, as I have discussed so far, but also because of its unique biology. For example, the life span of a fly is thirty days, more or less, and even up to three months, depending on temperature and living conditions. The female has a high fecundity, laying about a hundred eggs per day. Each egg

takes 12 to 15 hours to hatch and about 4 days to metamorphose into an adult fly. This reproductive capacity means that fruit flies provide a giant stock that is constantly reproducing and sustaining itself, making it possible for scientists to study several generations of the same fruit flies in only a few weeks. Moreover, fruit flies have four pairs of chromosomes, three of which are autosomes, meaning that they can theoretically be used for genetic alteration and manipulation, though the last pair is so small that it is often ignored in scientific experiments. The other pair is the sex chromosomes. The *D. melanogaster* sequenced genome has a little over 14,000 genes on these four chromosomes (Pandey and Nichols 2011). Most relevantly, 75 percent of human “disease-causing genes” are thought to have a close match in the fruit fly (Pandey and Nichols 2011). On the protein level, fruit flies and mammals are roughly forty percent homologous (Pandey and Nichols 2011). Because of these profound similarities and biological specificities, despite major difference between humans and fruit flies, the latter species has become an intrinsic part of natural sciences and drug development processes (2011). In fact, the major biological differences between human and fruit flies enact these flies as a promising model because they allow scientists to isolate biological functions in a simple organism with only four chromosomes, which is crucial to experimental biology. In other words, as I have shown and as I will further discuss in this chapter, flies and humans have long been each other’s “companion species”, coevolving culturally and materially, as well as making one another (Haraway 2008b).

The relation between flies and humans is not only about death, decay and disease. Flies have significant characteristics that make them particularly substantial socioculturally and biologically. In ancient Egypt, flies were understood to be the embodiment of deceased souls. People would refuse to kill them because it was suspected an ancestor was visiting the family in the form of a fly (Connor 2006). In his book *Fly* (2006), Connor argues that flies have also been also a point of fascination and envy due to their significant physiology. After all, they can fly and move freely in between spaces. It is as if they can see everything taking place in their surroundings at once with their magnificent eyes (Connor 2006). Flies have also

been associated with persistence and courage in some cultures. In Persian culture, there is a saying often used to describe people with extreme persistence which at points becomes irritating: “tenacious like a fly”. No matter how many times they are pushed away and rejected, a person with this quality keeps coming back until they get what they desire. Perhaps it is their persistence that enacts them as courageous. As in ancient Egypt, from Middle Kingdom to Hyksos period¹⁴, fly amulets were the symbol of honor and persistence, mainly military achievement (Wilkinson 1971, 98–99). Flies were also noteworthy for their therapeutic significance. In the Middle East, they were roasted and ground into powder, which was then used against insect bites (Connor 2006, 103). Even Galen, the Greek physician, surgeon and philosopher in the Roman empire, believed that flies were an effective remedy for maladies of the eye (quoted in Connor 2006). It appears that across various sociocultural imaginaries flies are perceived differently. At points flies are considered to be positive and productive, representing courage and achievements in Egypt or having therapeutic associations in the Middle East. In other contexts, such as in Western imaginaries (for instance during 1940s), they are associated with death, decay and disease.

Moreover, beyond such multiple sociocultural imaginaries of flies, looking into natural and biological differences between fly species also tells other stories about human and fly relations that exceed the negativities of death and disease. Not all fly species dwell in murky, nasty, dark and smelly spaces of rot and deterioration. For instance, a family of flies known as the hoverfly is famous for hovering over flowers and feeding on nectar and pollen, among other things. In fact, hoverflies evoke thoughts of a beautiful day in a blooming garden full of flowers, soothing scents and the spring breeze, on which the flies travel from one place to another. In this scenario, hoverflies are a figuration of life, as they are often considered to be the second great pollinators of flowering plants and agricultural crops after bees (Larson et al. 2001).

Although the larvae of some hoverfly species are known to prey

¹⁴Middle Kingdom is a period approximately between 2000 BC and 1700 BC, while the Hyksos period began approximately in 1650 BC (Wilkinson 1971).

on pest insects, the association with these flies is not of death but more of interdependence with humans. In fact, their appetite for pest insects has enacted them as a promising species for biological control on farms (Grosskopf 2005). In this sense, the relation of flies and humans can be seen through the lens of an interspecies symbiosis, where humans provide them with companion plants and pest insects and hoverflies help humans to control and exterminate pests in crops. This is to say that human-fly relations have not always been negative but also been affirmative in their coexistence and mutual flourishing. In fact, artist Laura Beloff (2016) tries to capture the possibility for different human-fly relations in her artwork called *The Fruit Fly Farm*, in which she invites the viewer to interact with flies as a community and not simply as pests. Another artist, Tarsh Bates (2011), explores the human-fly relation as a multispecies relation through an art project in which she takes care of flies for a period of three weeks. In other words, what these bioartists try to envision are “otherworldly” stories through which humans and flies are becoming together (Haraway 2008a). I will reflect on the question of care in my conclusion, but in this chapter, I will stay with exploring human and fly becoming and relations.

Haraway (2008a) argues that animals go through objectification not comparable to that discussed in Marxist theories, critical race studies, or feminist critiques of women’s objectification. As she argues, animals are not, and never have been, part of existing humanist social relations, and as such, animals have never had—and still do not have—social status or subjectivity beyond that of the “non-human, not subject, therefore object” (175). As Haraway argues, this lack of status is the problem with many animal rights movements and discourses; its proponents search at best to attribute a humanist subjectivity to the animal, which could never be fully human within existing sociocultural power relations. Indeed, Haraway argues, the last thing animals “‘need’ is human subject status, in whatever cultural historical form” (176). In this framework, they at best get the right to be represented “as ‘lesser human’ in human discourse, such as law—[...] the right to be permanently ‘orientalized’” (176). As such, animals will always be represented as “lesser humans”, which brings

about the question of who speaks for animals. In the case of my argument, the question becomes, who speaks for the flies?

Haraway suggests that we need “other terms of conversation with animals”—new practices rather than new representations. Inspired by Barbara Noske, she suggests “otherworldly conversations” with animals in order to recognize relationalities, the inseparability of the object and subject that not only problematize the autonomization of the self-sufficient subject but also the objectification of the animal, the Other (2008a, 176). As such, in the “otherworldly conversation”, what is at stake is accountability for the animal in its cultural, social, historical and biological significance. In other words, thinking with flies in terms of otherworldly conversation accounts for the complexity, multiplicity and materiality of human and fly encounters that intra-actively enact or as Barad terms, “cut together-apart” (see Barad 2012b, 32) the boundaries of a material-discursive reality often too hesitantly and hastily generalized as *fly*. Last but not least, these otherworldly conversations beg the question of ethics, because it is through such otherworldly conversation that flies become killable differently, as I discuss in the rest of this chapter.

5.3 On killability

They are not a projection, nor the realization of an intention, nor the telos of anything. They are dogs; i.e., a species in obligatory, constitutive, historical, protean relationship with human beings. The relationship is not especially nice; it is full of waste, cruelty, indifference, ignorance, and loss, as well as joy, invention, labor, intelligence, and play. [...] Dogs are about the inescapable, contradictory story of relationships—co-constitutive relationships in which none of the partners pre-exist the relating, and the relating is never done once and for all.

— Haraway 2003, 11–12

Thinking with relationality includes thinking about the constitutive

exclusion that makes such relations possible. As such, not only do joy, invention, intelligence and play become relevant in otherworldly conversations but, as Haraway argues in the above quotation, so do waste, cruelty, indifference and ignorance become a crucial reality to account for. However, as I argue below, I find Barad's concept of agential cuts a more efficient tool with which to stay with the violence of the cuts in their relationality.

Barad (2007) argues, in her agential-realist understanding of a phenomenon, that a phenomenon comes into being through the intra-action of object and subject and "agencies of observation" (such as theoretical concepts and frameworks, technological props and experimental materials and tools), in their ontological inseparability. Object and subject then can only become apparent as separate entities in moments when the agential cuts, or as she writes, the "boundary making practices" (Barad 2007), are enacted. Once the apparatus (or the agencies of observation) is set in motion, it cuts the provisional boundaries of the object. Apparatuses are always already a constitutive part of the object and the phenomenon. Apparatuses are important for me because in this chapter I use examples from my fieldwork to show how and when different animals become proper objects and therefore killable in the research lab, in relation to material-discursive apparatuses, while they are simultaneously enacted as apparatuses with which knowledge is produced about AD.

Barad argues that nothing exists before relations. This means that phenomena which are constitutive of reality and agential-realist themselves come into being through the intra-action of matter and discourse, human and nonhuman, subject and object, which enact and are enacted in relation to apparatuses. According to Barad, there is a causal relationship between phenomena and the apparatuses of bodily production. This causality can be understood in terms of materialization of agential cuts. Apparatuses are not merely instruments of measurement or observation but boundary-making, material-discursive practices that divide that which matters (or is materialized) from that which is excluded from mattering. Boundary-making practices are intra-actions that make cuts: agential cuts. These

cuts involve the subject and object coming together differently in their intra-action. Intra-active agential cuts are the condition of possibility for the boundaries of phenomena to become determinate, though they would otherwise be indeterminate. They enact what matters, what can come to matter and what is excluded from mattering. In the intra-active becoming of the subject and object, they only separate provisionally and once the cuts are made. But this does not mean that the subject and object are separate entities: agential separability means that they are always already constitutive parts of one another in and of the phenomenon. She writes that “intra-action enacts agential separability—the local condition of exteriority-within-phenomena” (Barad 2011, 125). It is with the concept of agential cuts that I discuss killability in the following pages.

Flies and humans are what Haraway refers to as “companion species”. In her book *When Species Meet* (2008b), she writes about human and dog material-semiotic “becoming with”, which is the relational material-discursive transformation, cobecoming and coevolving which always is in relation. To become a human, one is always becoming with, for example, bacteria in the body. She writes, “to become one is always to become with many” (3–4). However, since no relation is innocent and free from power relations, this relational becoming with is also a story about the “significant other”, and the “companion species” (16–18). She writes, “We make each other up, in the flesh. Significantly other to each other, in specific difference, we signify in the flesh a nasty developmental infection called love. This love is a historical aberration and a naturalcultural legacy” (16). So far, drawing on rich cultural studies, I have suggested that humans and flies are also companion species, as they make each other up in the flesh and share a historical aberration and a naturalcultural legacy—one that does not necessarily fold around love, however. This relational becoming with is rooted in disease, death and decay, while being a matter of intra-species symbiosis, coexistence and flourishing together.

To discuss companion species, as Haraway argues, is to discuss the ethics of relationality, which she explores through the concept of killability (among other concepts). She explores ethics through

killability because she acknowledges killing as a constitutive part of interspecies relationality. As Haraway writes, “Try as we might to distance ourselves, there is no way of living that is not also a way of someone, not just something, else dying differentially” (Haraway 2008b, 80). For example, one can think of all the bacteria one kills when handwashing or toothbrushing or the flies that one may accidentally swallow biking down a hill on a summer day. On the other hand, killability may not end with the act of killing. One may become killable; one may be made killable but not killed. In fact, according to science, technology and society (STS) scholar John Law (2010), killing can be an act of care. As he argues, with empirical examples from a farm on which cattle suffered from an epidemic disease in 2001 in England and had to be slaughtered to control the epidemic, killing can become an act of care in practice and in the ways in which it is practiced. For instance, what was at stake during this act of slaughter, he writes, was to “achieve a good death, humane and respectful. *Care for the animal in life, and care for the animal in the process of killing*” was at stake (2010, 62; italics in the original). I will come back to this in my conclusion. What I take from Law here is the difference between killing and becoming killable. In the following pages, I explore killability as such, as a phenomenon that involves not necessarily being killed but something more dynamic and complex.

Nonetheless, there is a connection between that which is killed, the actual act of killing in spaces such as the laboratory, and that which is made killable. I have to mention that it is not death per se that I am concerned with here. My project is not about writing a philosophy of life and death. Rather, I am concerned with the ways in which cultural imaginaries, scientific processes, biological and material specificities and laboratory practices of knowledge production make particular forms of life killable so as to bring about their premature death. I focus on exploring how such processes of making life forms killable are an ever-changing spectrum on which different lives become killable differently as a matter of “material-discursive agential cuts” (Barad 2007), in relation to ethical, scientific, material, contextual, historical, social and biological qualities that together cut

apart the boundaries of that which has become killable. Killability is a story about what I call *agential asymmetries*—asymmetries that are not set in stone but instead agentially enacted in situated relations once the cuts are made. As such, agential asymmetries are constitutive of a phenomenon while simultaneously enacting the phenomenon itself. I elaborate on this concept below.

According to Haraway (2003, 2008b), it is crucial to acknowledge the asymmetries in the relations of which one is a part, particularly when they are relations of use. It is crucial to ponder how such asymmetrical relations hold the potential of interspecies coexistence and coflourishing but also violence. What kind of bodies, realities and worlds are made possible or excluded through such asymmetries, and for whom? Haraway writes about killability in terms of not making someone killable in a relation of use. “Thou shalt not be killable” is then a call for an ethical response on the part of humans, one that can be achieved, for example, through sharing suffering and love. In this chapter, however, I am more concerned with the *phenomenon* of “becoming killable” or more specifically with *killability as a material-discursive phenomenon: an agential asymmetry that is enacted through agential cuts*. In this framework, asymmetry becomes more nuanced, as it focuses on the processes through which one is made killable, not necessarily due to discursive reduction into an object—a position of “thou shalt be killed”—nor the refusal to make a form of life killable. Instead, it highlights a state of becoming in agential asymmetries. Killability as a material-discursive phenomenon, therefore, does not take flies as merely a figuration. Rather, it emphasizes the very practices through which the material and discursive boundaries of flies as killable are cut in situated ways. For instance, as I show in the following sections, in the lab, fruit flies become killable because they are such promising models and because of their biological specificities that make them crucial to experimental biology in material ways. Therefore, in analyzing killability and discussing human-fly relations in the lab, I find Barad’s concept of agential cuts a suitable analytical tool because I think it captures the specificities of fly and human relationalities in ways that sharing suffering and love would not. Barad’s concept nuanced modes of accounting for relationality

emphasize the violence of the cuts and bring them forth in ways that Haraway's companion species cannot. I find the roughness of Baradian cuts a more suitable tool for discussing killability than the Harawayian approach, which is inspired by love and sharing, because as I have shown so far and as I show in the following pages, flies rarely trigger love. After all, to think with Haraway, what thinking with dogs engenders differs from the ethics that thinking with flies does.

To recap, not only do agential cuts allow me to bring to the fore the materiality, relationality and intra-active reality of killability, it also let me account for the exclusion and violence that such cuts produce. The exclusion, however, is not that of being excluded *from*, for nothing exists out of relation, and to be excluded from suggests there is something out there from which one has been excluded. Rather, the exclusion is always the constitutive part of any phenomenon, for materialization and meaning making are always situated and partial, and therefore they exclude other modes of becoming, meaning making and realities from being materialized.

I begin with the story of *D. melanogaster* and its appearance in natural sciences as one of the most significant otherworldly becomings, through which not only the human-fly relation is altered but also the very understanding of ethics needs to be rethought.

5.4 Fly and laboratory

We "hail" them [animals] into our construct of nature and culture, with major consequences of life and death, health and illness, longevity and extinction. We also live with each other in the flesh in ways not exhausted by our ideologies. Stories are much bigger than ideologies. In that is our hope.

— Haraway 2003, 17

On my own, purely subjective, scale of animal aesthetic, the fruit fly ranked pretty low; respectably higher than the flatworm, but some way below the dog whelk. Even among its

evolutionary relatives, the fruit fly hardly seemed to stand out. It lacked the ghoulish charm of distant cousins like screwworm flies, which laid their eggs in the genitals, mouth, and nose of their helpless mammalian victims. It had none of the infectious stealth of disease-mongers like mosquitoes, with their incumbent coterie of parasitic hangers-on. It didn't even have any annoying agricultural habits, unlike the notorious medfly (also known, confusingly, as a "fruit fly"), which grabbed head-lines by destroying citrus crops in California and Europe. As far as I was concerned, screwworm flies, mosquitoes, medflies, and the like were the real party animals: flies that evolution had blessed with intrinsically interesting lives. The fruit fly, on the other hand, seemed like an early-to-bed-with-a-cup-of-hot-cocoa sort of fly.

— Brookes 2001, 2

Flies' relationships to humans and their meaning and significance changed as they entered science laboratories in early 1900s. As evolutionary biologist Martin Brookes makes clear, fewer apparent evolutionary links or entanglements exist between humans and fruit flies than do with other fly species. So why did fruit flies become the perfect animal model in the laboratory? Brookes argues that the arrival of the fruit flies in the laboratory happened in the aftermath of the American Civil War as the result of political changes. According to Brookes, "the American Civil War was a watershed for American biology" (14). Before the war, biology was considered part of theology. But due to postwar political changes and cultural reforms, US academics, inspired by their European counterparts (particularly the Darwinian theory of evolution), started to develop and establish biology outside of museums and in universities as part of the newly built research institutes and academic departments. According to Brookes, this period marked the transformation of biology from theology into experimental biology.

According to history and sociology sciences scholar Robert E. Kohler (1994), it is believed that fruit flies first arrived to America via slave ships from Mediterranean countries and North Africa. The slave ships often traveled along the trade routes on the north east

coast of the United States to trade rum and sugar. The same route was used for the new trade in fresh fruits and bananas after the American Civil War. Fruit flies were travelers on these ships as well, mostly arriving in New York, Boston and other flourishing cities (Kohler 1994). Unsurprisingly, then, fruit flies first appeared in the laboratories located in the Northeast United States such as at Indiana University, Bryn Mawr College in Pennsylvania and Columbia University in New York City (Brookes 2001). Newly emerging US biology departments, Darwinian Theory, the scientific paradigm built around the ambition to understand heredity and evolution, and the flow of fruit flies arriving to the United States introduced fruit flies among other simple organisms as the iconic animal model in biology labs. As Kohler writes, “Of all the species of *Drosophila*, *melanogaster* was the most likely to be associated with urban academic biologists, the most at home among concentrated humanity. It was the most accustomed to crossing the threshold between indoors and out, the most opportunistic and versatile, and thus the most likely to find its way into a banana-baited trap and an experiment” (1994, 22). According to this historical narrative, the fruit fly had been transformed into a tamed, domesticated species long before it entered laboratories, as the byproduct of slavery, colonial voyages and capitalism, on the one hand, and human consumption and waste production on the other hand. As a postwar figuration that embodies traces of American Civil War and the transformation of the study of biology, fruit flies entered the lab as scientific troopers to unravel the mysteries of human biology.

The transformation in biology also involved the construction of the proper model with which experimental biologists would work. As a standard model organism for experimental biology, the fly, among other simpler organisms, officially entered the laboratory in the early 1900s, thanks to biologist William Castle, a professor at Harvard University. Experimental biology needed a simple model organism that could be manipulated quickly and easily but would also express relevant biological and genetic steadiness. Moreover, smaller and less complex organisms, biologically speaking, were favored because as simpler biological systems, their bodies and biochemistry

would affect the experiment less than bigger and more complex animals would. As such, fruit flies, as a simpler organism, would keep the integrity of the laboratory experiment intact. They were also a promising model because they are easy to manipulate and monitor while expressing a pliable stability (see Mehrabi and Åsberg, forthcoming). Last but not least, scientists needed a model that they could study in the laboratory and dispose of easily—a model that was easy and cheap to maintain as well as disposable. In other words, *Drosophila* embodies the new generation of biologists' approach toward "life with more materialistic and mechanistic eyes" (Brookes 2001, 4; see also Kohler 1994). Nevertheless, in the early years of their laboratory appearance, fruit flies were not very impressive. They were productive but not remarkable because, as the legacy of Victorian society, "bigger and bolder beasts" were still assigned higher value as "potent symbols of biological kudos" (Brookes 2001, 5). Brookes calls this relative assignment of value "the animal snobbery" of early experimental biology (5). Fruit flies at that time mostly played the "role of laboratory stooge" (5).

The fate of fruit flies changed, however, in 1909, when biologist and geneticist Morgan, mentioned earlier in this chapter regarding his fly laboratory and fruit fly stock at Colombia University, noticed a spontaneous change in the eye color of a fruit fly. Very soon, Morgan developed his theory of heredity working with the fruit flies, and as such, fruit flies and Morgan established the foundations for modern genetics (Kohler 1994). The fruit flies' four chromosomes and approximate 14,000 genes were mapped out around the same time as the human genome (Pandey and Nichols 2011). The fruit fly became "the experimental animal of choice for self-respecting geneticists" (Brookes 2001, 6) and continued to be so for years. As such, the fruit fly became "the biological icon of the twentieth century" (11). In other words, as I mentioned earlier, the imaginary of flies as deadly changed during the past century, and so did their relation to life sciences. The deadly fly, in this case the fruit fly, which was "ranked pretty low" in the animal kingdom, which seemed to be an "early-to-bed-with-a-cup-of-hot-cocoa sort of fly" instead of an interesting organism in early evolutionary biology, turned into the "experimental animal of choice"

for geneticists. Today, *Drosophila* is such a constitutive part of life sciences that national, international and regional conferences are held with exclusive titles such as Annual *Drosophila* Research Conference, European *Drosophila* Conference, Asia-Pacific *Drosophila* Research Conference, and Midwest *Drosophila* Conference¹⁵—all attest to the importance of this humble organism in everyday knowledge production across the globe and across disciplines. *Drosophila* brings together such a great number of fields and sciences that a well-known, giant fly database known as The FlyBase project has been established, supported by Harvard University, the University of Cambridge (UK), Indiana University and the University of New Mexico. The FlyBase aims to provide not only an overarching database about fly genes and genomes but also a forum and a consortium of drosophilists to share their funding and findings.

Today, the scientific life of a fruit fly is a success story, as *Drosophila* remains one of the most common laboratory creatures due to its unusual genetic stability—to the point that the US “Institute of Health and the National Science Foundation recognizes fruit flies as a promising model organism for humans” (Wayne 2000). Indeed, fruit flies have been the ultimate model for experimental biology; they increase the chance of getting published in scientific journals by a decent percentage. *Drosophila* has become a living test tube with which scientists can learn about genes in more complex and advanced living systems such as humans (2000, 142). There is a fruit fly today for almost every biochemical need on the biotech market. For example, one of the main *Drosophila* stock centers, Bloomington *Drosophila* Stock Center (2016a), held a collection of 58,874 stocks and distributed 243,148 subcultures in 2015, and that is only one among several other stock giants across the globe in the United States, Europe and Asia. These include the Kyoto *Drosophila* Genomics and Genetic Resource (DGGR), the FlyORF center in Zurich and the Vienna *Drosophila* Resource Center (VDRC). Scientists also exchange *Drosophila* stocks and maintain a specific culture of *Drosophila* science among themselves (Kohler 1994). Such an excessive appearance of fruit flies in natural sciences reminds me of a quote that I included

¹⁵ <http://www.conferenceseries.com/drosophila-melanogaster.php>

earlier: “While it is fly that spreads and carries disease to humans, it is also humans who spread and carry flies. Flies and human are reciprocal hitch-hikers. And, although flies can bring into our houses and onto our plates organisms that we would prefer to hold at a safe distance, the restriction of their range means that what they bring to us is mostly our own. Flies bring us disconcertingly to ourselves” (Connor 2006, 17).

The interesting twist here, once thinking with the appearance of the fruit flies in natural sciences, is how it is actually humans, scientists in this case, who bring disease and decay to flies. In the form of many genetic disorders and neurodegenerative diseases, just to mention a few, fruit flies are made and born with (partial) diseases such as Parkinson’s and AD, which are strongly associated with humans. This reality is in stark contrast with the cultural imaginaries about flies that I discussed earlier. It is indeed humans who are genetically manipulating fruit flies with their human diseases, creating novel way of dying and deaths, as I discussed in my previous chapter when I discussed molecularization and imaging of AD in the lab. As such, it is we, humans, who are disconcertingly bringing our fears, infection and disorders to the (fruit) flies in concrete, substantial, material ways from which they are dying in incomprehensibly large numbers to save our lives.

Despite such success stories and scientific recognition within natural sciences, flies are still not fully recognized culturally, especially in light of contemporary human suffering and bigger species’ extinction. Even within the natural sciences, fruit flies occupy the contradictory position of laboratory stooge but also one of life sciences’ authoritative, standard, favorable and crucial model organisms. For instance, fruit flies are exempt from many of the ethical protocols of animal models because they are insects, thus invertebrates and categorized as one of the lower order of organisms, which is one of many practical factors behind their scientific popularity. Indeed, the ethical principles of Reduction, Refinement and Replacement¹⁶ in animal welfare and

¹⁶According to Holmberg and Ideland (2010) the three Rs—Reduction (of the number of animals use), Refinement (of better methods for animal experiments), and Replacement (of animal models with “lower” species)—is a common and dominant

laboratory regulations (Holmberg and Ideland 2010) have dramatically increased the number of flies used in research, as higher order animals are set to be gradually replaced by computer models, cells or cell lines, or *invertebrates*, such as *Drosophila* or nematode worms.

As much as fruit flies are easily killed in massive numbers daily, they have also become a node around which scientific foundations, consortiums, national and international conferences and a community of interdisciplinary scientists have been established (Mehrabi and Åsberg, forthcoming). It is this contradictory yet simultaneous reality of fruit flies' presence in the natural sciences that makes me think about killability not as a singular structural power relation and a fixed position of being killable but as a dynamic, ever-shifting state of becoming with agential asymmetries. In other words, fruit flies become killable not simply because they are associated with death and disease or because they are abject beings that trigger disgust and discomfort but also because they are promising, black-boxed, easy to work with and biologically full of potential laboratory companions. Killability is, then, a phenomenon that is materialized through material-discursive cuts, such as the standardization of fruit flies; international and national availability and credibility; a well-established network of drosophilists and well-equipped *Drosophila* sciences; the social, cultural, structural and hierarchical categorization of life that subjects particular animals to more experimental biology than others; and, last but not least, fruit flies' unique biology and the materiality of their bodies. It is as if the fruit flies are becoming nonanimal not only due to their exclusion from ethical and legal documents and practices that include, advocate and protect bigger animals (which actually points out the limits of animal rights discourse, as I mentioned earlier), but also as a matter of their standardization as the perfect companion to and material for experimental biology.

To summarize, transgenic fruit flies reconfigure the very conception of the category of animal, as they transgress the boundaries between, for instance, biology and technology, nature and science, and human and animal as well as (bigger) animals and invertebrates. They are a natural-cultural-technological becoming that crosses the

ethical principle in animal ethics committees and laboratory research ethics.

thresholds of these categories, as they are not born naturally but made and born in technoscientifically advanced ways. In laboratory life, the conceptual category of *animal*¹⁷ seems to accommodate fruit flies as animated biological organisms: both an animal model and a nonanimal—at least not animal enough to be ethically protected. Even though flies are “nearby” (Bull 2014), present within our “human” ecologies, they are not familiar nor are they a kind of animal that matter in culturally, politically and economically significant ways as are domestic animals, pets, endangered species and those that are “big like us” (Hird 2009); these are the animals that we humans consume or care for (Bull 2014). Transgenic fruit flies are also nonanimal as they are radically different from humans and bigger animals in terms of their anatomy (number and shapes of legs, eye structure and cell type), environment (for instance, the larvae live in food, soil or decomposing matter) and reproductive strategy and sexuality (Bates and Schlipalius 2013). As such, transgenic fruit flies become nonanimal, an organism that is simultaneously categorized as animal and not animal. It is this specificity of these flies as nonanimal that enacts them as promising model organism in the lab that is materially and semiotically crucial to contemporary understandings of science and technology, which I show in the following sections. In the next part of this chapter, I move to the more specific context of three laboratories in which different organisms or animals become killable as a matter of material-discursive cuts that enact them as the proper

¹⁷The category of animal is as much a historical and sociocultural phenomenon as it is a biological reality. For example, Carl Linnaeus, the Swedish botanist, physician and zoologist, established the modern taxonomic order as a scientific classification of forms of life in hierarchical order based on shared physical characteristics, when he introduced the term *Mammalia*, which embodied gendered and class structures of the time (Schiebinger 2013). His classification, however, has been changed today. For instance Haraway (1989, 1997), inspired by technoscientific developments and feminist politics, suggests other forms of kinship that are about multispecies becoming rather than hierarchical taxonomy. Another example for alternative meanings for the category of animal and human and animal relations comes from within Indigenous cultures such as South American in which human and animals are always understood as entangled in contrast to those in Western cultures (see Armstrong 2002). What I aim to get to here is that there is no fixed, everlasting category of *animal*. Thus, the meaning of the word, the categorizations of different forms of life and their place in the social relations and realities of any particular historical and scientific era enacts animals in arbitrary modes that can shift.

test object in a particular context.

5.5

Biology and material-discursive cuts: On becoming a test object

In the beginning of my fieldwork, in 2012, I decided to talk with not only the drosophilists in the lab but also scientists in other laboratories who were working with AD using different animal models. I was trying to understand what criteria, mostly what biological specificities, make an animal or an organism a proper test object for AD research. I also wanted to know how these test objects were enacted through material-discursive processes of constructing the Alzheimer's animal model and AD. I interviewed scientists who were working with the mouse model in the lab next to the fly lab. I also interviewed a scientist who was working in a laboratory in a medical facility on the other side of the city and was an expert in neurodegenerative diseases like Alzheimer's. He and his research team were interested in the human cell model. Below, I will tell stories from my fieldwork and interviews in which scientists talk about brain tissue, fruit flies, mice and cells becoming the test object.

Brain: On the (im)possibility of becoming a test object

Anna is a biochemist who was enrolled in an EU-funded project for four years to study AD on the molecular level. The project was a collaboration between several European countries, and one of its aims was to develop more adequate detection techniques and possible future treatments for the disease. When I asked her about the best test object for her experiments, she responded as follows:

ANNA: My hope is that we will get more human tissues, and we need our tissues to be prepared in a different way than the standard procedure. In the pathology department they do chemical things with the tissues that they want to save, like conservation, and we want the tissue to be frozen fresh so there will be no chemical

modifications done. So that is a problem.

TARA: How come?

ANNA: Because this conservation [technique] that they use, it will alter these aggregated morphologies so that they will be more uniform, and we will not be able to see the differences that we are looking for.

TARA: And why is it difficult for you to have fresh tissues?

ANNA: We don't get to order tissues when it comes to human samples. For the mice, I can contact our friends in Berlin and say "I want five mice this age and they should be prepared in this way". They will go to the animal facility and sacrifice those mice, but that is not the way it works with humans because, first of all, people are not very pro donating tissue, especially not brain tissue for some reason. For example, you can donate your kidney to research, or your liver, but not your brain. It is more delicate, and I won't argue with that either—as a scientist this body is just a mass, a garment, but of course, I haven't been in a situation myself to have to do this. You never know how you will react. Anyway, the tissue that we get is in the tissue bank so it is already there and then we get this fixed tissue. There are few places in the world that have frozen tissue but it is very precious to those labs, and you have to have a very strong case to get hold of those.

In this excerpt, Anna explains how it is impossible for human tissue to become a test object in her lab. The fact that it is impossible for human brain tissue to become a test object is important because it enacts other organisms as test objects to stand in for human tissues or cells in the laboratory, and as such it speaks to what can(not) be exploited, killed and disposed of in the lab. Human tissue, even in death, is depicted as problematic as a test object, but animals and living organisms (for instance, the mouse) are not equally problematic in terms of being exploited and disposed of. Material, practical and humanist understandings of the human brain resist the construction of human brain tissues as a proper object in Anna's lab, as I will discuss below.

Anna has no access to brain tissue because there is a limited amount of brain tissue available to scientists. Even in death, brain tissue still represents life (the life of a dead subject), human subjectivity and individuality. The brain is culturally understood to be the locus of humanness. In contemporary cultural imaginaries and popular sciences, the human brain is where memory, intelligence, rationality and consciousness are located (Ramachandran 2012). In other words, humanist values that construct the human subject—the very same values that construct humans in relation to their Others (in terms of race, sex, gender, species etc.)—make up one of the cuts that undoes the human brain as a potential test object.

The materiality of preserved brain tissue is another cut that undoes the brain tissue as a test object in Anna's lab. Anna talked about how donated brain tissue is preserved in the pathology department through chemical conservation before being distributed. The brain, in becoming a test object, has to be prepared in certain ways. Conservation establishes and secures the brain tissue as a test material, meaning that the brain tissue has to be "preserved" with chemicals to create standard (and in Anna's case, unusable), legitimate test objects. The chemicals become an essential part of the preserved-brain-tissue-as-test-object in the pathology department and in the tissue bank not only because of guidelines—it is standard procedure that tissues are conserved through chemical processes before distribution to laboratories.¹⁸ The chemicals also become part of the preserved-brain-tissue-as-test-object in material ways. As Anna explained, the chemical procedures affect and change the morphology of the proteins she is looking for, making it difficult, if not impossible, to detect differences in proteins altered by conservation. Biochemical modification of the brain tissue undoes the tissues as a test object for Anna's experiment. Anna is interested in mapping out the morphology of aggregated proteins associated with AD; however, once the brain tissue is subjected to conservation chemicals, the proteins aggregate in a more unified manner. As a result, it is very difficult to read the morphological

¹⁸They conserve the brain tissue because it is such a rare and precious material for science that it needs to be kept in good condition as long as possible so that it can be used in a number of experiments.

differences between proteins. The very act of conservation, which is necessary for the brain tissue to become a test object, disturbs the experiment and affects its validity in Anna's lab.

Thinking with Barad, if discourse is always already material arrangements and matter is always already the intra-active materialization of discourse, then agential cuts are about how the intra-action of the material-discursive apparatus and the object create one another differently. In other words, the concept of agential cuts allows me to discuss not only discursive restrictions but also the materiality of the brain and the chemicals as cuts that materialize the boundaries of the brain as a non(object) and (non)model. Anna aligns herself with a particular theoretical hypothesis, namely A-beta aggregation. Her vision is to study different levels of toxicity of these protein aggregates through mapping out the aggregation stages and morphologies of A-beta peptides. Anna's alliance with the A-beta hypothesis and her vision for studying the protein morphologies enacts both agencies of observation but also the object of study in Anna's lab. Anna needs to adopt methods of experiments that can detect morphological differences between A-beta aggregates. Once the agencies of observation are set in motion, they make the cuts and enact possibilities for including or excluding a model organism in that particular lab. In Anna's lab, the brain tissue is unmade as the test object as a matter of such material specificities: it is excluded because the conserved brain tissue and the agencies of observation cannot interact within the Alzheimer's A-beta hypothesis, which aims to image the protein aggregation stages and morphologies. The aggregates in human brain tissue are not only due to AD. Conservation techniques with chemicals materialize and construct the test object but disturb the originality of AD-related aggregations. The brain tissue, in becoming a test object in the pathology department through conservation, is unmade as a test object in Anna's lab.

Importantly, the human brain is a constitutive part of the future animal model in the lab, as the animal model is created to supposedly replicate the brain tissue and its material, biochemical and functional specificities. Brain tissue is the constitutive exclusion in and of the phenomenon of becoming a test object in Anna's lab where, in other

words, in the absence of a brain tissue model, the prospective model would have to embody the A-beta peptide hypothesis, the biological ability to replicate the protein aggregation, as it would in freshly preserved human brain tissue. The prospective model and the brain tissue are constitutive parts of each other: the model has to be able to replicate the brain while standing in for it and engendering information about AD; it becomes an apparatus of knowledge production itself.

Mouse model

The mouse lab was located a couple of doors away from the fly lab. Some of the scientists in the corridor worked with both transgenic fruit flies and transgenic mice. Anna and Elen, however, put their faith in the mouse model and not fruit flies. As in Anna's lab, the German institution that Elen was affiliated with was also part of a larger EU project studying AD. The agreement between their respective institutes was that the German counterpart would provide access to their mouse facility and the Swedish counterpart would provide access to their imaging technologies. I interviewed Anna and Elen in a seminar room after Anna gave me a tour in the big lab. On one side of the lab, huge fridges covered the wall from corner to corner. On the other side of the lab, there were cubicles with desks and laboratory equipment (microscopes, petri dishes, brushes and bottles of chemicals). Anna and Elen told me that they were developing antibodies to detect the A-beta proteins and trying to use different mouse brain tissues with different protein aggregates (each, I assume, in a different stage of aggregation). They needed the antibodies so that they could image the aggregate morphologies and measure their consistencies with a giant microscope in the room across the hall. The antibody would attach to the protein, glowing, and create colorful patterns interpreted by Anna and Elen. The density of the patterns and the color would be translated into protein morphologies and their stage of aggregation. Anna showed me some pictures they had taken from a mouse model brain tissue. She explained to me how she understood at which stage the protein aggregates were by looking

at the shape and color of the tissue. The pictures included sharp beautiful colors like a work of expressionist art. The denser and bigger they were, the more advanced the aggregate. The smaller they were, the earlier the stage.

Anna told me about mouse model and why she preferred it over the fly model:

First of all, it is a mammal. Which the flies are not, I mean, they are more like us in many other respects than the A-beta. They have lots of other protein systems that may be involved in the disease process [...]. If you compare [mice] to the flies, the flies are not mammals, not even vertebrates. They are quite far off. But the main idea of using the mouse is that it is a mammal and that you can ... they have a longer life span and they can develop more plaque-like morphologies that flies won't. I mean, you can find the aggregates in flies but you never see the plaques like you see in human brain [...] so I get the brains from our German collaborator because they have different types of mouse models because different mice have different genetics. So they have different ways of expressing the plaques. So that is why we use several different models. And we know the genetic background and from this we can also draw conclusions maybe on what is provoking which types of plaque morphologies.

Anna and Elen were interested in detecting the A-beta protein and its multiple stages of misfolding in the brain. Due to the cultural and material impossibility of working with human brain tissue, as I discussed previously, they needed a different organism. Detecting aggregates in temporal stages is time consuming because the proteins need time to aggregate into different forms and mature. Therefore, Anna and Elen needed an organism capable of aging even when contaminated with AD plaques—an organism that would not die of Alzheimer's plaques. The stake in their experiment is the entanglement of aging processes with the scientific hypothesis on A-beta proteins, through which protein aggregates could accumulate over time and finally bind to the antibodies they would be exposed to. In other words, Anna's

experiment involved the A-beta hypothesis, protein aggregates, and a model organism, as well as of detecting antibodies and the time it took for plaques to aggregate, intra-acting and constructing the proper AD animal model. Once such an assemblage (a material-discursive apparatus) was enacted, it determined which animal or organism would become the animal model in Anna's lab. In other words, the determinacy of the animal model as "the animal" for this lab is not inherent but a matter of intra-acting components that come together and materialize in the form of an animal model. However, the realization of the mouse as the animal model is not only a discursive phenomenon but a product of the materiality of the mouse body and its liveliness, as an aging life form, that accommodates and intra-acts with biochemical functions needed for the experiment, which were also the agential cuts that fixed the boundaries of the mouse as the animal model in the lab.

The biological specificities of the mouse's body intra-act with agencies of observation, determining the mouse model as the animal model. As Anna said, a mouse is a mammal, and therefore it is more like humans biologically. Since we (humans and mice, as mammals) share a similar evolutionary trajectory, the mouse, in Anna's opinion, could stand in for human brain tissue in the lab. Moreover, as I have already mentioned, mice stay healthy even once they develop A-beta plaques in the brain. Apparently, a mouse brain has the ability to establish new neurological pathways once the previous neural pathways are killed and destroyed by the plaques. This regenerative ability of the neural pathways helps mice to stay alive even during an overexpression of A-beta plaques. A mouse brain then has the capacity to become a living incubator for plaque production. In other words, as the mouse ages, the misfolding proteins in its brain start accumulating and change from oligomers to bigger bundles of A-beta fibrils and into A-beta plaques. Therefore (together with the protein aggregates), the aging process provides Anna and Elen with a rich selection of misfolding proteins in different stages, which can be imaged and studied in terms of their pathologies. This is to say that the biology or biological capacities of a mouse intra-act with Anna's hypothesis, which enacts the mouse as the animal

model, selected from among other potential animal organisms, in her lab. The agential cuts, then, are as much about scientific discourse and practices around protein morphologies as they are about the materiality of the mouse brain and body, the agentiality of the neurons in the brain and gradual protein formation.

The model in Anna's lab is created through material-discursive cuts enacted in the intra-action of the mouse and agencies of observation. But there are also other intra-acting agencies that determine the materialization of the mouse model as the AD model in the lab—other actors that are the building blocks of the agencies of observation aside from the A-beta peptide hypothesis, antibody, or protein-detection techniques. As Anna mentioned, there is a large amount of material-discursive information and technological possibility available for scientists who wish to work with mouse models. In fact, the mouse has been a companion species in human laboratories for decades. This long-lasting relation between mouse and human within the natural sciences provides Anna with enough genetic background, on the one hand, and a large number of antibodies and technological possibilities on the other hand. The mouse model is easy to work with, as well, but it also bears a significant amount of legitimacy within sciences in terms of publication opportunities. Yet again, the cuts are not only about the discursive legitimacy and discursive knowledge available on mouse models but also about the very materiality of the mouse body as a research resource, as many different kinds of genetically modified mouse models are already made ready to order.

Last but not least, the EU project that binds the Swedish and the German institutes together is also a constitutive part of the mouse model as the animal model in the lab. In other words, working with these German collaborators provides Anna with the opportunity to have easy access to a giant mouse facility, which hosts a variety of genetic combinations. All she needs to do is to make a phone call and order the mouse brain tissue she needs. She doesn't even need to make the sacrifice herself (i.e., kill the mouse).

The apparatuses of production in Anna's lab are enacted in ways that perform and measure protein misfolding and their morphologies over time. This approach is a time-consuming material process, which

enacts and is enacted by AD discourse and the A-beta peptide hypothesis in Anna's lab. Anna needed a model that could biologically develop the misfolding proteins in the body or in the brain yet not die of their toxicity. In other words, the biological capacities of A-beta peptide production, the regeneration of neural connectivity, intra-university EU collaborative projects, the mouse model's historical high-profile association with experimental biology and the A-beta peptide hypothesis of the AD paradigm are the material-discursive cuts that constituted the mouse model as the test object in Anna's lab. This list highlights the cuts as not only discursive but also material—in the form of neuron regeneration, protein formation, the aging body of the mice and resources known as transgenic mice.

Fly model

The fly lab, like Anna's lab, was also devoted to the A-beta peptide hypothesis. However, scientists in the fly lab had a different take on the theory. The aim of the project in the fly lab was to study the chemical binding processes between molecular agents—namely APP¹⁹, gamma secretase²⁰ and beta-secretase,²¹ among others. According to the scientists in the lab, understanding such biochemical functions could become helpful in manipulating and preventing protein aggregation. Unlike Anna in the mouse lab, Karin (my informant in the fly lab) was not interested in protein morphology. It was the binding and unbinding of biochemical components and their toxicity that mattered for Karin; she and her team needed to mix a variety of genetic components in the model to see which genetic combinations caused toxicity. Therefore, what they needed in the lab was a model organism that could easily be genetically manipulated and die in an overexpression of the toxic protein aggregates. In other words,

¹⁹APP is a trans-membrane protein known to be supplementary for neuron synapses and neural plasticity. In other words, brain plasticity and neural growth is entangled with the APP function and folding for which APP is required to be cleaved by the gamma-secretase enzyme and beta-secretase in the right sequence.

²⁰Beta-secretase (BACE1) is an extra-membrane enzyme that cleaves to APP on the outside of the cell.

²¹Presenilin is a transmembrane protein related to gamma-secretase enzyme, which cleaves to APP inside the cell.

toxicity, and the capacity to die from the toxicity within the A-beta peptide hypothesis within the AD paradigm, cut the potential possible organism as the test object in Karin's lab.

There were other material-discursive cuts that were constitutive of the fly as the animal model in Karin's lab. Karin needed an organism that used little space and few resources to maintain so that the research team could run simultaneous subcultures in order to isolate the proteins and enzymes and study their mechanism in multiple assemblages. Working with fruit flies is very convenient in this sense, as it is inexpensive to keep a fruit fly stock. Fruit flies require little care, labor or complicated high-tech devices (Bilen and Bonini 2005; Michno et al. 2005). They also needed an animal model with a short life span so as to overrule the failed hypotheses quickly. Using a model with a longer life span would make the work time consuming, because the assemblages that could come out of such a genetic matrix would make a long list and therefore it could take years to get any results. Last but not least, as they needed to run parallel experiments, they needed a large number of test objects. An organism that reproduces massively allows researchers access to an almost unlimited stock. In other words, as a mode of her experiment, Karin needed to explore and breed different subcultures in parallel. The biological capacity of fruit flies then intra-acts with Karin's hypothesis and modes of experimenting, as I discuss below.

Whereas in Anna's lab the similarity between human and mouse is understood in terms of their shared evolutionary kinship, in Karin's lab, the similarity is a matter of genetics. This is to say that in the fly lab, scientists were interested in the fruit flies because of their compatibility with humans in their APP expression, as the fruit fly model would express A-beta peptide toxicity in a manner similar to that of the human brain. These humanized fruit flies are genetically 75 percent homologous²² with humans in the context of AD, which makes it easier to explore the genetics and biochemical processes associated with the disease in humans and therefore making them a perfect model for studying the protein-folding mechanisms. The biological specificities of fruit flies intra-act with the agencies of

²²They share 75 percent of the genes that are related to AD in humans.

observation. The materiality of the bodies of fruit flies allows for an expression of AD-like toxicity similar to that in humans with AD. Their brain structure and function is simple, and their simple brain has no brain barrier to complicate the passing of the radioligands²³ and molecular agents into the brain, which is necessary for AD detection and confirmation in this context. Fruit flies are simple organisms. As mentioned earlier, they have only four pairs of chromosomes, an amount far fewer than that in humans, which therefore undermines all the complexities that might be happening in the human body within the course of AD. Nonetheless, in practice, working with four chromosomes makes it very easy to manipulate fruit flies' genes and maintain control over the experiment's processes simultaneously, as many of my informants discussed. In other words, fruit flies give the scientists in the fly lab the ability to reduce a very complex problem, namely AD biochemistry, to something that can be studied by exploring it in a smaller, less complicated model. Looking at the fly lab with the lens of agential cuts shows how the very material processes of molecular binding and biochemical functions known as toxicity is one of the cuts that enacts fruit flies as the proper model. In other words, it is the biological ability of the fruit flies to materially produce such toxic processes and to replicate humanlike biochemical functions that enact these flies as the model in this lab.

As in the mouse model, flies were the proper objects for Karin because of their embodied credibility as living test tubes:

Actually, there are companies in the States that you can send in an order and in two weeks you will get the flies, and if you want to do that by yourself it will take years. So, I mean, you won't be able in your research time to work with other species like bumblebees or others because there is no knowledge, no tools available. They have been generated by researchers over the years. So, to be honest you don't need to know much about the molecular mechanism in the flies to work with them. You can work with them. Hmmm. It is

²³Biochemical substances that are used for diagnostic measurements in the clinic and in the laboratory.

like a car, the first car that came, you knew much more about the car, you knew all about the cars and everybody needed to know everything about cars. Because you repaired your own car. Now you go and buy your car and drive it and you don't need to know how it works (also the complexity of the car), you can use it and you can do a lot with it. Little bit it is the same with *Drosophila*; of course, as a researcher you want to know a lot of things but you don't need to know all the details. The car is complicated, *Drosophila* is complicated as well. But you can use it as an excellent tool to take you from point A to point B in your research traveling.

As sociologists Carrie Friese and Adele Clarke argue, the “increased use of a species in scientific research results in greater knowledge regarding that species, which has resulted in certain animals being better commodities for the bio-sciences and biomedicine” (2012, 42). Massive amounts of details about fruit flies’ genetics, behavior and life span have been published, which has consequently black boxed *Drosophila* as the convenient—almost necessary—animal model, like a car on a road trip, as Karin mentioned in the above excerpt. To be more concrete, the available AD fly protocols can be ordered from fly stocks because they have been already tested, made, approved, patented and standardized as promising and acceptable apparatuses within the life sciences. Yet again, from the perspective of agential cuts, the discursive performative power of the fruit flies’ credibility within natural sciences emerges as one of the cuts that enacts them as the model. This perspective also highlights the material reality and availability of giant transgenic fly stocks with thousands of different kinds of genetically modified fruit flies ready to order, which materializes *Drosophila* as the animal model in this lab.

Drosophila, then, is not necessarily the lab model because it is the closest organic model to AD in humans, but it is privileged over other animal models because it embodies well-studied material and discursive infrastructure such as fly stocks, material intimacy with humans such as molecular and genetic homology, and fundamental material and discursive differences such as a limited number of chromosomes

and low status as a life form. *Drosophila* intra-act with the dominant hypothesis of AD in material ways, for instance as molecular agents bind with proteins and biochemical processes of becoming toxic take place in their bodies—particularly in ways that other animal models cannot biologically perform. As such, *Drosophila* become the proper test object in the lab. To summarize, the fruit flies' bodily materiality, known genetics and basic genomes (in comparison not only to humans but to other animals), low maintenance needs, reproductive cycles, simple biology and toxic A-beta peptide hypothesis, together with gamma and beta-secretase, are constitutive of AD transgenic fruit flies. They, together, cut-apart and constitute *Drosophila* as the proper model organism in this lab.

Cell model

Johan is a neuroscientist who researches AD in a laboratory located on the other side of the city from the mouse and fly labs. He is also interested in the protein aggregates of A-beta, and with his research team he is searching for a way to detect and stop the progress of AD. I interviewed him in his office across the hall from his lab. Even though he shared their interest in the A-beta paradigm, he had a different understanding of it and research agenda than Karin and Anna. He also had a different idea about the proper animal model for his laboratory. After mentioning that ethically he has difficulty working with animal models, he explained the following:

We try to understand, why does the neuron become sick and why [does] the disease progress? In the brain, the disease starts in the hippocampus and spreads out and affects more areas. And the pattern is always the same pattern. The same area is affected and you can correlate the spread of the disease and how demented the patient was when [they] died. This progression is one key to understanding the disease. It is a long anatomical pathway. It spreads to areas that are connected via neural connections. What is the messenger? What we did was, instead of looking at [the] brain, we looked at cells. Because we think when the cell dies it [A-

beta aggregate] leaks out and makes plaques. So we want to see why the cell gets sick, because once they are dead the deed is done.

According to Johan, uncovering the secret of AD may be related to the idea of A-beta contagiousness and the leakiness of the brain neurons, which, as he explained me, is difficult to detect in animal models. Johan told me that in order to study the contingency hypothesis, researchers must inject the plaque into the mouse brain (if working with a mouse model) and image the spreading patterns of the aggregates. There is, however, a possibility that A-beta aggregate moves from the place of injection into other spheres of the brain, because the animal model is a living organism that intra-acts with and interferes with the process of injection and protein formation. In other words, if the protein aggregates appear far from the injection site, scientists can never say for sure if the aggregation is from the injected protein or if it is simply a biological process, unrelated to the injection. The liveliness of the mouse model does not intra-act with the agencies of observation in ways that can provide scientists with meaningful results. In other words, mice as a bigger, living and more complicated organism can alter the protein patterns of movement in unpredictable ways. At the same time, researchers need a living life form to see if the A-beta aggregate can infect other cells through neural connections. Johan chooses a basic form of life, cell tissue. On the one hand, this qualifies as a living organism that can fulfill the required criteria (neural connection and contagiousness), yet it is simple enough compared to the organismic complexities in mice, for example, and thus does not affect the experiment like the mouse model would. The cuts are made here as the matter of neural connection, contagiousness, living organisms and their simplicity, and the A-beta peptide hypothesis, which are all constitutive parts of cell tissues as the test object in this particular laboratory. In other words, the cuts are about the materiality of moving proteins, toxic neural connections and cell death, and maintaining a living cell line.

Moreover, in Johan's lab the similarity between the prospective model and human brain has been defined differently than it was in

Anna's lab. In other words, unlike Anna, who relied on the common mammalian evolutionary heritage between mice and humans, Johan looked for a model that was extracted from a human. He dismissed the option of working with either fruit flies or mice as his experimental models because neither of them is human. The cell line he was working with, on the other hand, was descended from a nerve tumor—a human tumor—and therefore was a closer model to stand in for the human brain. Moreover, like fruit flies and mice, cell lines are scientific and commercial properties: they are established models that increase the credibility of the study and the chance of publishing the results. Cell lines are also easy and practical to work with. As Johan said,

What we did was to take these cells and put an extra gene into them so they become green, and then we take the same kind of cell which we grow in a flask in liquid medium and we add oligomeric A-beta to them. To that we put a red florescent that is tagged to A-beta and we add them on top of the green ones, and those will make contact to the green ones after few hours. We can see the red travel over to the green one and this one gets a red spot, while the other green neuron which has no contact with the red one, it wouldn't get any different. The transfer depends on the connection. The green cell after few days becomes a red cell and the only difference between the sick one [red] and the healthy one [green] is the A-beta. This is similar to the human brain.

The biological specificity and simplicity of the cell lines allows Johan to literally see how A-beta aggregates spread from one cell to another, as they slowly turn red. Moreover, due to the low maintenance requirements to run and keep a cell line, Johan and his team can run parallel experiments. Nevertheless, unlike fruit flies, which provide unlimited access to the test objects, cells have their own limits. The cell line cannot be kept for a long time, because after a certain number of divisions the cells change shape.

Evidently, animal models are enacted in a hierarchy when it comes to laboratory work. The value of the animal model is not

universal. Rather, a prospective animal model is made as a matter of a particular laboratory and its scientific agendas, scientific paradigm, alliances and resources as well as of the biological capacities of different animals and material realities that together cut the boundaries of a proper test object. What agential cuts then highlight in these processes is the liveliness of scientific practices, as animal models are made and born as living test tubes and continue to live this way, and through them knowledge about AD is produced not only discursively but also in terms of specific material: living cell lines, living fly stocks and transgenic mice. However, what agential cuts also highlight is the violence that comes with these lively processes, as these models are made and born to be experimented on and to die. Killability then becomes a material-discursive phenomenon and a state of becoming-the-animal-model yet to be killed, which I will discuss below.

5.6 Spectrum of killability: Order and fluidity

FIELD NOTE MAY 2012: *Anna and I were sitting in a small seminar room across from each other behind a round table. It was my first interview and I was so nervous that I was using two different recorders. I was not yet obsessed with fruit flies but simply curious to know about Alzheimer's animal models. I was curious to know why and when Anna chose her model organism, whether it was flies or mice or another biological living critter. As I posed my question, she started to explain that depending on the nature of the experiment, she chose the animal model, keeping in mind which animal biologically allows her to carry on her experiment. But also, as she explained, there is a hierarchy between the models and there are ethical procedures that allow or prohibit scientists to use different animals. In the beginning of the experiments, when an idea is pitched into an R&D, there is a lot of guessing, speculation and uncertainty. This means that until the initiated hypotheses come to the point of relevant certainty and safety, many model animals would die simply just to rule out nonrelevant components or to exclude the unsafe procedures that would cause harm. In those stages, usually smaller organisms are preferable*

because it is easier to work with them, isolate and control them as biological systems but also because they are cheaper and it is less complicated to get an ethical committee's permission. She further explained that as a drug or a procedure moves forward and looks promising, then the animal becomes bigger, like the mouse model. By the time that the drug reaches the preclinical trial, it should have been tested at least in two animal species. The animal would be chosen in relation to the specificities of the drug at hand since each model has its own biological specificities. Nonetheless, as the drug moves to the preclinical stage, apes are one of the best models for their similarities to humans.

STS scholar Hannah Grankvist and biomedical ethicist and sociologist of medicine Jonathan Kimmelman (2016) write that despite a large gap between the biological capacities and specificities of humans and animal models and the number of uncertainties that follow from animal studies, a new drug has to first be proven safe in animal models, even if the safety of the treatment in animal models is not often translatable and identical to human bodies. Humans can never become test objects in the early stages of translational medicine in the laboratory. In this context, animal models have become a crucial part of experimental biology and drug industries (see Asdal 2008). As professor of psychology, neurology and radiology Diana S. Woodruff-Pak (2008) writes, legal and ethical issues on human experimentation often inspire scientists to use animal models and computer simulations. As such, animal models are an essential tool and a constitutive part of experimental biology, which help scientists to better understand disease mechanisms.

As Anna explained me in the above excerpt, within laboratory practices, particularly within drug industries and life sciences, there is a ranking between animal models. Fruit flies are one of the first model organisms (along with nematode *C. elegans* and other simple organisms) exposed to new drug developments and early trials. If they survive the experiments, then the next and more advanced models, namely mice and other mammals, are propelled into experimental trials. Fruit flies die in massive numbers within daily experiments to gain scientific results, which gives relevance to, in the context of the lab, idioms such as “drop like flies”—an expression

commonly used when a large number of people die in wars and disasters. This is to say that killability is not about the act of killing but about how bodies and their bodily matter have transformed into a resource for scientific inquiries as the result of sociopolitical and economic contextual specificities in which not all bodies, but only particular bodies, have been circulated and subjected to scientific experimentation as test objects. In this process, to create information and to preserve and sustain bodies that matter, masses of Othered bodies have to die first. This view of animal models in the laboratory, which sees the animal as the sacrifice for the better good, is what Haraway problematizes.

According to Haraway (1997, 2008b), such logic and narratives of sacrifice are indeed to decide, calculate and make killable some lives for the sake of others, and therefore they are problematic. Within such logic, there will be always lives that are valued less and others that are valued more, and the former become collateral damage and a necessary sacrifice. The problematic element is that there will always be a threshold that justifies killing, even if it is limited. As Haraway writes, according to such narratives of sacrifice, “there is a whole world of those who can be killed, because finally they are only something, not somebody, close enough to ‘being’ in order to be a model, substitute, sufficiently self-similar and so nourishing food, but not close enough to compel response” (2008b, 79). It seems that, inspired by such logic, throughout the past century, smaller animals and organisms have become the threshold of killability in laboratory life both as a result of animal rights movements but also as a matter of structural and methodological changes in biology, which I explained earlier.

Although animal rights discourses have been a great achievement by animal rights movements in raising awareness, compassion and legal protection for (some) animals, they are not without limits. In other words, the animal rights movement is another way of thinking about ethics that Haraway criticizes because, according to her, if we think about killing as a part of life, it is also problematic to “pretend to live outside killing” (79), an argument I discussed in my theory chapter. In other words, to think about killability not in

terms of sacrifice or animal rights leads to a consideration of how we, as humans, can think responsibly and ethically about killing and also stay with the trouble within relations of use. Thinking about killability does not justify killing nor does it pretend that it is possible to reach a point of no killing at all; instead, it leads to facing the killing in responsible ways. Killability is then to stay with the cuts that enact a form of life as different than others and as killable. As Barad writes, “the point is that the very practices of differentiating the ‘human’ from the ‘nonhuman,’ the ‘animate’ from the ‘inanimate,’ and the ‘cultural’ from the ‘natural’ produce crucial materializing effects that are unaccounted for by starting an analysis after these boundaries are in place. In other words, what is needed is an account not only of the materialization of ‘human’ bodies but of all matter(ings)/materializations, including the materializing effects of boundary making practices by which the ‘human’ and the ‘nonhuman’ are differentially constituted” (2011, 124). In the context of my study, then, I use Barad’s agential cuts as boundary-making practices with concrete materializing effects through which fruit flies, mice and cell models become killable differently. These boundary-making practices are not only social, cultural and performative of the human, but the nonhuman is as well performative of such cuts. I use the concept of a *spectrum* of killability to highlight both structural and material dynamics through which animals are made killable differently and also to stay with the fluidity of this spectrum. In other words, once the cuts are made, animals become killable differently in relation.

I use the term spectrum in affiliation with *not* optics²⁴ but queer feminist theories. For example, it has been discussed within feminist queer studies that human sexuality as well as gender identity can best be seen as a spectrum and therefore manifold rather than a binary dichotomy (Fausto-Sterling 2000). Even though the cultural appropriation of nature is often polarized in hierarchical ways (for example, man and woman or nature and culture), the very boundaries

²⁴“The word was first used scientifically within the field of optics to describe the rainbow of colors in visible light when separated using a prism”. It is a very precise range of colors that appear one after another on the spectrum, always in the same order (<https://en.wikipedia.org/wiki/Spectrum>)

that enact one or the other are so fluid that they implode the binary itself. Indeed, as biologist and gender studies scholar Anne Fausto-Sterling (2000) argues, if one takes biology seriously one realizes that biology is more vibrant than social constructions of, for instance, sex. Thinking with biology highlights how such binaries are made rather than found in “nature”. Julia Serano, trans activist and biologist, argues that “with heterogeneity in taste, the full spectrum of gender and sexual variation can only be adequately explained through a holistic (rather than homogenizing) perspective. Because gender and sexuality have many biological, social and environmental inputs that are not particularly malleable” (2013, 156). Yet, despite the work of many to queer such binaries in favor of multiplicities, there are often cultural, social, economic and other power relations that imply hierarchies in affective, performative and often violent modes. As Serano argues, regarding this spectrum, “at the far end lies complete dehumanization” (2013, 248). In other words, and thinking with Barad’s agential cuts, this spectrum is about the dynamic relations that have in themselves both the structural power relations that do violence and the testimony to the arbitrariness and fluidity of such systems. The spectrum is then performed and performative, it is agential and agentially enacted, material and discursive. I use the concept of spectrum in this way together with killability to highlight that even mice, fruit flies, cells and brains become killable differently in the lab as a matter material-discursive cuts. Nonetheless, these models are imagined as killable in a hierarchical system within life sciences and pharmaceutical industries in comparison to other animal models.

In the 1990s, apes gradually became contested test objects. In 2006, many countries such as New Zealand, the Netherlands and Sweden banned any invasive experiments on apes (Langley 2006). The same reason that once constituted apes as the perfect animal model, namely their similarity to humans, unmade apes as the animal model in some geographical locations, but not everywhere²⁵. Lynda

²⁵Nature journalist Alison Abbott (2014) writes that even though medical testing on apes is highly regulated and even banned in Europe, many Western scientific institutes are closely involved with ape facilities that are located on other geographical locations,

Birke, Arnold Arluke and Mike Michael write that due to the long history of domestication, using dogs and cats for experiments “means confronting their ‘special’ status and meaning within society” (2007, 21). In other words, animals such as dogs as test objects “provoke particularly strong reactions” for humans due to their long history of domestication: they have names and stories, and their lives matter²⁶. Nonetheless, while bigger animals like apes are not enacted as models for early stage experimental research, they are still an important model before a drug can be tested in clinical trials. Unlike with bigger animals, not everybody gets excited “over potentially invasive or fatal experiments with nematodes or fruit flies”, particularly because they do not identify with fruit flies as they do with mammalians; they also do not get nostalgic over fruit flies as they do regarding domestic animals (23). Even within the humanities and social sciences, as social and cultural geographer Jacob Bull (2014) argues, critical discussions on human and animal relations focus mostly on not only bigger animals with a recognizable face but those animals that are situated nearby geographically. As he argues, “nearby” is not literal in these cases, but this requirement highlights the fact that often these studies are concerned with an animal that “ties species together along lines such as domestication, consumption, companion animals, or taxonomic class” (2014, 74). As I argued earlier, flies, although they are nearby according to human ecologies, are not fully culturally related to as animals. Fruit flies hold the same contradictory position as nonanimal in the laboratory. On the one hand, fruit flies are considered animal enough to become part of experimental biology, yet they also fall out of the category of animal, as I discuss below.

Flies appear very far from apes, dogs and cats on the spectrum of killability. Even though they are domesticated, they are not cozy, nostalgic or useful in everyday realities. Neither do they share the most obvious taxonomic kinship with humans. Rather, they are enacted as the threshold for killability. For instance, according to the fly company’s website (with which the laboratory of my fieldwork had contact), transgenic *Drosophila* is used to single out “those strong

namely China or Singapore, that do not share the same bans on ape testing.

²⁶For instance, the Brown Dog Riot in 1907 (Lansbury 2007).

candidates that are worthy of exploration in higher systems to reduce the number of animal experiments that needs to be done”—higher systems such as apes, dogs and even mice. Moreover, as I mentioned before, in my interview with Anna, she explained to me that many scientists often start experimenting with flies before they move on to the mouse model, and later on, if successful, they move to bigger animals before the experiment goes for clinical trials. Fruit flies, as such, are not higher systems and therefore not as worthy as primates or rodents. They are ordinary and simple. There is no wonder that they have never been a subject for animal rights discourses or campaigns. As Connor writes, flies are understood as “ontologically nugatory when it comes to the capacity for pain” (2006, 77), despite studies that investigate and suggests flies’ responsiveness towards pain (Smith 1991). Yet fruit flies are still one of the most killable creatures not only in the lab but also daily over a basket of fruit in the kitchen, which begs the question, why are flies such killable creatures? According to Connor (2006), the anthropomorphist understanding of consciousness, pain and suffering requires a conscious subject upon which pain and suffering is inflicted from an external source. The conscious subject then has the ability to perceive it. He continues, asserting that a fly is a faceless “creature of such puny substance and brief persistence” that it can never be a subject of suffering and pain within modernist ideals (77).

It is not only in the cultural sense that flies are killable. In the lab, fruit flies are equally killable. Humanized fruit flies are not considered a matter of ethical concern by ethics committees, as they lack a spine. There are different guidelines and academic courses on how to handle lab animals such as mice (Holmberg 2008, 2011). There are many national and international discussions on ethics and legal procedures on the use of animal models in laboratories (Asdal 2008). Transgenic fruit flies are nowhere on this map. They are instrumentalized and become killable in their absence from all the guidelines, discourses and practices of care in the laboratory. Within the lab care protocols, they are not only nonhuman but also nonanimal in contrast to other lab animals. Fruit flies are not even considered to be a sacrifice.

Within discourses in the lab, when scientists *talk* about sacrificing

animal models, fruit flies are never included. Fruit flies became killable because they are not sacrificeable, unlike the mouse models in Anna's lab. Even though the act of killing did not happen in Anna's lab but in a German facility, the discourse of sacrifice was pretty dominant when she and her colleague were talking about mouse models. On the other hand, even though the act of killing fruit flies fits the definition of scientific sacrifice (killing the flies for the better good and finding a cure for AD), it is not conceptualized and related to as sacrifice on the discursive level. Looking through my field notes, I picked up on quotes such as "the mice had been *sacrificed* in Germany", "the mouse had to be treated in ethical ways and to be *sacrificed* in particular age or it would be of no use", "the *sacrificed* mouse was an AD mouse" and so forth. I came across an interesting headline on the Bloomington *Drosophila* Stock Center webpage: "Getting rid of the flies". Clicking on the link brought the reader to a page with guidelines how to *get rid of* fruit flies. In other words, the discourse in the fly lab has never been about sacrifice. Fruit flies may be squashed, killed and dumped with no stories, no obituaries and no status of a grievable sacrifice; rather, they are something to get rid of.

What is interesting here is how the spectrum of killability narrows down and pushes the threshold of killability, from human to animal and from bigger animals to smaller animals such as mice, then invertebrates and organic matter (e.g., the cell model and fruit flies). The smaller the animal, the more likely it is to appear in the experimental and preclinical laboratory experiments. The violence here is not about the act of killing the flies but about making them killable in their nonexistence, facelessness and invisibility. It is about what Haraway argues is making something killable. How can one talk about killability and fruit flies but not make them killable?

What the concept of agential cuts added to the above-discussed Harawayian concept of killability is the materiality of killability itself as a phenomenon. Indeed, with the concept of a spectrum of killability as agential cuts, I aimed to discuss the dynamic of asymmetrical use in the laboratory in which different models, fruit flies in particular, become killable, yet I did not wish to normalize this dynamic reality

of killability. In other words, I showed killability to be not a discursive construction nor a symbolic figuration but a material-discursive practice through which animals become killable differently. Killability involves species' biological capacities, specificities and possibilities such as fruit flies' simple chromosomes and reproduction habits. I also aimed to highlight that this spectrum of killability is an ever-changing scale that enacts animals as killable differently once relations change.

As fluid as the spectrum of killability is, it is also situated and context dependent. In other words, within the natural sciences, there have been efforts to find the perfect model organism that can stand in for humans. Becoming the standard model is not only a matter of similarities between the prospective organism and humans and how that particular animal interacts with scientific discourse and technological possibilities. As I demonstrated, in each lab, different organic entities became the test object and killable because they were replicating human AD in singular ways. In other words, killability in these three labs is also a question of how similar an animal model's biology is to human biology. This is to say that these three models differently occupied a space on the spectrum of killability in terms of their similarity to human biology within the context of AD. However, too much similarity could also be problematic. For instance, as I mentioned, apes unbecame test objects because they were too similar to humans; humans came to perceive them as entitled to consciousness, subjectivity and perception and therefore not killable. In other words, the significance of the animal model is not universal; rather, it is dependent on each laboratory's practices, scientific agendas, scientific paradigms, alliances and resources as well as the animal's biological capacities, which cut the boundaries of a particular animal model as the proper test object (they are coconstitutive). Even within the same lab, as in the fly lab, the killability of animals is situated on an ever-changing spectrum upon which fruit flies become killable and nonkillable in relation to different stages of the experiment. There are multiple modes of killing fruit flies: some killings make waste, and others make scientific results.

Ultimately, my point in this chapter was not to discuss the

bioethical dimensions of animal testing, for I believe this has been done by others more elaborately. Rather, my point was to trace the spectrum of killability through which different animals unbecome the test objects and nonkillable differently in relation to political, geographical, social, scientific and ethical factors. Similar to anthropologist Simone Dennis's argument about the meaning of mice and rats in the laboratory, fruit flies "occupy ambiguous and ambivalent positions between the polar opposites of humanity and animality, and disposable laboratory equipment and animate beings" (2011, 76). But they also occupy ambiguous and ambivalent positions within and outside of the category of animal itself, which I refer to as nonanimal. They simultaneously embody "opposing and conflicting characteristics and values", such as "pests and pets" (75–76) or "ordinary treasure", as well as by promising a cure for AD but also being disposable and killable (Holmberg and Ideland 2009). In other words, *Drosophila melanogaster* has become a model organism and a crucial part of modern life sciences for over a century, helping scientists to learn about "human" biology. Despite all cultural alienation and abjection that comes with flies, on the one hand, and their exclusion from life stories and scientific discoveries, on the other, these fruit flies hold to a certain degree the key to understanding diseases such as AD.

5.7 Conclusion

In this chapter, I discussed killability in relation to sociocultural imaginaries, bacteriology and early health campaigns in response to insect theory. I argued that flies have been understood and imagined in relation to death and disease and therefore they are seen as killable. However, I also discussed how fly and human relations on the one hand and the fly's cultural imaginary on the other hand changed as the biproduct of transformations in biology and the natural sciences, namely the rise of experimental biology and genetics. I argued that fruit flies not only entered the laboratory as an animal model but became one of the most popular models.

Fruit flies became part of genetics and other sciences in the study of, for instance, neurodegenerative diseases. I suggested that flies became killable as they became the standard model for experimental biology. Fruit flies also became killable in a hierarchy of animal models in the lab on which they became nonanimal as they occupied a lower status than other, bigger animal models as well as those animals privileged by “nearby” geographies of domestication, love, distinction and consumption. As they were enacted as both animal and not animal, fruit flies became disposable and killable, both in everyday life and in the laboratory.

Moreover, I showed that killability is not only about discursive and social abjection. Neither is it only a matter of practicality, scientific prestige and credibility: fruit flies did not solely become killable because of their well-established status as a standard animal model. Killability is also about the material conditions and biological specificities of an animal model. As I exemplified via the mouse, fruit fly and cell labs, each laboratory’s choice of animal model was due to a particular understanding the researchers had of AD. In other words, I highlighted that the “the style of reasoning” (Hacking 2002) enacts a particular animal model because of the biological specificities that it offers. Whether AD is understood and set to be measured in terms of protein aggregates’ morphology, biochemical functions and toxicity, or the contagiousness of protein and neural contamination, each materializes the test object and cuts the boundaries of becoming the test object differently. An animal’s biological specificities matter, as they determine which animal model can become the test object. In other words, the determinacy of the animal model as “the animal”, in the three labs I discussed in this chapter, is not self-evident but, as I showed, a matter of intra-acting components that come together and materialize in the form of the proper animal model, or the test object.

Inspired by Barad’s agential cuts, I argued that killability is always materialized through material-discursive cuts that are enacted within a phenomenon and are constitutive of that phenomenon, in this case an Alzheimer’s test object. I argued that there is a spectrum of killability on which different animals or organisms become killable

differently depending on their biological specificities, cultural imaginaries, ethical dilemmas, laboratory discourses and technical practicalities. This spectrum, however, is a fluid, relational phenomenon that changes constantly. In other words, depending on the above-mentioned criteria, one animal may be the perfect model in one laboratory while it is not desirable and functional as a model organism in another. Moreover, different stages of laboratory experiments demand various models. For instance, as I showed, in the early research and development stages, it is often the case that scientists prefer simpler and less developed organisms on which to try out their hypothesis. In the later stages of, for instance, preclinical trials, however, bigger and more biologically advanced models on the evolutionary scale are desired because they are thought to be more complex and closer to humans biologically. This fluid spectrum of killability not only differs between laboratories but also changes within the life cycle of a drug's development, as the prospective drug gradually develops from a scientific curiosity to a possible cure in the clinic. Killability, if agentially enacted, is not only about discourse (it is not only a concept) but about material arrangements in the laboratory through which bodies are killed in different ways. Killability is a spectrum, always already agentially enacted and always already a matter of material-discursive cuts.

Finally, it is the specificities of fruit flies and the multiplicity of contradictory relations between humans and flies that inspired me to think about killability with the analytical tool of agential cuts. As I demonstrated, with agential cuts, I can account for the asymmetries of human and fly relations (of use) in their relational becoming with. As such, killability refers to social, political, cultural, economic and material processes of being made killable (Haraway 2008b). It is a relational phenomenon of becoming rather than being. As I have shown so far, the killability of the flies is a story of disease, dirt, death and decaying matter. It is a story of bacteriology and campaigns against invisible germs and bacteria and flies as their carrier. It is a story of modernism and the effort to keep the boundaries of social structures of class, nation, civilized and savage, nature and culture, human and animal, and the borders of belonging

and nonbelonging intact. It is about the illusion of closed boundaries. As flies move freely between such spaces, they claim recognition even in their extermination. Nonetheless, the word *exterminate* means to alienate, to campaign against that which cannot be tamed and therefore to acknowledge the unnameable's existence, its persistence and its unruliness. The story of killability of the flies is a story about disgust, abjection and subject formation in which fly-human relations are coconstitutive, and as such it is a story of cobecoming. To be human is to stay away from flies, to distance oneself from them, because they strangely remind us of our vulnerability, death, mutual cross-species belongings and unholy, undesired connectedness. However, in order to distance oneself from the flies, to make them invisible, one needs to call upon them, name them, look at them, intimately know what it is that one is rejecting. In other words, while making the flies killable is a story about making the Other invisible, faceless and nonexistent, killability is about more: it is also about mutual survival, pollination, flower blooming and biological control; it is about becoming (in)visible, (non)existent and killable in relational becoming. It is also about learning to live, to kill and to die together responsibly in an interspecies relation of cohabitation (81).

Waste liveliness in the lab

In the previous chapter, I wrote about killability as an intrinsic part of the natural sciences—a part in which particular kinds of bodies become raw material in laboratories, on a spectrum that cuts these forms of life as killable differently based on scientific discourses, biological capacities and sociocultural imaginaries. In other words, in writing about killability in the lab, I also indicated how particular kinds of bodies and lives have become both generative of scientific data and the waste product of biomedicalization processes and life sciences. In this chapter, I focus on how transgenic fruit flies were enacted as biological waste in the laboratory where I did my fieldwork. The categories of waste in the lab, according to standard laboratory guidelines (specifically, I referenced my fieldwork university's instructions), have often been made in relation to the degree of the hazardousness of the laboratory material and laboratory waste. I will show that even if transgenic fruit flies fit into any of the categories of laboratory waste defined by standard laboratory guidelines on a discursive level, they are handled differently across laboratories because they are not concretely hazardous material and therefore practices vary according to the needs and realities of different laboratories. I argue that flies are ambiguous as waste: On the one hand, they are biological waste. On the other hand, they are not always handled in ways that biological waste ought to be handled. I am curious about whether the enactment of flies as biological waste has to do with the local, situated understanding of transgenic flies as hazardous or

nonhazardous. As I discuss the handling of biological waste, I also speculate on the agency of the flies' bodies and whether they cross the boundaries of biological waste indicated in the university guidelines about laboratory waste. In fact, in staying with *waste in/determinacy*, as Myra Hird (2012) argues, using Karen Barad's principle (2012b), I wish to both stay with the flies as a "boundary object", an object that has been categorized and treated differently across the boundaries of the social world of different laboratories (Bowker and Star 2000), but also move beyond the discursive and take the materiality and liveliness of waste seriously.

Whereas I discussed killability in the previous chapter using Barad's (2007) concept of *agential cuts*, in this chapter I will discuss the material and discursive enactment of waste in the laboratory as a relational phenomenon. As such, I argue that waste, in Baradian (2012b) terminology, is an inherently in/determinate phenomenon that comes to matter once the agential cuts are enacted and provisionally materializes the properties of the phenomenon of waste in its relationality. I start by discussing laboratory practices of handling waste. I will highlight that "knowing waste" (Hird 2012, 454) is a practice that enacts flies as ambiguous differently in relation to the understanding of hazardousness and hazardous entities. To know waste is to categorize, to manage and to make specific distinctions between different kinds and realities of waste known as hazardous waste; it is to handle them differently; it is to enact boundaries that contain waste in both a material and discursive sense. In discussing how waste is in a state of constant becoming in relation, I will focus on the in/determinacy and intra-active materialization of waste in the lab. Finally, in discussing the materiality of waste, I will focus on "waste liveliness" (463) and its agentiality (Barad 2007). All three components—knowing waste as agential cuts, relational becoming, and the liveliness of waste—are constitutive of waste as ambiguous, or to draw on Barad's and Hird's work, they highlight that waste in the lab is an intra-active in/determinate phenomenon. Waste always becomes determinate in relation.

6.1 Waste, ambiguity and in/determinacy

Rooms matter. Location matters. Science is produced in everyday rooms, in particular locations, in situated ways that blur the boundaries between fact and fiction, science and narrative, nature and culture (Haraway 1997). Rooms tell stories, not only about the acts taking place in them but also about how their very arrangement and materialization of the space can be a contagious boundary-making practice embedded in sociocultural understandings of, for example, life and waste, safety and risk, natural and artificial, belonging and nonbelonging. A good example of such boundary-making practices and its materialization is the space of a laboratory. The laboratory I worked in during my fieldwork was a carefully arranged space for doing science, especially because in it, scientists were working with transgenic fruit flies.

Information and computer sciences scholar Geoffrey C. Bowker and sociologist Susan Leigh Star (2000) analyze classification systems in relation to historical and political dimensions through which social worlds, activities and memberships are formed around “boundary objects”: objects that are then perceived differently across multiple social worlds and are used differently within these social worlds. To them, categories are not abstract products of the mind to which objects are assigned but made in material symbolic practices. As such, categories are made in relations that are historically and socially contingent. How objects are used in different communities often enacts categories on the one hand and on the other hand becomes standardized and institutionalized in ways that structure everyday life. For example, in my fieldwork lab, standard protocols exist regarding handling the flies, the waste (flies), and the arrangement of space in the lab. In other words, working with these protocols and the assumptions about flies’ spatial belonging (e.g., whether they belong in or outside of the lab, whether they should be kept in the first or second room) gives rise to standard infrastructural arrangements of the space in the lab. These protocols and assumptions also enact categories such as natural and safe (i.e., wild flies outside of the lab),

on the one hand, and artificial and hazardous (i.e., transgenic flies in the lab), on the other hand.

Remember the fly lab and its two related rooms connected via a door in the middle? A door that that my supervisor told me to keep closed at all times? The door had a huge sign on it indicating “close the door” in bold, black font. The first room was more like a medium, a point of passage into the artificial world of experimental biology and transgenic fruit flies. If a fly escaped a vial and then the second room, it would be contained in the first room. I wondered whether the arrangement of the space in the lab was indeed a materialization of a boundary-making practice. It immediately gave me the assumption and feeling of danger, risk and separateness—as if there was something about these room that mattered so much, something that had to be kept separate and contained in a particular place.

The lab was an “unnatural”¹ environment in which we were breeding transgenic flies. “Closing the door” was then crucial to keeping the natural and the artificial apart. Closing the door was about “sorting things out”, making categories and keeping the transgenic flies where they belonged (Bowker and Star 2000). Closing the door limited any chance of contamination, of coming together and of mixing with nature—in other words, mixing both natures, of the transgenic flies made in the lab with the wild flies outside of the lab. It was indeed an implication of the “great divide” in action (Latour 1987). However, as I will discuss in this chapter, the boundaries enacted through materialization of the space and rooms in the lab were not to tame and to keep (potentially dangerous) nature contained, as is depicted within modernist sciences (see Åsberg and Mehrabi 2016). Rather, nature (outside of the lab) was understood as

¹When I use the term *unnatural* I do not mean in the sense of a dichotomy of natural and unnatural. I am aware that the category of nature is always already natureculture, as Haraway (1992, 1994) argues. However, I use the term to indicate how the space of the laboratory has been heavily regulated. As such, the term *unnatural* references the everyday work put into manipulating, regulating, measuring and disposing of that which is a biological artifact—especially the work that is put into sorting out that which belongs to the space of the laboratory and that which must not escape, that which does not belong to “nature” outside. In my use of the term, I do not refer to an assumed pure nature outside of the laboratory but rather to keeping transgenic biological organisms where they “belong”.

something to be preserved from the potential contamination of that which was made in the lab. I will discuss this dynamic of naturalness and hazardousness in this chapter as I write about handling the biological waste in the laboratory inside these rooms.

I started to look for more clues hinting at such boundary-making measures appearing in material forms in the infrastructure of the lab: All the windows were carefully sealed so that the flies could never get out. All the ventilation systems were sealed with a net similar to mosquito netting in order to avoid any unwanted fly escapes. The drains in the sinks in both rooms were covered with a net. Even when disposing of the flies, the scientists in the lab and I were careful not to dispose of them accidentally in the sink when we were washing tools and vials. Instead, we would carefully dispose of them in different ways: either into the ethanol bins or contained in a tube into the waste bin. In other words, we had to constantly decide what waste was in order to make decisions about modes of handling it. This brings me to my second point, which is about knowing waste.

Differences according to which categories are made are a matter of knowing, measuring and enacting those differences in intra-action, which in return materializes the phenomenon differently as well as the enacting categories to which the phenomenon belongs (Barad 2012b). Phenomena, categories and differences are then enacted in intra-action within practices of knowing. In other words, as Barad (2012b) argues, boundaries do not exceed relations. The object is enacted as different than other possible materializations only in intra-action. For instance, as she argues, once the boundaries of light as a particle are materialized in an experiment, it excludes the possibility of light becoming wave. Although wave and particle are both different potentials for materializations of light, it is enacted differently as one of the two possibilities (either as particle or wave) in intra-action with measurement practices. To think with intra-action highlights the problem of categorization because it shows that realities as well as objects are potentially in/determinate and they are materialized as different only in intra-action. In intra-action, the differences as well as the phenomena become determinate—a determinacy within which indeterminacy is always inherent; a determinacy that is the

intra-active materialization of in/determinate potential possibilities. For example, in the lab, depending on the experiment at hand, sometimes flies with curly wings were waste; other times flies with curly wings were the treasure offspring that we needed for the experiment. The in/determinacy of flies in the lab which would only become determinate as either waste or treasured offspring in relational practices of knowledge making is similar to Hird's (2012) argument about the in/determinacy of waste.

Inspired by Barad's (2012b) concept of in/determinacy, Hird argues that waste is in fact in/determinate dynamic mattering. In her article "Knowing Waste: Towards an Inhuman Epistemology" (2012), she argues that waste is an inherently indeterminate phenomenon that becomes determinate (categorized) once one approaches it and intra-acts with it in order to know it. To know waste is to categorize, measure and intervene. It is to set the boundaries of the phenomenon of waste. She writes, "Knowing waste is, [...] about rendering indeterminate entities determinate" (454). In the lab, to know waste was about sorting out which flies to keep and which flies to throw in the waste bin or the ethanol bin. It also involved knowing which kind of waste was hazardous and which biological, which then enacts modes of handling it differently. I will explain this in the following paragraphs.

The second room was the space in which the scientists and I would keep and handle the biological waste for disposal, which was mainly the leftover flies. The leftover flies were the bodies of the flies that were squashed for imaging purposes and soaked in the antibodies. They were the mass of dead flies that went to waste after the experiment. The leftover flies were also the surplus living flies, which were not needed and therefore went to waste while still alive. The leftover flies were also the mix of the living and dead in the tubes that were thrown away as waste. It was as if these flies and their bodies became food for science, consumed by everyday laboratory practices, and then the leftovers of such consumption processes, in which their bodies were digested and transformed into scientific knowledge about Alzheimer's Disease (AD) and then disposed of on a daily basis. Handling biological waste in the lab involved

handling the massive numbers of leftover flies. The second room was the place where scientists and I were constantly disposing of the leftover flies in the waste bin, as we made decisions about which flies to dispose of, and how, and which flies to keep. Through these decisions and actions, we engaged in practices of knowing waste—practices through which the boundaries of that which was waste and the kind of waste it was were enacted in relation to the experiments. As such, waste was not a pre-established category; it was enacted through each experiment differently.

There were three ethanol bins in the second room, each sitting next to a microscope. Working with the flies under the microscope was tied in with disposing of many of them into the ethanol bin. In other words, every time I looked at the flies under the microscope, flies that were sedated carefully, I would choose the ones I needed and collect them in a vial, then dispose of the rest. I would turn the plate upside-down over the ethanol bin, and as the sedated flies were still lying on it, unmoving and tranquil as the dead, I would let them slide into the liquid at the bottom of the bin and die. The ethanol bins would stand there on the table for days with dead flies floating in them, during which time the scientists and I would constantly add to their numbers on our daily visits. Eventually, one of us would seal the ethanol bin and take it to the hazardous chemical waste storage room.

We would also dispose of the flies in the waste bin. It was a blue plastic bin the shape and size of a wine barrel. There was a sign on the bin which read, in Swedish, “hazardous waste”. There was a black plastic garbage bag inside it. We would never dispose of loose flies in this bin for the obvious reason that they would fly away. We would always dispose of them into this bin in vials that contained both dead and living flies. As soon as the plastic garbage bag was filled with fly vials, one of the scientists or technicians would take it away to a walk-in fridge, which was the storage room for biological waste located at the end of a long hallway at the other end of the natural sciences department.

In the ways in which we handled the waste bins and their content, flies were enacted as different kinds of waste. In the blue bin, flies

were biological hazardous waste to be taken to the walk-in fridge. The flies in the ethanol bin were treated as part of a chemical substance to be handled as chemical waste and taken to a different section for waste disposal. In other words, through practices of disposing of the flies in the ethanol bin and the blue waste bin, the boundaries of laboratory waste were enacted differently and became determinate either as biological waste or chemical waste. In other words, Hird (2012) argues that waste's ambiguity is not about how waste becomes waste as a matter of perception and in the eyes of the beholder. Rather, waste is an onto-epistemological becoming in intra-action. Matter and meaning surrounding categories such as waste are enacted by measuring; they are the effect of measuring and knowing (462). In other words, living flies² in the lab would not be enacted as waste simply because they were flies and killable, as I discussed in the previous chapter. I would not dispose of every fly; only particular kinds of flies were waste. In each experiment, I was trying to breed a particular genetic combination, and whichever flies were not born with that combination were enacted as waste. As I was intervening with, manipulating and breeding flies in the course of each experiment, some flies were born waste and would end up in the waste bin, and others were kept as important scientific material. In this chapter, I discuss how waste has been enacted differently in the practices of handling, storing and disposing of flies. I have to mention that I did not follow the waste after it left the university campus, not in person at least. However, I collected information on websites that were related to waste management and others that provided information on handling laboratory waste within the local context of my study. As such, I made a cut to stay with the waste in the lab and outside the lab, but only within the context of natural sciences department at the university.

Last but not least, as Hird (2012) argues, it is not humans in particular who do the cuts and perform knowing. Rather, knowing is a matter of human and nonhuman performativity and intra-action (see also Barad 2007, 2011). In other words, the nonhuman Other is

²Any fly that died automatically became waste. However, the kind of waste that they became was multiple, as I show in this chapter.

agential. The agentiality of the nonhuman is related to “waste’s liveliness” (Hird 2012, 463) and its capacity to do, to flow, to generate and to transform. The agentiality of waste and its liveliness highlights the “uncontainability” (Radomska 2016) of waste and that waste escapes order, categorization and human supremacy. As Hird writes, “Nature relentlessly flows, but not in ways that are necessarily compatible with human flourishing” (2012, 464). Flies fly away and move in between spaces in which they do not belong. The leftover flies that are, supposedly, waste and belong in the waste bin occasionally fly away before being contained and tossed away. I explain more about this movement below.

The arrangement of the rooms, the division of labor in these rooms and the everyday rituals for handling biological waste were also related to life and death. The first room was about living but also containing. The incubators and fridge were located in this room. Only trays of fly vials that were already closed and contained would be moved into this room to be put in the incubators. No open vials and no uncontained flies were welcome. Moreover, not all live flies were welcome in the first room—only the flies with the right genetic combination, which were carefully selected by the scientists, were moved to the first room. All the other ones, although alive, would be brushed into the ethanol waste bin or left in vials in the blue plastic bin in the second room. In the first room, scientists maintained and fostered new life and living bodies, while in the second room we acted, experimented, killed and disposed of the flies and handled the leftovers as biological waste. Ultimately, as the result of the division of tasks according to the rooms and space, as well as everyday knowledge-production practices, the first room was the *living space* and the second room welcomed death as well as life.

In the second room, I had to open and change the tubes occasionally, which increased the risk of the transgenic flies running free. I opened the tube to move flies from the old tube to the new one or to give them fresh food or medicine. I also had to open the tube at least once a month to change it so as to avoid unwanted bacteria or mites. I opened the tube to breed the flies. Last but not least, I had to open the tube during measurement practices and to record

the flies' velocity. At points, I would use anesthesia to take away the flies' agency but not always. Sometime I had to rely on the speed of my hands and hope that my speed would beat the flies' famously fast movements. My point is that I opened many tubes in the second room during every visit to the lab, while flies were moving inside of the vial. No matter how fast I moved, one or two flies would escape.

Unlike in the second room, I never opened a tube in the first room. Nevertheless, the runaway flies in the second room had a way of appearing in the first room. Maybe in the split second when I passed through the door to the other room, or through a secret escape which I never found out about, flies always broke the ideal of contamination and boundaries, of separation of the rooms and of the living and the dead, as they escaped the second room and entered the first room not contained in the vials but exposed and uncontained. I speculate that the uncontained runaway flies would occasionally escape the first room into the realm of the "natural" world in ways quite similar to how they found their way from the second room into the first. However, I will never know for sure, as I never actually captured one. In this chapter, I also write about negotiating agency and waste's liveliness while handling biological waste in the lab.

6.2 Waste as a technoscientific legacy

Handling waste is not a new phenomenon. Handling waste as a matter of public health and responsibility has been at least an intrinsic part of social systems for over a century (Rathje and Murphy 2001, 40). Often handling waste has been equivalent to disposing of it out of sight, which, as Hird (2012) writes, brings about a kind of forgetfulness, as though once the waste is out of sight, somehow, it is contained. However, the materiality and agency of waste has proven this to be a naïve illusion. As gender studies scholars Cecilia Åsberg, Redi Koobak, and feminist STS scholar Ericka Johnson write,

It [waste] finds no rest in landfills or in waterways. It haunts us in outer space as the junk-yard belt of discharged satellites

and rocket parts that orbit the Earth. It surfaces in the ocean as the Great Pacific Garbage Patch, a marine sludge of plastic debris that kills all kinds of flying and swimming animals, and outnumbers plankton and marine life as it keeps expanding. This particular patch of plastic sea soup was recently estimated to be twice the size of France, but it is probably not the only one. Not visible through modern imaging technology, such as satellite surveillance, and gathering where major currents converge, they are thus places often avoided by ships and are very hard to detect unless one actually goes there. (2011a, 218)

In other words, no matter how far and out of sight we humans banish waste, it always finds a way to come back and make itself visible as an environmental dilemma, wildlife threat or health issue. As such, waste is not a problem that can solely be contained and removed by technologically assisted means. As I will argue in the following sections of this chapter, technological and scientific progress sometimes add to the problem of waste by bringing about new forms of waste. Therefore, in order to handle the problem of waste, humans need to rethink the politics of production and consumption, of nature and culture and of waste itself. As Åsberg et al. argue, waste begs the question, “What are we doing in new ways” (2011a, 218). In the case of my study, then, the question is as follows: What are we doing in the lab that is, in novel ways, engendering new worlds in material and discursive ways? What modes of engagement and relating to such newly made phenomena are available inside and outside of the lab, and why does it matter?

Although today there are great personal, national and international efforts aimed at handling waste by categorizing, separating, managing and recycling it differently, the question of waste is still pressing. The problem is not only to find ways to deal with the abundant waste produced by previous generations (see Rathje and Murphy 2001) or to manage “the increasing mountains of waste humans produced [that] are made possible through mass production, global transportation and communication, and cheap mechanized

labor” (Hird 2012, 454). It is also to find ways to handle the new forms of biological and technological waste produced as the legacy of high-speed technological progress and revolutionary scientific advances. One such unprecedented technoscience legacy of the New World Order—a world that Haraway (1997, 55) argues is obsessed with molecular genetics, molecular biology and genetic engineering (see also Franklin et al. 2000)—is laboratory waste.

As I discussed in chapter 4, new forms of life and death are created daily in laboratories and in life sciences. As Haraway argues, creatures are born through “ordinary practices that make metaphor into material fact” and science fiction into everyday reality (1997, 79). Nonetheless, the other side of these exciting stories of scientific progress and creation is the dead and dead bodies (see chapters 4 and 5). As with any other invention, an intrinsic part of such newly born technoscience creatures is also developing modes of handling them as waste, once they have served their purpose (Radomska 2016). In other words, what is at stake within the New World Order and its laboratory space is not only tackling the ethical, political and cultural anxieties around transgenic creatures and discussing their subjectivities and place in this new world (Haraway 1997). What also matters is deciding and determining how to handle them once they are transformed into laboratory waste. Nonetheless, to know waste, as Hird argues, is to enact the cuts. It is to set the boundaries of laboratory waste as a novel kind of waste. In other words, these new forms of waste not only transgress the threshold of nature and artifice but also change the ontology of waste, as they disturb its existing categories in the laboratory in material, symbolic and discursive ways. Handling the novel forms of transgenic organisms, animal models, living creatures and infectious bacteria as (laboratory) waste is specific to these practices, and therefore in need of careful consideration.

6.3 Sorting waste out

On a rainy day in autumn 2015, I was sitting in the university cafe with my friend Helen, who was a master’s student in biochemistry.

She was working on her thesis at the time and was therefore spending a lot of time in a different laboratory close to the one where I was doing my fieldwork. She was working with proteins and bacteria, trying to develop a particular kind of molecular agent that could be, among other purposes, useful for detecting AD-related proteins. In order to culture proteins, she needed to work with bacteria. I will not get into the details of her project, but what was interesting for me as a feminist social sciences enthusiast was the way she was handling the waste. She explained to me that every time she did an experiment, she had to wash everything with ethanol: the petri dish, the tubes and all the objects that had been in contact with the bacteria during the experiment. Then she had to categorize and separate all the remains, ranging from the tubes to the gloves she had used, and put them in separate plastic bags: the tube in one, the gloves in another, the biowaste in another and so on. Afterward, she had to autoclave³ them all. The whole process had to be done by the same technician who was doing the experiment. She said that some of the bacteria in their lab were also made resistant or immune toward antibiotics for experimental reasons. She said, “You don’t want that to get outside of the lab at all”.

Helen’s warning can be read in relation to sociologist Zsuzsa Gille’s (2007) argument in which waste is categorized as a matter of being a natural scientist—a position in which biological waste is understood as something hazardous and negative. Here, an understanding of waste and modes of handling it were situated within the binary opposition that Gille critically refers to as the binary of hazardousness and clean, natural and artificial. Gille reflects on how waste is, problematically, often associated with the negative and undesirable pole of these dichotomies. She argues that the negativity of waste is part of a sociocultural legacy, because in different contexts waste actually may be something exciting rather than negative. Such a categorization of biological waste as dangerous is not limited to the context of the laboratory but present in the cultural imaginaries of biological waste. It is both a cultural imaginary and a laboratory

³An autoclave is a pressure chamber that is used for predisposal procedures as well as sterilization and neutralization of (infectious) material waste in laboratories.

reality.

The conversation I had with Helen about the waste, and particularly her last sentence, “You don’t want that to get outside of the lab at all”, reminded me of a science fiction movie I watched some time ago, *Rise of the Planet of the Apes*, directed by Rupert Wyatt in 2011. In the movie, scientists develop the substance of a drug to cure neurodegenerative diseases such as AD. As the movie goes on, the audience comes to realize that the drug has the unexpected side effect of making chimpanzees develop superintelligence. At the same time, it appears that the substance (a virus) is deadly to humans and highly contagious. Within the movie, a chimpanzee who was to be euthanized (and to become biological waste) gets away and becomes the leader of other chimpanzees. One of the scientists in the lab, who was infected by the virus in an accident, also leaves the laboratory with the virus in his body. As the virus leaks outside of the lab—in the body of the researcher and as the chimpanzee breaks free from human control—life on earth turns upside-down. The contagious virus travels around the world. The researcher travels from the United States to Europe, and as the virus spreads, it wipes out the human race on the planet. At the same time, the same substance gives rise to a superintelligent race of chimpanzees who take over the planet.

This scenario can be read as an exaggerated dystopian future that provokes ethical responses toward animal use in science or questions the anthropocentric understanding of life. But it can also be understood as a warning, a speculation about the potential effects of tampering with “nature”. It reminds the viewer of the fantasy of human control, the permeable boundaries between nature and artifice, and the leakiness of laboratory space and humans’ bodily openness to hosting other forms of life, especially viruses. Such a cultural imaginary is not far from the realities in the lab. I started this chapter describing the division of rooms in the lab, the carefully sealed windows and mosquito nets covering every ventilation opening, the hysteria regarding keeping the door closed and keeping the science in action in the isolation of the second room behind the closed door, and managing the living and dead bodies of the transgenic flies in ways that are carefully contained. All of these details speak to the

fact that such a boundary-making practice and nostalgia for purity and separation of forms of life is not only a cultural imaginary and a subject for science fiction. It is already a reality around which laboratory space, laboratory life, laboratory activities and practices, and biological waste management are arranged. It is a boundary-making practice by which the very category of waste is formed and multiplies as, for instance, biological waste, hazardous waste etc.

However, the way that Helen referred to the laboratory waste as hazardous was not necessarily about negativity but also acknowledging and taking seriously the potential liveliness of the waste that could act in unexpected ways. To go back to the movie, despite all the shiny, supersecure and almost isolated areas within the arena of the biotechnology company developing the drug, nature has its own unexpected agency. Glass shatters; technologies break down; the animal model becomes the master; the facility comes to its knees when the chimpanzees are freed by their own kin. At the same time, the virus gets out without anybody even noticing it. All of these elements remind the viewer of nature's agency or, as Haraway says, nature as a "trickster" and a "witty agent" (1988, 593). The agentiality of animals is similarly evident in the fly lab, as the flies occasionally fly away and leave the space in which they ought to be contained.

I would like to juxtapose my reading of the dystopian drama of Alzheimer's sciences and imaginaries around laboratory animals and biological waste alongside the arrangement of laboratory spaces and practices in life sciences. In performing such a juxtaposition, I wish to highlight the coexistence of control and agency within life science. On the one hand, laboratory creatures and laboratory waste are enacted as hazardous and in need of strict control and containment, and on the other hand, they are enacted as agential and therefore not easily constrained despite security measures. In fact, what was at stake in the lab was to keep the flies and their capacity for agency under control, because scientists were indeed taking nature's agentiality seriously. It seemed to me that the human devotion to nature's liveliness and capacity to act, do and perform in uncontrollable ways initiated the practices of categorization, sorting and keeping the boundaries of spaces of belonging and nonbelonging

in order to avoid any unwanted accidents.

6.4 On danger and hazardousness

In the movie, it is imagined that what comes out of the laboratory is potentially dangerous to “nature” and life on earth. The life at stake, however, is the life of humankind: human life is commensurate to life. It is human life that needs protection from getting infected. As is shown in the sequel movie, *Dawn of the Planet of the Apes*, directed by Matt Reeves in 2014, life on earth continues for many creatures except for the majority of humans. However, what is interesting for me is how nature, life, humans and animals are all imagined as prediscursive, singular and separate categories that stand on their own. The mixing of genes and bodies, whether in terms of transspecies modifications or mobile viruses and bacteria taking up residence in other bodies, is portrayed and imagined as deadly. This is not new, though. As scholars such as Haraway (1999) and feminist philosopher Margrit Shildrick (2015) argue, the same modernist imaginaries about the self-sufficient, closed body of the human and its protection from contamination by the Other is evident within discourses of immunology. In these narratives, not only is life reduced to human life, it is humans’ survival that matters and is at stake. In other words, nature survives, but it is the survival of humankind that is threatened and put at risk. One can understand the anxieties about hazardousness in relation to laboratory waste and risks of contamination as a matter of disease outbreak. Bacteria and viruses can theoretically get outside of the lab and spread diseases, killing humans and nonhumans. The same anxiety about contamination and hazardousness was also implicated in Helen’s warning about biological waste when she said, “You don’t want that to get outside of the lab at all”.

As anthropologist and cultural theorist Mary Douglas writes, “any object or idea” that can “confuse or contradict cherished classifications” is “matter out of place” and potentially dangerous to the social system (1966, 45). Such ambiguous matter embodies the power

to contaminate and to disrupt order and therefore to “provoke others to demand that ambiguity be reduced” (1966, 127). Douglas writes that “pollution beliefs” are often related to contacts that are “thought dangerous” (1966, 176). These beliefs are often burdened with a symbolic load and are embedded in social orders, often in hierarchical ways. As such, pollution beliefs enact something as dangerous in opposition to “in danger” in order to hold in place social units and keep them separated by firm boundaries—between, for example, pure and impure, the civilized and the savage (4). The social category at risk within the narratives and imaginaries of hazardousness seems to be that of speciesism, and more broadly evolutionary taxonomic systems. It is the very construction of nature, life, humans and nonhumans, and bodies that is at stake, threatened by contamination of that which is not (culturally perceived as) nature. The matter “out of place” in the film consists of hazardous laboratory animals and biological waste, not only because they escape the space of the laboratory but also because they escape the cherished classificatory systems of inheritability, heterosexual reproduction and heredity. As such, they work against the idea that novelty (i.e., evolution) comes from within a species rather than from interactions between “species”⁴.

However, as *The Rise of the Planet of the Apes* demonstrates, it is not only the social order, namely speciesism, that is to be kept in place through the conceptualization of the dangerous and “in danger”. The materiality of the animal model and biological waste is also a boundary-making actant. Not only in the movie but also in the laboratory where I did my fieldwork, new materials, new forms of life and death, new biological models and new biological wastes are materialized and as such transgress the imagined boundaries of “purity” and “impurity” (see Haraway 1997). The note on the door, the arrangement of the space and my everyday rituals of carefully handling the living and dead flies (such as being careful not to dispose of them in the sink) were inspired by the university guidelines about how to handle animal models and biological waste. These practices and guidelines were at the service of an important

⁴I would like to thank animal geographer Jacob Bull for his input and suggestions regarding my analysis of the film and the complicities embedded in it.

purpose, which was to keep the natural and artificial separated—to keep that which belongs inside the lab separated from the supposedly natural environment and wildlife in the world and nature outside of the lab. In pursuing such agendas, however, what was happening was also that these boundary-making practices were enacting what is natural and what is unnatural, what is biological waste and what is ordinary nonhazardous waste. As such, not only nature and that which is natural was enacted; the boundaries of biological waste also became determinate in the everyday practices of handling the waste, which I discuss in the rest of this chapter.

In these practices and guidelines, it appears as if “nature” has to be secured and kept away from the laboratory and all the creepy, potentially harmful biological creations in it made by human scientists. It is the “natural order” that seems to be in need of protection through new modes of cleansing and handling waste. It was the mixing of “natures” (for instance that of humanized flies with wild flies) that was enacted as hazardous, as though nature could ever be something separate with a true essence which transgenic flies could then contaminate. It was as though nature was anything but natureculture. I do not mean to undermine the possibilities of contamination and danger in the potential of a breakout from the lab but to highlight that companion species relations are risky. Contamination and sharing bodies are the nature of nature, whereas nature as something detached and divorced from relationalities and relational becoming is indeed a construct of culture. Nonetheless, with the rise of transgenic organisms, biologically and genetically modified microorganisms and novel technoscience products in the lab, it appears as though there should be even stricter attempts to keep nature out of harm, to keep nature’s “purity” intact both in terms of its cultural representation but also in material ways, such as keeping the “natural order” in place. In this framework, these attempts should succeed at sorting out the nature that belongs to the space of the lab, namely the transgenic fruit flies, and the nature that belongs outside the space of the lab, namely the wild flies. As such, the arrangement of the rooms, precautionary arrangements, guidelines and scientists’ careful practices were trying to keep these forms of life in place not

only symbolically but materially (with the nets, the door and waste disposal management techniques). It is through such practices that scientists sort and categorize laboratory waste and modes of handling it differently, which I discuss in the next section.

6.5 On materiality and hazardousness

Let me go back to Helen's story about bacteria and laboratory waste. Like the chimpanzee and the virus in the movie, bacteria can be dangerous, as Helen indicated. They are invisible to the naked eye and cannot be detected as easily as bigger animal models. Bacteria can transmit infection to other living creatures. And worst of all, as Helen worried, some of these bacteria were resistant or immune to antibiotics, which made it more necessary to contain and destroy them in the lab, because should they get out, they could potentially wreak havoc. However, when I brought up the question of the bacteria's hazardousness as waste to my lab supervisor, I realized that the reality of such danger is not necessarily as acute as has been imagined, at least not in this particular fly lab. Nonetheless, processes and practices of handling laboratory waste seem to be inspired by potential risk factors, even if these risks are very slim, because laboratory waste is often made up of living entities, which can mutate and act in (un)predictable ways.

TARA: Can bacteria cause a problem if they get out of the laboratory?

KARIN: We often work with *E. coli* and we [humans] already have them in our system. I have a very hard time seeing if they can actually be spread, but yes! It could be. I have not dug into it. But I am not worried about it. I mean, if you create a super bacteria that can spread fast by the air and is super good at spreading and has some super gene that can resist a lot of other stuff, then, maybe.

TARA: Is it a bit science fiction then?

KARIN: Yes. That sounds like science fiction. The bacteria we are working with here are quite harmless. I mean we are in the lab,

working with them and we don't have any masks or particular uniforms. Well, viruses are different. For example if you are working with an HIV virus and you get a wound in the lab and get the virus into your blood system, that could be dangerous.

TARA: What do you think about chemical waste?

KARIN: If you get a lot of chemical waste accidentally in to the water system, it can poison our drinking water, which is very unlikely. Chemicals that are toxic should not be let out.

TARA: You think that is more risky than bacteria then?

KARIN: Yes, by far more risky. They are lots of chemicals that can interfere with the DNA, and if you get it in your body then it interferes with your DNA and can easily cause cancer.

Thinking through my conversation with Helen and other people in other labs, the conceptualization of biowaste had to do often with its potential risk to the environment or wildlife but mostly with its hazardousness to humans. As such, the laboratory is not the imagined clean, closed and controllable place for science but a risk zone that instead of being contaminated could contaminate⁵. If infectious superbacteria or chemicals that can alter DNA got out of the lab and spread around the world, they could hypothetically cause problems. What matters here is that most of this kinds of laboratory waste is living microorganisms, and as such active agents that escape control and therefore constructed as hazardous. It is the relation between the nonhuman agency and hazardousness that is interesting. In other words, and thinking with Douglas, they have the "power to

⁵Of course people in the lab would take precautions about bringing the wrong bacteria into the lab. For instance, one needs to clean all the tools and the table's surface before starting the experiment. No food or drink is allowed in the lab. Often it is expected of the technicians to wear laboratory clothes or coats and to wash their hands before starting in order to avoid contaminating the experiment. In that sense, the laboratory is a sterilized place. However, what is to be protected in this scenario is often the scientific experiment, material for the experiment and the result of the experiment from contamination, as unwanted organisms in the lab can create costly effects for experiments. Yet the kind of precautions taken about waste were on a different scale. They were not geared toward protecting the scientific experiment but protecting "nature". Such an attempt to protect nature outside of the lab from that produced in the lab challenges modernist ideas about nature as unpredictable and dangerous and the laboratory as a safe, sterilized space of (predictable) science.

contaminate and to disrupt order" (1966, 127). The hazardousness, however, is a locally specific, relational phenomenon that is enacting and embedded in practices of handling waste. It is a matter of which waste is potentially more risky—for example, chemicals are by far more dangerous than bacteria in the fly lab. A virus lands somewhere in the middle of this range. The scale of hazardousness is specific to the experiment and the bacteria, viruses and chemicals that are moved around, produced and handled as waste in a particular laboratory, and it can change once the material, experiments and species change.

Transgenic laboratory animals and (micro)organisms are not only a model invention but also a kind of waste that remain as living entities. Within a culture that is obsessed with purity, this kind of laboratory waste is often highly regulated and carefully handled for at least three reasons: First, this kind of waste is a relatively new phenomenon that needs to be managed; it may not fit within previously available categories known as waste. Second, this category of waste is not pure or "natural", and as such it embodies potential danger to the "natural order". Third, it consists of living entities that can mutate and escape regulation and control. As materials that are manipulated, changed and infected—and who have agency—transgenic lab animals and (micro)organisms as waste can have unpredictable, sometimes costly, effects for nature, humans, the environment and other living creatures if handled improperly. Their danger is not on the symbolic level of mixing nature and artifact that disrupts the nostalgia to achieve purity (Douglas 1966), but regarding the material probability of getting infected. As such, "knowing waste" and its careful categorization and regulation has become a well-known reality in many laboratories.

In a Baradian sense, the boundaries of waste in the lab are materialized through the intra-action of experiments, potential risks that are locally embedded in the modified (micro)organism, the cultural and social understanding of nature and artifact, and the practices of handling the organism. The hazardousness, materiality and liveliness of the organism and modes of experiments enact categorization, instructions and modes of handling the waste in order to keep nature intact. As such, and as I discuss in the following section, in

the laboratory where I did my fieldwork, laboratory waste was an ambiguous phenomenon. It was ambiguous because it is a relational phenomenon that has often been defined, categorized and handled locally in relation to “material-discursive cuts” (Barad 2007) that enact them as hazardous waste. It is within this particular context that I have collected my material and that I do my analysis of waste in the lab.

6.6

Flies as waste: On relationality, in/determinacy and the agentiality of waste in the lab

As a way of organizing waste in laboratories, the university affiliated with my fieldwork laboratory provides instructions regarding various kinds of waste based on the following categories: chemical waste, pharmaceutical waste, radioactive waste, infectious waste, waste containing genetically modified microorganisms (GMMs), non-infectious cell cultures and microorganisms, antibiotic waste, noninfectious blood waste, biological waste and sharps. Flies fit none of the categories of laboratory waste. They are genetically modified but they are not microorganisms. They are not cell cultures or infectious waste. They are not antibiotic waste or blood waste. They could have been considered biological waste, but once I dug into the practices of handling biological waste in the lab, I was not sure anymore. In other words, I came to realize that handling the flies as waste is a situated practice related to local modes of knowing and determining flies to be waste and handling them as such. It is this ambiguity, or in/determinacy, that is the issue I discuss next.

FIELD NOTE APRIL, 2012: *What is this sensation of disgust? The smell! Rotting food and rotting flies. There are dead flies at the bottom of the tube, half buried in the goeey food. The larvae are moving on top of them or on the sides. As the larvae dive deep into and out of the food, I can see them, the moving black dots, with my naked eye. There are also live flies that are stuck in the food; I can see them moving their wings and their legs, struggling to get out of the food. Those I have to push deep down into*

the food and bury them, and as I do it I can feel the texture of the food, I feel the gooeyness even through the brush. I have to look close to see if the fly is properly buried. The sour smell rushes into my nose as I get close to the tube. I gag. I take the next tube. I turn the tube to empty it of flies, and the gooey food starts running down the tube and taking over some of the flies' bodies, covering them with the rotting food. The texture of the food is runnier than it has to be. It tells me that the food is no longer useful and healthy for the flies and that the flies might have been contaminated by mites. I have to throw the tube out as waste no matter how many larvae, pupae and flies are still in there. I feel a twist in my stomach.

Flies as waste are ambiguous material entities. In the tube, food, bacteria and flies get mixed with one another, which makes it extremely difficult if not impossible to draw a clear-cut boundary between these biological entities. The food gets runny and takes over the flies; the decomposing materials are witness to the existence of different bacteria; the larvae and eggs are living in the food, moving in and out, making it extremely (technologically) demanding and time consuming for the technician to separate them from one another and handle them as singular entities. As Sebastian Abrahamsson and Filippo Bertoni (2014) argue, if one looks into the phenomenon of decomposition from a posthuman environmentalist perspective, one realizes that decomposition is about togetherness. As they argue, composting involves becoming together in relation. Such an understanding not only renegotiates the concept of decomposition as something not necessarily grotesque but also renegotiates the concept of togetherness to possibly include decomposition, rotting, digestion, bacteria and fungi. As such, decomposing matter troubles the clean boundaries of biological waste and hazardous waste in the laboratory because even in death, that which is decomposing is always a living togetherness of multispecies relations.

Flies, as waste, escape categorization on the material level. The agency of the matter problematizes the categorization of waste, as it enacts the waste as a bundle of entangled materials. One knows, at least partially and on the theoretical level, what the tube contains: flies, yeast, larvae and microorganisms for example. But looking into the tube full of mushy food, one cannot say where the fly's body

begins and ends as a separate entity from the rest of the material in the tube. However, it is not only the fluid and runny material substance in the tube that enacts the flies as ambiguous waste but also modes of handling waste.

Knowing waste: Becoming biological waste as matters of practice

Flies become waste differently as *matters of practice*. Even though they are animals and therefore should supposedly be handled as biological waste, they were in practice handled differently in different labs. The reason for such ambiguity was not laboratory negligence but the enactment of fruit flies as a form of waste that is not hazardous (enough) and therefore left in a grey zone of ambiguity.

Biological waste, namely, “body parts of humans or animals”, have to be handled in particular ways. According to the website of the university at which I did my fieldwork, biological waste is to be packed in leak-proof boxes and labeled as “Biologiskt avfall” (biological waste). These can be kept at room temperature for a maximum of four hours but then have to be moved into fridges where they can be stored at two to eight degrees Celsius. However, if the waste is to be kept for more than five days, it must be frozen. These guidelines are based on the fact that body parts of animals and humans decompose if handled otherwise and produce problems ranging from bad smells to infections. These kinds of waste, according to the university guidelines, should then be collected by the local waste company upon request. The packages then ought to be categorized and labeled. In the following paragraphs, I will compare two different laboratories that handle flies as different kinds of laboratory waste: the fly lab and Helen’s lab. I argue that in the absence of clear-cut instructions, flies were enacted and handled as laboratory waste in relation to hazardousness.

Laboratory one

Laboratory one is the fly lab where I did my fieldwork. During my lab work with the flies, I did not categorize or separate the material

before I threw it into the biowaste container in the corner of the room. I would simply dispose of the tube containing the rotting food, dead and decomposing as well as living flies, the larvae and the pupae. I would not even empty them into the waste bin but throw away the tube with everything in it. Although at points I would dump the flies into the ethanol bin, it was not necessarily for the purpose of disinfecting the biowaste and separating the flies as a particular kind of waste. Rather, it was a simple, practical way of killing many flies at once without the risk that they might escape and spread throughout the room. The ethanol and the flies in it were considered chemical waste or, as my supervisor said, “chemical waste that has some organic material [flies] in it”. I did not carefully dispose of the flies in a waterproof package. Often, there was an odd scent coming out of the waste bin, testifying to the probable leakages inside the bin. We would often leave the waste bin for days, until it was filled with tubes. Flies and all the other decomposing matter would remain at room temperature until it was collected at the end of the week. Then one of the lab technicians or scientists would carefully pack the black plastic bag from the blue waste bin and take it to a fridge, where the flies would remain sometimes for days before being collected by the local waste company. The ethanol bin would end up on a shelf in the chemical waste storage room before being collected by the same company.

Laboratory two

Laboratory two was the laboratory in which Helen was doing her research. Even though she was not working with flies herself, she connected me to another researcher who was. This researcher explained to me that they put all the flies, in their tubes (with all the additional components), into a nonleaking trash bag and store the bag in a freezer at four degrees Celsius for couple of weeks, before it was collected by the local waste company. During this time, flies, larvae and eggs would eventually die because of the temperature. The trash bags, once collected, would be disposed of as combustible waste. I was confused over the differences between Helen’s lab and

my fieldwork lab; I asked my informant, with my sociologist-in-the-lab bluntness, “Do you know what kind of flies are they? I mean, are they transgenic flies or are they infected with something particular, or are there any other reasons”? I was wondering if the way they handled the flies was because they were infected and therefore they resembled the danger of bacteria. I was surprised to get the answer, “All kinds”. In other words, it did not matter what kind of a fly they were experimenting on, they handled them all as hazardous waste.

Flies as ambiguous: The in/determinacy of waste in the labs

As I explained, my experience of handling waste in the lab was different from Helen’s experience with bacteria or her colleague’s with flies. In lab one, there was no such careful categorization and separation of the components, no packing and disinfecting, and no autoclaving. Before I talked to Helen’s colleague, I thought that the difference in practices of handling the waste was due to differences between species on the one hand, and hazardousness on the other hand. But after talking to her, I realized even the same species can be handled differently. Being hazardous and being handled as hazardous laboratory waste is a situated practice that differs between laboratories even in handling the same kind of organism, namely flies. The difference, however, seems to be due to the fact that flies are *not* hazardous. Flies were not perceived to be as potentially dangerous as bacteria, viruses or chemicals and were therefore not as intensively discussed in the guidelines. Of course, scientists did not want transgenic flies to get outside of the lab because they would possibly have an effect there. However, such dangers were not a reality in the laboratory of my fieldwork because of Sweden’s climate. I realized that flies *cannot* be hazardous in Sweden:

TARA: How dangerous is it if the transgenic flies get out of the lab into the environment?

KARIN: They die, they don’t survive the Swedish winter. They will die very quickly. The eggs can’t live long either. It is so unlikely that a transgenic fly goes out of the lab and infects the fly colonies

here in Sweden.

TARA: Then how do they survive, I mean if they die in winter where do they come from in summer again?

KARIN: They usually come with the fruits from other countries. That is why you get them in the summer. However, there are restrictions about the room: we have to have a middle room to the fly room to control them from getting outside the lab and it is so unlikely that they do get out. Unless someone takes it and keeps it and feeds it as a pet [*we both laughed*].

Flies were not hazardous in the particular context of Sweden because of the harsh environment and cold climate. Hazardousness as such was a matter of transgenic modification, experiments and fly bodies and life cycles as much as it was about the climate. One can argue that flies are not hazardous (enough) to be included in guidelines on handling laboratory waste because nature can take care of itself: even if a fly gets out of the lab, it will not survive to do any damage.

As the result of such a dynamic—specifically the agential climate, the flies' short life cycle and vulnerability to the harsh winter, and the room arrangement in the laboratory that prevented them from getting outside—flies' enactment as waste has become a matter of laboratory practices. In other words, each laboratory handles flies differently, due to a variety of reasons that are specific to each lab such as technologies, daily patterns of handling waste and traffic in laboratory waste. For instance, my laboratory supervisor told me that they did not have autoclave technology in the fly lab, and if they had to autoclave the flies every time they disposed of them, they would have to go through a time-consuming process, unnecessary because flies do not even constitute a risk for nature. However, Helen's laboratory, in which people work with both flies and bacteria, had the autoclave nearby. The technological possibility of the autoclave gave shape to modes of handling the flies in a particular way, and the material traffic of bacteria in large numbers appeared as a regulatory factor. Due to the large number of bacteria and MMG disposal, waste management in Helen's lab had become a routine, unified practice that included the flies as well. The ontology of flies as waste is a

matter of practice of knowing and handling the flies in relation to everyday practices, laboratory realities, experiments and technological possibilities.

In the absence of the generative intensity of hazardous waste as a form of waste that can do things, that can disturb nature outside of the lab, flies are enacted as waste in multiple ways (Mol 2002). Even though in both labs flies are understood as agential, according to Karin, flies' agentiality does not pose a threat to wildlife because, for example, even if they get away they will not survive the harsh winter. As such, flies are enacted as hazardous waste in Helen's lab and as biological waste in the lab where I performed my fieldwork. However, one can argue that in my fieldwork lab, flies were not exactly enacted as biological waste either, because they were not handled according to the biological waste guidelines. Nonetheless, practices of handling the flies in this lab were closest to the designated modes for handling biological waste.

As I showed above, hazardousness is an apparatus that cuts the boundaries of waste as hazardous and determines what is laboratory waste. Because flies are excluded from mattering, in terms of being hazardous, because they do not perform a particular danger, they also generate alternative modes of handling waste. In other words, handling waste is about knowing the waste; it sets the boundaries of waste in particular ways. It involves decisions regarding whether the waste is to be handled as hazardous waste or as combustible waste and determining waste as hazardous or not. As I showed, two laboratories handled flies differently because the boundaries of waste were enacted differently. In Helen's lab, flies are understood and enacted as hazardous because they are handled in ways similar to hazardous waste: separated, categorized, labeled and autoclaved in the same lab. In my fieldwork laboratory, the boundaries of the flies as waste were set as biological waste because they are not handled as hazardous (at least to some extent). In other words, and thinking with Hird (2012), waste—or flies as waste—is an inherently indeterminate phenomenon, which becomes determinate once one approaches and intra-acts with it in order to know and handle waste. It is in practices of handling the flies as waste in the two labs discussed in this chapter

that the boundaries of flies as waste, as a phenomenon, materialize. Although flies fit closely within the boundaries of biological waste in the lab, they also fall out of the category of biological waste, as I discuss in the following section.

6.7

Waste in/determinacy, life and death and becoming waste in relation

According to the information on my fieldwork university's website, flies fit into the category of biological waste because they are animals. In other words, because animal by-products and body parts are categorized as biological waste, so are the discarded flies. Nonetheless, it was indicated on the site that animal by-products are dead animals. The whole categorization of biological waste in the guidelines is based on the fact that the animal model is dead. It is either the animal's carcass or body parts that go to waste after the experiment, which indicates the animal is already dead. The flies were not necessarily dead when I threw them into the waste bin. Although we were supposed to store the flies in the fridge for up to three weeks before they were taken by the local waste company, not all of the flies would die in fridge temperature. Indeed, during my fieldwork, I might have disposed of more live flies (if I count all the larvae, pupae and eggs in the tubes, not to mention the fully grown live flies) than dead flies in the waste bin that was then sent to the storage room. In other words, the living bodies of the flies both fit in the category of biological waste, as they are animals, but simultaneously exceed the boundaries of this category, because they are living animals. However, as feminist philosopher Rosi Braidotti (2013) argues, there is not a clear cut between life and death in general. In particular, such an imagined clear-cut distinction between life and death becomes even less apparent in the lab and within the context of natural sciences (Landecker 2003). In the lab, life and death is a matter of transformation. The ambiguity of the flies as waste lies in their constant transformation between life and death—or, in other words, the transformation of waste and generative material.

During my fieldwork, I would often dispose of flies that were no longer part of the experiment, as they were no longer part of the apparatus of knowledge production about AD. I disposed of the living flies for variety of reasons: overproduction of the flies I needed (I would throw the surplus flies in the bin). I would dispose of living flies when an experiment was coming to an end or if an experiment failed. What matters here is that as long as a tube and the flies inside of it were part of an experiment, as long as they were a constitutive part of the apparatuses of knowledge production and of the produced scientific data, they would remain on the shelf and I would constantly attend to them. However, when the relation and the apparatus of knowledge production changed, either due to failure of the experiment or another reason, both the tube and the flies in it would become unnecessary goods.

This transformation from being a constitutive part of knowledge-production processes into being waste can be seen through the lenses of Hird (2012) and Barad (2012b). In other words, if waste is intra-active in/determinate mattering, then one can argue that the flies were not inherently waste but enacted as waste in the lab in particular relations. Whereas flies may always be a killable, disgusting and disposable entity in a kitchen, as I discussed in my previous chapter, in the lab, flies are valuable because they are part of the knowledge-production apparatus about human diseases. However, as the premise of an experiment changes, and as results are produced, the same valuable fly is enacted and disposed of as waste. The flies become determinate as waste as a matter of failed experiments, overproduction, an experiment's end or contamination by bacteria and mites. This is to say that flies are in/determinate waste not only because they disturb the category of biological waste which is defined as a dead, lifeless entity, but also because in the lab relations constantly change, apparatuses shift and they are disposed of in different ways. Moreover, even when flies become determinate as waste in relation, their status as waste is not a once-and-for-all permanent status. As I show in the following paragraphs, flies become waste and are undone as waste constantly.

FIELD NOTE APRIL 2012: *There are dead flies at the bottom of the tube and larvae moving on top of them or on the sides. I see dead flies, eggs and moving black dots, the larvae mixed with the food. Life and death mashed up together. The flies live, mate, reproduce and die in the same tube. If they die because they are stuck in the food, I do not take them out because it is very messy. I leave them be there, stuck in the food. As other flies live, as eggs hatch and larvae crawl, the dead bodies of the forgotten flies at the bottom of the tube decompose into the food, the same food that the living creatures in the tube consume. I toss the tube in the waste bin with all of them inside it: life and death, flying flies and decomposing ones, eggs and larvae. All at once it becomes waste.*

Before I disposed of the tubes in the blue waste bin, I usually kept them for weeks for breeding. Even though I emptied the tube and collected flies from it daily, I kept the original tube in which new flies hatched every day because there were so many eggs and larvae in it. If a fly died in the tube before I got to collect it, it was wasted. It was no longer part of the experiment and of no value. It had no meaningful significance for the scientific experiment. However, I left flies in the tube rather than fishing them out of the food and disposing of them in the waste bin, simply because it was practical. However, as they started to decompose, they would become part of the food material at the bottom of the tube. They became food for living larvae and flies that were important for the experiment. In other words, waste became a “lively and flowing metabolic resource” (Hird 2013, 27). These flies became waste even before being born or entering the laboratory, as I discussed in my previous chapter in relation to cultural imaginaries of flies and human-fly relations. These flies became waste before they ended up in the blue waste bin, but they were also undone as waste if they became food for the flies that were part of the apparatus of knowledge production. Yet again, once I was done breeding the flies I would dispose of the tube and the flies in the bin. As such, the flies previously enacted as productive material, either in the form of a metabolic resource or as the apparatus of knowledge production, became waste. They remained waste the whole time they were in the bin and once they were transferred to the storage room in which they were left for weeks. Nonetheless,

flies ontologically change once they are collected by the local waste company; they are transformed from laboratory waste into an energy resource. In other words, as the flies in the blue waste bin leave the campus in sealed black plastic bags, they are undone as laboratory waste. They become a combustible energy resource.

Thinking with Hird (2012), the in/determinacy of waste is about its openness and the infinite possibilities of becoming in relation. Flies in the lab constantly become waste and are undone as waste. They become waste once they are pushed down in the food at the bottom of the tube. They become waste once they are tossed away with the tube into the blue waste bin. But they also are undone as waste once they become a generative material resource for other flies and larvae. They are undone as waste once they are taken by the local waste company and become an energy resource. In their metamorphosis from being egg to larva to fly to decomposing matter to metabolic resource to energy resource, flies are witness to the relational in/determinacy of waste in the laboratory. As a matter of such intra-active transformations and of life and death, the living bodies of the flies and the dead, decaying ones get mixed with one another in the tube, which troubles the clear-cut description of biological waste on the website's guidelines, highlighting the in/determinacy and relational becoming of waste as a phenomenon that escapes categorization.

6.8 Conclusion

The extensive laboratory facilities at X University⁶ give rise to large amounts of laboratory waste of varying types. This waste must be handled in a manner that ensures the safety for all employees and students. Furthermore, the waste must not cause damage to the surrounding environment or constitute a hazard to those handling the waste after it has left X University. **Therefore, laboratory waste must be packed, labelled, handled and in some cases destroyed in accordance with the instructions [...].** All laboratory waste must

⁶The name of the university has been anonymized

be handled by laboratory personnel.

— Excerpt from the university website

A large amount of laboratory waste is produced daily in my fieldwork university's laboratories. This waste is to be handled in strict ways in order to avoid any potential harm or constituting a hazard. In other words, and as I have discussed in this chapter, there is a relation between the conceptualization of particular entities as hazardous and laboratory waste. The more they are considered to be hazardous, the stricter and clearer the instructions are on handling them as waste. The less hazardous they are, the more the ontology and modes of handling them as waste become ambiguous. Flies are not hazardous "enough". Therefore, in each laboratory flies are enacted as waste differently.

As a way of organizing waste in its laboratories, the university gives instruction on various kinds of waste through categorizing them into the following: chemical waste, pharmaceutical waste, radioactive waste, infectious waste, waste containing GMMs, noninfectious cell cultures and microorganisms, antibiotic waste, noninfectious blood waste, biological waste and sharps. Most of the categories are defined in relation to the potential risks and hazardousness of the material at hand as well as modes of handling the waste. For instance, chemical waste is supposed to be "labelled with a hazard symbol or hazard pictogram [and] must be handled as hazardous waste". Often pharmaceutical waste, if in larger amounts or from an older pharmaceutical product, "must be packed in a cardboard box for hazardous waste labelled "Läkemedelsavfall" (pharmaceutical waste) and then sent together with hazardous waste". Infectious waste, or "all material that contains infectious waste must be decontaminated. Infectious waste includes microorganisms and their toxins which are able to cause infections or other disease in humans or animals". All the GMMs as well as all material that contains GMMs "must be decontaminated before it is washed, reused or disposed of. The transportation requires packing and labelling according to rules for transportation of dangerous goods". However, the conceptualization of biological waste is explained according to a different dynamic:

“Biological waste consists of body parts of humans or animals. Under normal circumstances, biological waste carries no risk of infection. For ethical reasons, it is handled separately”.

Yet again, what unifies all these categories in contrast to biological waste is the potential danger, risk or hazardousness with which they are associated. Therefore, they ought to be strictly controlled, disinfected and decontaminated, then labeled and handled as hazardous waste (e.g., being autoclaved in the same lab). It is the hazardousness of such biological and chemical waste that functions as an apparatus that determines and sets the boundaries of laboratory waste and generates different modes of handling it. Even though many of the other categories, such as GMMs or infectious waste, are also biological waste, as they contain living organisms and bacteria, they are categorized and handled differently. In other words, the fear of a breakdown and disaster and the urge to keep “nature” intact enacts hazardous waste as a node of knowledge production around which managing and handling the waste has been formulated.

In this chapter, I contributed to the understanding of laboratory waste as a phenomenon that is specific to contemporary biotechnological hype within the context of AD. As such, I engaged with the problem of categorization, on the one hand, and the relation of waste and dead bodies on the other hand. In other words, I showed that the very categorization of waste is a performative, situated act, which only becomes determinate in relational practices. I argued that there are different modes of handling waste in different laboratories, which pinpoint the ambiguity of and the impossibility of categorization of waste in the lab as a singular, easily bounded object. Transgenic flies fall in and out of categories known as laboratory waste in relation to guidelines, everyday laboratory practices and materiality. The ambiguity of waste that I am concerned with in this chapter is not only related to discursive exclusion, symbolic order or epistemological uncertainty but to intra-active becoming and ontological in/determinacy (Barad 2012b). In other words, the ambiguity of waste in the lab centers around how fruit flies become waste in specific relationalities and in everyday practices in the lab as well as in different laboratories. Last but not least, I showed that

the materiality of waste and the reality of working with fruit flies disturb the relationship between biological waste and dead bodies. In other words, biological waste in the laboratory is often assumed to be a dead body or dead body parts. However, when working with the flies, often the discarded tubes of flies that end up in the waste bin contained eggs and living larvae, which disturbs the relationship between biological waste and dead bodies.

In summary, according to Barad, the in/determinacy principle is the condition of possibility and the condition of materialization of a phenomenon. She writes, "In/determinacy is not the state of a thing, but an unending dynamism" (2012b, 12). Such ontological in/determinacy is a "radical openness, an infinity of possibilities", which is what she calls "the core of mattering" (2012b, 18). As such, "matter in its iterative materialization is a dynamic play of in/determinacy" (2012b, 18). The reason I used the concept of in/determinacy was to highlight the problem of categorization. This concept reveals that categories are always in/determinate—that they are materialized in intra-action and their boundaries become determinate within, to reiterate Barad, a radical openness, an infinity of possibilities. In this chapter, I discussed the problem of categorization as I analyzed handling biological waste in the laboratory. I argued that biological waste, namely the living and dead fruit flies, in the lab are agential-material discursive phenomena that become determinate in relation. Inspired by Barad and Hird, I conceptualized waste as a radical openness and an unending dynamism: an in/determinate phenomenon that comes to matter in relation to agential cuts. Waste as such is then always already lively and agential. Last but not least, while AD is often associated with human deterioration and "wasting away" in Western cultural imaginaries, in the lab, it is flies that are consumed by scientific experiments and life science and as such either born waste or wasted away as leftover flies.

Prelude

I pick up a tube and bounce it on the desk so that the flies that were flying up close to the cork will fall to the bottom of the tube, giving me just a second to remove the cork and flip the tube onto the experiment plate before any can fly away. I wonder how it feels for a fly to be shaken up so hard, as if an earthquake had hit the tube. How do these flies feel as they bounce back and forth to the sides of the tube and roll down to the bottom, where some get stuck in the mushy food before they can respond? How does a fly respond and what are the possibilities for response while they are shaken so hard, over and over, every day, sometimes couple of times a day?

I hold the tube and the plate together and bounce them at once on the desk so that all the flies in the tube will drop off onto the plate. The tube opening is the size of a coin and there are too many flies, maybe thirty or forty of them squeezing into the opening. They fall on top of each other, accumulating on top of one another as they slip into unconsciousness because of the released nitrogen oxide. I remove the tube. As the pile of flies loses the support of the tube, the unconscious flies tremble, some falling down from the top of the pile and spreading around on the sidelines. However, the pile is still there. It is an affective scene—not because there are so many of them, not because you can see so many different eye colors ranging from deep red to orange to white, not because of their monstrous eyes. It is their *facelessness* and their *nonexistent individuality* that strike me.

At first glance, and before I look at them through the microscope, the pile on the plate seems very abstract. It has no recognizable shape, nor any reference to the nature of that which is on the

plate. It looks like an ant nest. A brown pile of substance linked to itself, leaving hollow spaces in between the cotton-shaped strings. The entanglement of the shreds and strawlike threads resembles the stickiness of the A-beta peptide, the protein fibril that these flies were genetically modified to express. As if these entangled sticky fibers came together in an inseparable unity and promises disorder and chaotic mess. However, it is not an ant nest or a plaque, that which lies there on the plate. The bundle is motionless. It does not have the crowded rumbling movements that one registers looking at an ant nest or a plaque. The pile is still as death itself, as the flies are unconscious and seemingly lifeless. The pile seems like a weightless dust fluff. As if once you blow at it, it will blow away.

I pushed the plate under the microscope and look at the pile up close. I took the brush and poked the pile. The scenery changed but not so much. I could see body parts. I could see that the straw and the fiber were fly legs, hair and antennae. I could see that the colorful shreds were fly faces and eyes or bodies. The hollow spaces turned out to be the space where their bodies detached from one another but their legs were entangled. The clarity, the reality that I could now see and name the constitutive parts of this unruly mess, did not necessarily reduce the facelessness of the flies. To the contrary, the clarity under the microscope reinforced their facelessness because even magnified under the microscope, that which was there on the plate was more a bundle of mass rather than individual flies. As I poked the bundle some of the flies trembled from the top and fell separately from the rest on the sides. If I was lucky I could find the flies I needed among the fallen ones and I could dump the rest of them at once as they were, a bundle of body parts entangled with one another. If I was lucky I did not have to deal with the messy mass. But, laboratory work is never that easy and orderly. I could find three flies out of the fallen ones with the exact morphologies I needed. I pushed the rest of the fallen ones aside into another bundle on the plate. I had to get into the messy mass of flies and collect what I needed out of the bundle. Separating the flies is not as easy as it may sound. I want healthy flies and I want them in one piece. To separate them I had to disentangle them carefully, one

at the time. To recognize which legs is attached to which body and where to pull so that I won't rip them apart. One after another until I got ten flies. Along the way I squashed some flies, ripped off some wings and left a couple of detached legs on the plate. Then I pushed my ten flies into a new tube. I put the cork on and lay the tube on the side and waited for the flies to wake up. I picked up the plate and turned it over on top of the ethanol bin and bounced it hard so the rest of them, the bundles and the body parts, fell into the liquid and died if still alive. Down in the ethanol bin, there were masses of floating dead flies just like the bundles on the plate; all tangled together, intertwined, indistinguishable.

Conclusion

In this study, I have explored the underlying politics and ethics of knowledge production practices in the laboratory within the context of Alzheimer's sciences, using a practice-oriented approach. Based on empirical material collected from one year of conducting interviews and participatory observation in a laboratory, I came to write about the *spectrum of killability*, imaging and *animating death* and life, and the categorization of the natural and artificial as well as hazardous and nonhazardous waste as constitutive dynamics of Alzheimer's disease (AD) knowledge-production practices in the laboratory. My aim was to contribute to feminist technoscience studies (FTS), which highlights the entangled *naturalcultural* processes of knowledge production and discusses scientific facts as realities enacted through practices and as such always entangled with political, social, cultural and scientific discourses and concerns as well as materiality. Such realities are then performed by humans and nonhumans while being performative of that which is enacted as categories of human, animal or *nonanimal* as well as the world they inhabit. As such, with three empirical chapters, I discussed how bodies, categories, life itself and death are made and become meaningful in different spaces and relations. I discussed that such scientific practices hold the potential of *agential asymmetry* and of violence as constitutive parts of knowledge-production practices, which brings up political and ethical questions about whose life matters and how. In order to explore the underlying ethical and political dynamics of AD knowledge-production practices in the lab,

I introduced three research questions in chapter 1, and I return to them in the following paragraphs in order to answer them based on my findings.

7.1 Making death matter: On animating death

My first empirical question was about images of AD-related misfolding proteins: What stories do these images tell about AD, life and death and what forms of life and death are made, imaged and animated in practices of imaging AD? I argued that novel biomolecular technologies help scientists to literally make dying bodies as a material for knowledge production about living bodies. In other words, living models are made and born in ways that mimic processes of dying, which allows biomedicine to study not only their corpses (as in the history of medicine and the use of cadavers), but also the very processes of decay and dying itself. Such processes of animating death, as in animating theories about AD-related neural death, contributed to a long discussion on the entanglement of animation, biological knowledge and anatomy. In it, I critiqued the ironic relation between the production of biological knowledge about living bodies and the processes by which it is acquired, involving dead organs and cadavers—processes that disrupt life in order to study it. However, I suggested, it was not only dead specimens that were the source of knowledge about lively processes of protein misfolding in the lab, but neural death and neurodegeneration processes were organically made, grown and brought into life as scientific theories about neural death were animated for knowledge-production purposes.

Furthermore, inspired by *new materialism* and Karen Barad's concept of *posthumanist performativity*, I argued that images of AD are dynamic processes rather than static objects. The images made in the lab not only enact AD but also produce new forms of life and death and modes of living and dying with AD. For instance, flies were bred and animated in large numbers in order to bring scientific theories about neural death into life. As flies lived this partial AD, and as their living and dying bodies were measured, filmed and

imaged, facts about neurodegeneration and toxic protein- misfolding processes related to AD were produced. Last but not least, images in the lab were not only performed by human scientists but enacted through entangled processes of human and nonhuman performativity, or posthumanist performativity. Such a posthumanist lens rearticulates knowing as a form of posthumanist *doing* that goes beyond the imaginary of the rational human as the only source of knowledge production. For instance, as I showed, proteins communicate and bind in ways that enable or disrupt imaging. This posthumanist account of the images in the lab takes nonhuman agency seriously, challenging the dualistic imaginary of the animator (often the human subject), and animated (often the passive nonhuman, matter or object).

7.2 Making death matter: On killability

My second research question explored the dynamic processes through which animal models are made and enacted as killable in the laboratory and in relation to biological and material specificities, scientific discourse and sociocultural imaginaries. In chapter 5, I started by wondering why don't we, as humans, care about the millions of flies that are killed in everyday practices within life sciences? I explored the relation between human and flies, focusing on fruit flies, which were the animal model in my fieldwork laboratory. As I showed in chapter 5, human-fly relations are complex and dynamic, and they are historically entangled with death, disease and decomposition. I showed that fruit flies became a "proper" animal model not only because of this historical relation but also because of flies' successful appearance in natural science as a living test tube for decades. Flies are also enacted as the proper model in the lab and killable because of their biological potential to replicate toxic biochemical processes similar to those associated with AD in humans. In other words, I argued that killability is a complex material and discursive phenomenon that is always in flux. Flies become killable in relation to other animals and in different laboratories as a matter of biological specificities, scientific credibility, and the technical and discursive scientific infrastructure

built around them such as *Drosophila* genetic banks as well as their alienation from the category of *animal*. In other words, as I discussed, flies were enacted as nonanimal, absent from ethical frameworks, and enacted as killable but not a sacrifice, as mice models or bigger animals are. For instance, animals “nearby”, such as pets, animals we eat and care for, or big animals such as apes with which humans share a more visible evolutionary kinship are considered more problematic to use in the lab even if killable in other settings such as a farm. As such, flies in the lab were nonanimal—remarkably valuable as the animal model yet pretty low on the hierarchy of animal snobbery.

I used the Baradian concept of *agential cuts* to show that the spectrum of killability in the lab is a dynamic, entangled, material and discursive phenomenon. I used the term spectrum to simultaneously highlight the structural hierarchies within the animal kingdom in the context of laboratory practices within life science, as well as to account for the fluidity and relational dynamics of killability that change based on laboratory agendas, biological capabilities, experiment and drug development stages, scientific discourse and ethical dilemmas. Killability as such is about the relational becoming through which different forms of life become killable as they die prematurely and differently on the killability spectrum. This spectrum, then, involves material-discursive cuts in the lab that enact the boundaries of that which is killable and always entangled with agential asymmetries, which are relational, fluid, ever-changing and agentially enacted in situated ways.

7.3 Making death matter: On handling biological waste

The third research question in my thesis was about biological waste, or biowaste. In other words, I wondered if biowaste in the lab is enacted as a *matter of practice* and how categorization and handling the dead and living bodies of *Drosophila* in the lab fits in or challenges the already established categories of natural, hazardous and waste itself. I contributed to scholarship discussing waste, not only in terms of social construction but as material-discursive enactments.

As such, arguing with the materiality of the bodies of the fruit flies, I argued that preestablished categories such as hazardous waste or biowaste are constantly challenged and renegotiated in the laboratory. Specifically, I proposed that the materiality of the flies' bodies, living matter and dead matter challenge the categories of biological waste in the laboratory, which links waste, life and death together. In many ways, the liminality of the flies as waste points to the entanglement of life and death, living matter and dead matter, and stresses the uncontainability of biowaste. Such liminality and uncontainability bear witness to the agency of matter, which is socioculturally imagined as passive, highlighting (dead) matters' performative powers. As the clear-cut categorization of biological waste fails to accommodate the flies' bodies, and as humans try to get rid of these dead bodies as soon as possible, the dead bodies of the flies call upon us humans, forcing us to stay with them—to figure out how to handle them in everyday practices, to rethink our relation of use and codependence, to discover why flies are not only such killable creatures but also so easily disposable.

7.4 Making death matter

I engaged with knowledge-production practices through which death and dead bodies, particularly those of the flies, are made invisible and banished into a land of nonhuman and nonbelonging, while being heavily colonized and regulated within the regimes of knowledge production. Despite the creation of novel modes of death and dying and despite the large number of fly deaths in the laboratories and their crucial role in experimental biology, these deaths and dead matter are often not discussed, not even by nonhuman theorists. These dead bodies are absent in the lab (as they are made invisible and excluded in order to create knowledge, the knowledge which contains, embodies and bears the death of thousands of flies). But they are also present in material ways, as there are thousands of flies in the lab to be killed monthly, and thousands of dead fly bodies to be handled and managed as biological waste. Death as constitutive of

knowledge-production practices within the context of AD was the main thread running through this dissertation: in terms of animating death—which is to make and breed theories about neural death and grow them organically and materially—or categorizing and handling the dead and semiliving bodies of the fruit flies as biological or hazardous waste in the lab, or asking whose death matters and how on the spectrum of killability. In other words, as the title of the thesis, *Making Death Matter*, suggests, this dissertation focused on practices of making, breeding, animating, categorizing and handling death and dead matter in material and discursive ways as well as making flies' deaths matter as an ethical and political question.

7.5 Theoretical Contributions

This thesis contributes to the broader field of feminist technosciences studies (FTS) and new materialism while taking inspiration from a variety of fields such as gender studies; human-animal studies (HAS); science, technology and society (STS); and posthumanities. With each empirical chapter, I discussed a different dynamic of knowledge-production practices in the laboratory and the ethics and politics of such practices, which I will summarize in the following sections.

On imaging practices and death itself

In chapter 4, I contributed to discussions of *life itself* as occurs in FTS. Drawing on my material, I argued that not only life but also death was detached, isolated and reduced to fixed objects or images in the lab in order to be studied in everyday practices of understanding AD biochemistry. However, once thinking with practices (specifically, understanding AD and an AD-related death as matters of practice), even in isolation, neurodegeneration and toxic mechanisms of A-beta protein misfolding are always naturalcultural and procedural. In other words, looking through the lens of matters of practice highlights that both humans and nonhumans are performative of AD as well as death itself while simultaneously renegotiating AD as

not necessarily a human disease. AD and an AD-like death in the lab becomes a procedural molecular phenomenon enacted through nonhuman bodies.

Moreover, thinking with matters of practice and posthumanist performativity, I came to analyze imaging in relation to animation theories as a phenomenon that is not static: images are not only about the image that is taken and frozen in time. Rather, as I argued, images are a procedural and temporal phenomenon; images are a dynamic material-discursive phenomenon that enact and animate not only that which is thought to be AD but also theories about death (as in neural death) and life (as in protein life). Images produced in the lab disrupt the static temporality of the photos, as they are the result of months of breeding flies and days of preparing proteins—and, furthermore, as they embody many intersecting and simultaneous failed attempts to image proteins. Moreover, images point to the entanglement of life and death temporality, problematizing the linear temporality of life (i.e., life as a linear process ending with death). By showing how protein life begins as neurons start dying within AD progress, I argued that the life of proteins and the death of neurons is an entangled dynamic of transformation that contains both life and death simultaneously. Last but not least, imaging and animating neurodegeneration and the toxic process of A-beta misfolding is not a *doing* of a cognizant subjects but a relational transformational process through which nonhuman actors, such as proteins and antibodies, together with humans and technologies perform that which is AD, life and death.

On killability, response-ability and ethics

In chapter 5, I contributed to the ethical discussions on animal and human relations within natural sciences, particularly relations of use. I discussed killability, drawing on a relational ethics, or to use Barad or Donna Haraway's term, an ethics of accountability that highlights the mutual process of *becoming with* on the one hand and agential asymmetries on the other hand. Such an ethics, according to Barad, is to be "accountable for our part in the world's differential becoming",

which also means taking the “world’s ongoing intra-activity, its dynamic and contingent differentiation” (2007, 351) seriously. According to such an understanding of ethics, “instrumental relations of people and animals are not themselves the root of turning animals (or people) into dead things”, but making them faceless is the problem (Haraway 2008b, 71). I discussed fruit flies, one of the pillars of modern natural sciences and human companion species in the laboratory, commenting on the structural and sociocultural exclusions that enact them as faceless. I contributed to the understanding of killability as a material-discursive phenomenon that is not about the act of killing itself, even though it brings about a premature death. Killability, instead, involves the dynamic processes of becoming that have in them constitutive exclusion: an exclusion that does not come from the outside but is enacted through situated relations and is a constitutive part of the phenomenon.

Overall, I tried to be accountable for the agential cuts while take the agentiality of the matter seriously. As such, I took my point of departure in the dynamic, multilayered relations between humans and flies, arguing that such relations are *unique, situated and capable of violence*. Such relations are not fixed, remediable through a generalizing moral framework (which are often exclusionary, as I just discussed), but they are constantly in flux—as such, it is crucial to attend to the specificities and differentials that materialize and are materialized by such relations.

On practice and the politics of categorization

In chapter 6, I yet again used the analytical lens of matters of practice on the one hand and posthumanist performativity on the other hand to discuss the politics, materiality and realities of categorization in the lab through which categories such as waste, natural and hazardous are in/determinate. I used a Baradian understanding of in/determinacy and Hird’s understanding of waste as always in/determinate in order to argue that the boundaries of that which is enacted as biowaste is a matter of practices of knowing and handling not only waste but also that which is understood as natural or hazardous.

As such, the categorization of waste and the materialization of living matter in the lab as biowaste is linked to the understanding of natural and artificial, and it is through such conceptual categorization as well as material and local practices of handling waste that the boundaries of flies' bodies as biowaste become determinate in situated ways. I showed that depending on the understanding of that which is enacted as natural (often called "nature" outside of the lab) and that which is categorized as hazardous (often not considered "nature" inside the lab because it is mutated, genetically modified and therefore artificial), flies were handled differently in various laboratories.

Last but not least, I showed that often biowaste categories in available guidelines accommodate dead bodies and body parts; however, in the lab, both dead and living flies are thrown away as waste. The liveliness of the flies challenges such prescribed categories not only discursively; as I demonstrated, death and life, living and decaying matter mingle and merge into one another in the waste tubes, making it extremely difficult if not impossible to separate them. It is in response to such material realities and posthumanist performativity that the boundaries of biowaste in the lab become determinate in ways that are multiple. Biowaste becomes a matter of practice.

7.6 Pondering care: Suggestions for further research

As I have edited and re-edited my thesis, the question of ethics has been haunting my text. I kept coming back to how to think about the possibility of having an ethical relation with the flies in the laboratory, particularly given the overwhelming number of fly deaths in the lab, performative agential asymmetries and flies' agentiality. One of the possibilities for an ethical relation with the flies in the lab may be thinking through the theoretical concepts and practices of care and response-ability. Haraway argues that to avoid turning animals "into machines whose *reactions* are of interest but who have no *presence*, no *face*, [...] demands recognition, caring, and shared pain" (71). She suggests sharing suffering as a form of care for the animal, in

a setting in which sharing is “built into any decision to use another sentient¹ being where unequal power and benefit are (or should be) undeniable and not innocent or transparent” (Haraway 2008b, 84). She understands sharing the suffering as “paying attention and making sure that the suffering is minimal, necessary, and consequential” (82). It is for humans to learn “to kill responsibly”, to care for the animal and to be accountable for the suffering and the asymmetrical relations of use. In other words, caring for the animals and response-ability is about sharing suffering rather than making suffering invisible. However, while scholars such as Haraway (2008b) and Law (2010) write about particular nearby animals such as dogs or cows, scholars such as Lien (2015), Bull (2014), Hird (2009) and Bates and Schlipalius (2013) call for the need to discuss the ethics and practices of care in relation to animals and organisms that are radically different from not only humans but also nearby animals: such as fish, ticks, bacteria, and flies. As Bates and Schlipalius write, “Unlike encounters with cats, dogs and other familiar mammals which are visibly similar to us and hence evoke a strong sense of empathy, engagements with radical difference tend to elicit disinterest at best and violent disgust at worst” (2013). Therefore, caring for the animal embodying such radical difference becomes a challenge to the existing ethical frameworks even within HAS.

Therefore, thinking with flies leads toward different ethics and practices of care than Haraway proposes. Indeed, differences between dogs and flies matter because such differences give shape to situated realities about flies as killable and possibilities for practices of care that may not be imaginable if thinking with dogs. Unlike dog and human relations, what signifies that of humans and flies is not love but a multiplicity of contradictory relations and emotions, ranging from disgust and fear of contamination to fascination and mutual reliance. However, what particularly stands out in the lab, once thinking about human-fly relations, response-ability and care, is the materiality of the flies’ bodies. As I tried to capture in all three empirical chapters as well as the prelude to the conclusion, one of the main differences between the oncomouse or the dog in Haraway’s

¹In her account, anything that responds is sentient, such as matter, bacteria, dogs.

work (1997, 2008b) and the flies in the lab is the individuality of the dog or mouse against the affective appearances of flies in the lab as *masses, bundles or body parts*.

On the one hand, it can be argued that flies respond with their bodies, when they get sick or refuse to get sick despite genetic mutations. They respond with their speed, their patterns of movement when they are measured by technical means. They respond as they (do not) glow green under the microscope. They respond as they (do not) hatch in overexpression of particular enzymes or proteins. They respond when they (do not) reproduce offspring with the desired genetic mutations. Sure, they do respond through consuming food, dying in it, decomposing in it and affecting the scent of the room. They respond when they interact with the temperature. However, their response is almost always collective. There is no individuality, no “intercorporeal” (Shildrick 2012, 18) connections, no touching, no looking into each other’s eyes, no knowing one another as in the relationship between dog and human or lab mouse and human. Flies appear often as buzzing clouds in the tubes or bundles of shreds and strawlike dust fluff. They often appear as a pile of abstract lines, hollow spaces and nodes, like an ant nest. Even when I separate one fly in the corner of the plate under the microscope, it is not the fly that I am looking at but its body parts such as eyes, hairs or wings, in search of morphologies I need to detect in order to confirm the genetic mutation.

In the lab, and in everyday practice, flies always appear as masses as the cuts are made. Flies are indeed the perfect animal model because they reproduce beyond control and beyond need, allowing multiple experiments to run at the same time. There are always trays of flies on the shelves, each tray representing a whole generation of flies that are produced and kept alive for particular experiments. There is never a tube with one fly in it but always *tubes of flies*. When breeding the flies, scientists always collected minimum ten flies. Even though they knew there were ten flies in the tube they could never tell which one was which, for the flies were moving, flying, jumping around and shifting so fast that it was not possible to trace one fly with the naked eye. Even when recording the flies for experimental

purposes, the iFly program required us to have at least ten buzzing flies in each tube so that it could register the movements in meaningful ways. Even with the help of technologies, the flies were still enacted as bunches, rather than individuals. Even when ordering them from the genetic companies, scientists always ordered vials of flies, full of flies, eggs and larvae.

I cannot even acknowledge their individual deaths. Even in acknowledging the fly deaths, there is always fly deaths as plural, never singular. There are always piles of flies going into the ethanol waste as a bundle or discarded, leftover flies in the test tubes. Even when crushed on the plate for imaging purposes, there are bunches of flies smashed together, faceless, not even recognizable as flies. There is no individuality as such in acknowledging the death of a fly. Even if I can count every single fly that I have killed over the course of experiment, I still do not see and do not count the newborn flies in the tubes I have thrown away as waste. In other words, when I throw the tube in the bin, I am throwing away many living eggs, larvae and flies that keep reproducing, whose deaths will never be registered for they have never been registered as living to start with.

Thinking with new materialism and a feminist posthumanities framework, although living beings are always multispecies and therefore never one singular being, when I think about a dog or a mouse, I relate to them as an individual creature with whom I can interact in tangible ways and whose reactions I can register, at least partially, without needing a microscope or high-tech devices. With the flies, our relationship, our touching and connecting was mediated through the brush, the lens of the microscope, and the glass of the test tubes. As I gazed and as they moved, our relationship seemed to be about me and the flies, in plural. Of course, I would care for them, for example, by religiously flipping the tubes every third week so that they would have a clean tube to live in, but as I flipped the tubes, there were always dozens of flies moving in between. I wondered whether that which I was caring for was keeping the *stash of flies* healthy rather than caring for each individual fly inhabiting those tubes. In fact, the practices of care in the lab were always collective in comparison to the intimate caring practices that my informants told me about in the

mouse lab, such as holding the animal, knowing it and looking into its eyes. This is not to romanticize the relation between, for instance, mice and humans against that of flies and humans but to ponder what kind of practices of care and sharing suffering may be possible between humans and flies when we humans cannot even perceive, touch or register the fly's individual body? How does one care for and take care of a body that always exists in plural?

Not only did such a plural existence of flies and their appearance in laboratory practices enact them as faceless, bodiless collectives but technologies contributed to the utter facelessness and lack of individuality. Our relationship, mine and the flies, was about my daily desperate attempts to out-speed them while flipping them between the tubes. One or two would often get away and disappear before I could register them. Of course I would count them to see if I was missing flies—if, for instance, there were eight flies instead of ten, and it was then I would realize two were missing. Even though I would know how many flies were missing I would never know, *I could never know*, which ones flew away. It would not matter anyway, because I could always substitute the runaway flies with new ones from the backup stash. As long as we had ten flies with the same genetic modification for the recording experiments, for example, it would not matter which flies were in the tube. In fact, each individual fly was enacted as a phenotype; all were enacted as the same Fly. As such, and as they all were enacted as the same phenotype fly, their individual existence seemed irrelevant. The flies, then, as the same one phenotype Fly rather than the flies, were not only faceless because they appeared in masses in the tube but also because they were enacted as faceless as they became one Fly phenotype—they became the same.

So, to go back to the question with which I started this section, I believe follow-up research could investigate common spaces of response-ability and modes of care when humans and flies come together in a relation of use, such as transgenic fruit flies in the lab. How can one acknowledge flies' deaths and share suffering when there is no tangible relation between the flies and humans? How can humans engage in relations of care with the flies that do not rely on

an individual entity? In other words, what kinds of practices of care and caring for the flies can be taken up within an economy of use in the lab, which consumes flies not as individual beings but as faceless masses? And how can these practices begin? Can I think with killing and practices of care, when there are thousands of flies dying daily in the lab? Can I think about sharing suffering with the flies when even touching, looking and perceiving one another may seem impossible? What kind of theoretical tool would I need to analyze practices of care for the flies in the lab? To answer these questions, further research is needed.

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