Evolutionary Psychology
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Virgil Zeigler-Hill *Editors*

Evolutionary Perspectives on Death

Springer

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ISSN 2197-9898 ISSN 2197-9901 (electronic)
Evolutionary Psychology
ISBN 978-3-030-25465-0 ISBN 978-3-030-25466-7 (eBook)
https://doi.org/10.1007/978-3-030-25466-7

This Springer imprint is published by the registered company Springer Nature Switzerland AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Foreword

The interdisciplinary conference, "Evolutionary Perspectives on Death," truly represented a breakthrough forum at Oakland University.

Held over 2 days in April 2018, the gathering of international scholars represented a compelling range of viewpoints and disciplines, including psychology, anthropology, biology, medicine, English, and philosophy. The probative and provocative scholarship discussed at the conference presents an expansive examination of death in the latest installment in the "Evolutionary Psychology Interdisciplinary Conference Series."

Expertly collected and edited by Oakland University Psychology Professors Todd K. Shackelford and Virgil Zeigler-Hill, the volume represents the scientific and intellectual richness that emerges when scholars employ an evolutionary perspective as the means to deepen their understanding of the role death plays in nearly every organism.

The presentations are focused on a wide range of fascinating topics, including philosophical approaches to understand death, sexual cannibalism in spiders, and how nonhuman primates respond to the death of conspecifics.

Exploring the connections and contrasting fundamental approaches of a range of disciplines has the effect of strolling through a hallway with many doors, each door presenting a unique entryway to the changing nature of how we contemplate and study the mechanisms, forensics, social aspects, and archetypal stories of death.

Collectively, the thoughtful and provocative views included in this volume establish new intellectual pathways and offer a profound contribution to the scholarly catalog of how opinions and experiences of death derive from an inextricable relationship among culture, customs, personal psychology, and science.

Indeed, the exciting, productive, and intensely interdisciplinary nature of *Evolutionary Perspectives on Death* offers an engaging complement to the four-volume collection of scholarship presented in the last several years at Oakland University conferences on the evolution of violence, sexuality, morality, and psychopathology.

The deep connections among the scholarship herein spotlighted by Shackelford and Zeigler-Hill serve notice of fertile interdisciplinary approaches that will find a wider audience when shared with the broader scientific community.

President, Oakland University
Rochester, MI, USA

Ora Hirsch Pescovitz

Preface

In April 2018, we welcomed dozens of scholars from North America, Europe, and Africa to join us at Oakland University in Rochester, Michigan, for a 2-day interdisciplinary conference on "Evolutionary Perspectives on Death." We invited some of the leading minds from disciplines such as psychology, anthropology, biology, medicine, English, and philosophy to serve as panelists for this conference. These scholars have conducted and published substantial work addressing various aspects of death and mortality from an evolutionary perspective. This volume showcases the groundbreaking empirical and theoretical work from several of these panelists and other distinguished conference guests.

The volume opens with a wide-ranging contribution from Pyszczynski, "The Role of Death in Life: Exploring the Interface Between Terror Management Theory and Evolutionary Psychology." The author discusses the areas of compatibility between terror management theory (TMT)—which argues that anxiety about the inevitability of death serves as a driving force in shaping many areas of human cognition and behavior—and evolutionary perspectives concerning human nature. Pyszczynski acknowledges that evolutionary psychologists have been critical of TMT, but he provides a thorough review of the considerable empirical support for TMT that has accumulated over the decades and how these findings may be integrated with evolutionary perspectives. He concludes by arguing that TMT and evolutionary perspectives on human behavior should be viewed as compatible and complementary rather than as opposing frameworks.

In Chapter 2, "Evolutionary Perspectives on the Loss of a Twin," Segal reviews recent research concerning comparisons of grief intensity ratings provided by bereaved monozygotic (MZ or identical) and dizygotic (DZ or fraternal) twins. This research—which was guided by kinship-genetic theory—offers a novel way for gaining insights into the effects of genetic and social relatedness on bereavement. She presents evidence that genetically identical (MZ) twins tend to experience more intense grief following the loss of their co-twin than do genetically nonidentical (DZ) twins which are consistent with kinship-genetic theorizing. Furthermore, both genetically identical (MZ) and genetically nonidentical (DZ) twins reported experiencing more intense grief for their deceased co-twins than for other relatives who

had died during their lifetimes. Segal argues that the bereavement responses of twin survivors serve as something akin to the "wail of frustrated genes."

Soper contributes Chapter 3, "Beyond the Search for *Suigiston*: How Evolution Offers Oxygen for Suicidology." The author argues that the search for the contingencies and risk factors that lead to suicide may be similar in some respects to the search for *phlogiston* (a fiery element that was believed to be released when a substance burned prior to the discovery of oxygen) by scientists during the earlier centuries. Soper argues that the reason suicide researchers have struggled to explain suicide as the result of specialized contingencies may be because suicide is actually a regular concomitant of the human condition. He concludes by arguing that an evolutionary perspective on suicide may be helpful for understanding suicide as well as identifying and prioritizing opportunities for suicide prevention.

In Chapter 4, "Animacy and Mortality Salience: New Directions for the Adaptive Memory Literature," Altarriba and Kazanas review recent empirical evidence that memory tends to be optimized when information is processed for its "survival relevance." That is, individuals tend to perform better on various memory-related tasks (e.g., remembering a list of concrete nouns such as *screwdriver* and *cathedral*) when these tasks are framed as relevant to survival instead of other areas of life (e.g., moving to a new house). The authors consider the various proximate and ultimate explanations for this pattern as well as recent attempts to integrate mortality salience and perceptions of animacy into this area of the literature.

In Chapter 5, "Nonhuman Primate Responses to Death," Brosnan and Vonk provide a comparative psychological perspective on issues surrounding mortality and death by considering the responses of nonhuman primates to death. The authors review evidence suggesting that nonhuman primates tend to change their behavior following the death of a conspecific with these responses being especially strong in some situations (e.g., a mother losing an infant). Brosnan and Vonk consider various theories for the emergence of these behavioral patterns including underlying emotional experiences (e.g., grief, empathy) and physiological mechanisms (e.g., hormonal changes). The authors conclude by outlining many of the questions that remain concerning how nonhuman animals respond to death and argue that answering these questions may shed light on the cognitive abilities of many species, including our own.

Varki proposes in Chapter 6, "Did Human Reality Denial Breach the Evolutionary Psychological Barrier of Mortality Salience? A Theory That Can Explain Many Unusual Features of Human Origins," that *reality denial* is vital to understand how humans view their own mortality. Varki argues that the human ability for reality denial may have emerged at a similar time as the ability to understand the mental states of others (i.e., theory of mind). He argues that these two seemingly disparate cognitive abilities may have jointly shaped the evolution of our species. Furthermore, the author argues that reality denial is a fundamental aspect of human psychology that may help us understand how individuals are able to go about their daily lives despite knowing that they are inevitably going to die.

In Chapter 7, "Death in Literature," Carroll considers a framework for understanding depictions of death in literature that incorporates ideas from evolutionary

psychology, human life history theory, terror management theory, the psychology of meaning, the psychology of fiction, and evolutionary literary theory. Carroll explains why humans create literary depictions of death and characterizes the attitudes toward death that tend to be adopted by the authors and the characters they create. The author uses examples from a wide variety of sources to illustrate the ways that death is depicted in literature.

In Chapter 8, "Last Moments: Witnessing and Representing the Death of Pets," Pierce and Taylor explore the phenomenon of in-home pet euthanasia, which is becoming increasingly common each year. The authors describe two recent projects that document the in-home pet euthanasia experience: a series of still photographs called *Last Moments* and a feature-length documentary film called *The Hardest Day*. These documentary projects provide viewers with a window into the experience of death for pets and their families. The authors discuss issues such as the role of the documentarian in witnessing these intensely personal and potentially traumatic experiences as well as the possibility that these images may help reduce the social isolation and psychological distress that individuals often experience following a pet's death.

In the concluding chapter, "The Evolution of American Perspectives Concerning Treatment of the Dead and the Role of Human Decomposition Facilities," Zejdlik and Burke describe the shifts that have taken place in the United States concerning the views of death and the treatment of the dead. The authors consider a range of unique, relatively inexpensive, and environmentally sensitive options that exist for the disposal of human remains. One of the options they review is donation to a human decomposition facility, which benefits science by allowing forensic anthropologists to better understand aspects of decomposition while disposing of human remains in an environmentally friendly way.

Evolutionary Perspectives on Death showcases the considerable and sweeping intellectual value of an interdisciplinary approach to understand psychological processes and behavior. Guided by Darwin's insights, the contributions to this wide-ranging volume provide a compelling case for an evolutionary analysis of mortality and the consideration of death.

Rochester, MI

Virgil Zeigler-Hill
Todd K. Shackelford

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The Role of Death in Life: Exploring the Interface Between Terror Management Theory and Evolutionary Psychology

Tom Pyszczynski

Death is the worm at the core of the human condition.

—William James

I am going to die!—am I not like Enkidu?!Deep sadness
penetrates my core,I fear death, and now roam the wilderness—

—The Epic of Gilgamesh (9.2–5)

The problem of death has been pondered by poets, philosophers, and ordinary people since the beginning of written history, and perhaps since the earliest days of our species. The oldest surviving narrative text, the *Epic of Gilgamesh,* tells the story of a young king who is deeply troubled by the death of his friend (Enkidu), which leads him to realize that he, too, will die someday, inspiring him to embark on an epic quest for immortality. The earliest fossil remnants of our species coincide with the earliest unambiguous signs of ritual burial of the dead. All cultures teach practices to forestall death and prescribe rituals to be performed after the death of others. Despite this, if one were to survey the literature in empirically oriented psychology in the early 1980s, it would appear that the problem of death played little if any role in human affairs, or perhaps didn't even exist. Terror management theory (TMT; Greenberg, Pyszczynski, & Solomon, 1986; Solomon, Greenberg, & Pyszczynski, 1991) is an attempt to bring the problem of death into the mainstream of contemporary psychology. Toward this end, TMT posits that anxiety about the inevitability of death is a driving force behind the human motives for self-esteem and meaning in life, and thus plays an important role in diverse aspects of human behavior.

TMT emerged around the same time that evolutionary perspectives on human behavior were gaining prominence in the various sub-disciplines of psychology. Though most evolutionary psychologists have had little to say about TMT and the existential problems it addresses, others have been highly critical (e.g., Buss, 1997;

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T. K. Shackelford, V. Zeigler-Hill (eds.), *Evolutionary Perspectives on Death*,
Evolutionary Psychology, https://doi.org/10.1007/978-3-030-25466-7_1

Kirkpatrick & Navarrete, 2006; see Landau, Solomon, Pyszczynski, & Greenberg, 2007, for a response to these critiques). We have long maintained that evolutionary and existential perspectives on human nature are compatible (e.g., Solomon et al., 1991) and to some extent need each other to provide a comprehensive understanding of the human condition.

TMT posits that awareness of death emerged in early humans as a side effect of the evolution of sophisticated cognitive capacities selected because of the advantages they provided for survival, reproduction, and caring for offspring. This awareness emerged in a species with an already long evolutionary history that inhabited specific environments but had a proclivity to wander and expand its habitat. Thus, evolutionary psychology is relevant to understanding the way our species dealt with their emerging awareness of mortality. Similarly, existential psychology provides ideas about how early humans used their cognitive capacities to respond to their experience of themselves and the world in which they lived and how this shaped culture and continues to influence diverse aspects of human behavior. This chapter explores the interface between TMT and evolutionary psychology, with a focus on ways in which each perspective could enhance understanding of issues of central importance to the other.

Terror Management Theory and Research

TMT was inspired by cultural anthropologist Ernest Becker's (1971, 1973, 1975) attempts to synthesize and integrate what he believed were the most important insights to be gleaned from diverse scholarly disciplines focused on the human condition. Becker drew heavily on evolutionary thinking in his attempts to bring together ideas from psychoanalysts such as Sigmund Freud and Otto Rank, sociologists such as George Herbert Mead and Erving Goffman, anthropologists such as Claude Levi-Strauss and Bronislaw Malinowski, philosophers such as Soren Kierkegaard and Friedrich Nietzsche, and poets and playwrights such as William Shakespeare and Tennessee Williams. My colleagues and I were impressed with Becker's ideas because they provided a broad integrative perspective on human motivation that we believed was sorely lacking in empirically oriented psychology as we began our academic careers in the early 1980s. We believed that emerging research methods in cognitive social psychology could be used to subject existential ideas, previously viewed as untestable, to rigorous empirical scrutiny.

TMT's Central Propositions

TMT begins with a consideration of how human beings are both similar to and different from other animals. Humans, like other animals, are born with a diverse array of biological and psychological systems that evolved to keep them alive long enough to reproduce and care for their offspring, which, by increasing the likelihood that

their genes would survive in future generations, became widespread in the species. What distinguishes humankind from other species is their highly sophisticated cognitive capacities, which Becker argued evolved to increase the flexibility and adaptability of human behavior to a broader range of environments. Particularly important in this regard are the cognitive capacities for symbolic thought, which gave rise to language; causal and future-oriented thought, which facilitates planning and behavior to change the environment to meet human needs; and self-awareness or autonoetic thought, which makes it possible for people to conceive of themselves as unique objects with agency to act on the world in which they live.[1] Each of these cognitive capacities plays a central role in contemporary theories of human self-regulation (e.g., Baumeister & Vohs, 2007; Carver & Scheier, 1981).

These evolved cognitive capacities led to awareness of the inevitability of death, of the ultimate fragility of life, and that death can come at any time in a multitude of ways. Awareness of the inevitability death in an animal with diverse biological and psychological systems that promote continued existence gives rise to the potential for existential terror, which is highly aversive and, therefore, disruptive of goal-directed behavior. TMT posits that our ancestors used the same sophisticated intellectual abilities that gave rise to awareness of death to manage the potential for terror that resulted from this awareness.

Awareness of death put a "press" on the ideas that our ancestors were using their newfound cognitive abilities to construct to help them navigate life. This awareness continues to motivate contemporary humans to commit themselves to worldviews that help manage their potential for terror. We emphasize *potential* for terror, because, due to the effectiveness of cultures in managing the emotional consequences of death awareness, well-enculturated people rarely experience this terror full-on; indeed, research testing TMT propositions has found reminders of death to produce surprisingly little conscious distress.

When we say culture is "designed" to manage terror, we do not mean to imply conscious or purposeful design, just as evolutionary theorists do not imply agency when they refer to adaptations being "designed" by natural selection. Rather, the potential for anxiety motivates people to prefer ideas that shield them from anxiety. However, there are exceptions to this general rule of nonconscious design: people sometimes do consciously ponder the problem of death and actively think about ways to minimize its impact. Buddhist sages designed doctrines aimed at minimizing suffering, estate planners devise strategies to reduce worry about the financial impact of one's death on one's survivors, and humanistic psychologists generate cognitive strategies to maximize self-actualization.

Ideas that helped manage this potential for terror were more likely to occur to people and attract their interest, be communicated to others who found them comforting, and gradually spread within and across groups to become part of emerging *cultural worldviews.* Cultural worldviews are theories of reality shared by groups of people that provide (1) a coherent understanding of reality that imbues life with meaning, significance, continuity, and permanence; (2) standards of value that

[1] Though some other species appear to have rudimentary levels of these cognitive capacities, they do not approach the level of sophistication and complexity found in *Homo sapiens*.

specify desirable and undesirable behaviors; and (3) hope of literally and/or symbolically transcending death. Worldviews provide meaning in life by answering basic questions about life and the universe: Where did I come from? Why am I here? What should I do while I'm here? What happens next? By providing standards of value, they make it possible for both individual lives and life in general to feel significant. This enables people to avert the potential for anxiety associated with awareness of their mortality.

Literal immortality is provided by the belief that physical death is not the end of existence; these beliefs are usually contained in a culture's religious doctrines, and include concepts of heaven, reincarnation, or merger with the spirits of one's ancestors. Though the vast majority of cultures, past and present, include literal immortality beliefs, their specifics vary greatly. *Symbolic immortality* is the sense that one is a valuable part of something greater than oneself that will continue after one's death. Identifying with groups, such as families, ethnicities, nations, and even seemingly trivial entities, such as sports teams and *alma maters*, provides symbolic immortality. Symbolic immortality is enhanced by valued contributions to one's culture, such as having children, developing inventions, contributing works of art, or providing stories that will be recounted long after one has died. Though fortune and fame have clear pragmatic value while one is alive, TMT argues that the symbolic immortality they provide is necessary to explain the fervor with which people pursue leaving their mark on the world. Religions provide both literal immortality, through the hope of an afterlife they provide, and symbolic immortality, through the community of believers in which they embed people.

On a moment-to-moment basis, this sense that one is a valued participant in a meaningful universe is experienced as self-esteem. Self-esteem begins to develop its anxiety-buffering properties early in life, before children are aware of their mortality, as a result of a complex interplay of evolved attachment tendencies and culturally prescribed socialization experiences (for a more thorough discussion, see Pyszczynski, Solomon, & Greenberg, 2015). Children are born with an evolved readiness for their distress to be quelled by cuddling, rocking, cooing, and other signs of affection from their parents or primary caretakers (Bowlby, 1969). As cognitive and motor skills develop, parental affection becomes increasingly contingent on children's behavior, such that more affection and attention are given in response to behavior that pleases the parents, leading children to equate parental love with the absence of distress. As self-reflective thought and other cognitive capacities mature, the capacity for self-evaluation emerges and these evaluations—self-esteem—emerge as a central mechanism for managing distress. With further cognitive development, awareness of death gradually emerges, and parents and other agents of the culture introduce children to religious concepts that detoxify death by embedding them in a world of gods and spirits that enables them to believe that they will continue to exist after their own physical death.

Effective terror management requires certainty regarding the veracity of one's worldview and the extent to which one meets its values. Because the most important aspects of cultural worldviews are abstract ideas and values that cannot be directly verified by one's senses, this certainty depends on social consensus (Festinger, 1954).

Those who share one's worldview and affirm one's value increase this certainty, whereas those with different worldviews or who challenge one's value decrease this certainty. Though a single person who believes in an invisible world of gods and angels would have difficulty maintaining confidence in such beliefs, when these beliefs are shared with billions of others it provides convincing "evidence" that these things exist. Because of the protection from terror that worldviews and self-esteem provide, people react positively to those who validate them and negatively to those who threaten them.

Empirical Evidence for the Fundamental Propositions of TMT

Over the past three decades, researchers have tested a multitude of hypotheses derived from TMT regarding diverse aspects of human behavior. Death concerns have been shown to influence diverse aspects of human behavior related to the pursuit of meaning in life, self-esteem, and close relationships. Because these three human needs are implicated in most of what people do, and have important effects on the way other motives and needs are expressed and pursued, the problem of death influences many aspects of human behavior. This research has been guided by variations on three broad hypotheses, which each takes logically distinct approaches to assessing the impact of thoughts of death on human behavior. The overarching strategy of TMT research has been to conduct experiments that triangulate on the theory's core ideas to provide converging evidence regarding its fundamental propositions.

Mortality salience hypothesis. The most oft-studied implication of TMT is the mortality salience (MS) hypothesis: if a psychological entity provides protection from anxiety, then reminders of the source of that anxiety should increase the need for that psychological entity, and thus lead to more positive attitudes and behavior toward anything that supports it and more negative attitudes and behavior toward anything that threatens it. In a typical experiment, participants are randomly assigned to receive reminders of either death or an aversive topic unrelated to death, and their responses to people or ideas that impinge on their worldview, self-esteem, or close relationships are then assessed. In the first such study, Rosenblatt, Greenberg, Solomon, Pyszczynski, and Lyon (1989) found that MS led municipal court judges to recommend nine times higher bail for a woman accused of prostitution than judges not reminded of their mortality. Later studies showed MS to increase the harshness of judgments of a wide range of immoral behaviors and to increase the favorability of evaluations of those who uphold cultural values (e.g., Florian & Mikulincer, 1997; Ochsmann & Mathay, 1994). MS has been shown to affect behavior related to interpersonal attraction, intergroup relations, aggression, support for war and terrorism, pursuit of fame and fortune, morality, religious beliefs, romantic love, conformity, attitudes toward sex, desire for children, health-related behavior, disgust, objectification of women, charitable giving, and many other important domains of human behavior. In a meta-analysis of 277 experiments

available at that time, Burke, Martens, and Faucher (2010) found MS manipulations to yield moderate-to-large effects ($r = 0.35$, $d = 0.75$), falling in the top quartile of effect sizes in psychology (Richard, Bond Jr., & Stokes-Zoota, 2003).

Research has also supported the *anxiety-buffer hypothesis*: to the extent that a psychological structure buffers anxiety, and then strengthening it should lead to less anxiety in threatening situations. Greenberg et al. (1992) found that participants whose self-esteem was increased by bogus-positive personality feedback did not show the increase in anxiety in response to a graphic death-related video found among participants given neutral feedback. This finding has been replicated with different manipulations of both self-esteem and threat, and with physiological measures of anxiety. Other research has found that both experimentally elevated and dispositionally high self-esteem are associated with lower levels of death-denying defensive distortions (Greenberg et al., 1993).

The *death-thought accessibility (DTA) hypothesis* asserts that if a psychological structure protects people from death anxiety, weakening this structure should increase DTA and strengthening it should decrease DTA. Both word-fragment completions, some of which can be completed in either death-related or death-unrelated ways (e.g., SK _ _ L can be completed as "skull" or "skill"), and lexical decision tasks assessing response time to death-related words have documented these effects. Cross-cultural replication of these findings with DTA measures in Hebrew, Chinese, French, and Dutch documents the construct validity and generality of these effects. Hayes, Schimel, Arndt, and Faucher (2010) reviewed 80 published DTA studies and concluded that there is strong evidence that threats to worldview, self-esteem, and close relationships increase DTA, that bolstering these entities decreases DTA, and that these effects do not emerge for aversive thoughts unrelated to death. These studies show that anxiety-buffer processes do not emerge only when death thoughts are activated by external events (as in MS studies), but that they are continuously operating to manage death-related thoughts.

Other studies combined the above three hypotheses to show that bolstering self-esteem, faith in one's worldview, or close personal relationships eliminates the increase in defensiveness that MS otherwise produces (e.g., Florian, Mikulincer, & Hirschberger, 2002; Harmon-Jones et al., 1997). Research has also shown that expert opinion that near-death experiences provide evidence of an afterlife eliminates the effect of MS on both worldview defense and self-esteem striving. The convergence of findings across these distinct hypotheses provides compelling evidence that the problem of death is an important influence on human behavior.

Distinct Responses to Conscious and Nonconscious Death Thoughts

In response to findings from the first 10 years of research on TMT processes, the theory was amended to distinguish between *proximal defenses* that directly address the problem of death by denying one's vulnerability or simply suppressing such thoughts, and *distal defenses* that involve construing oneself as a valuable

contributor to a meaningful universe—that is, maintaining self-esteem and faith in one's cultural worldview. When the problem of death is in current focal attention, it activates proximal defenses that address the problem in a pseudo-rational manner: denying vulnerability to disease, injury, accident, or violence; exaggerating health and hardiness; promising to adopt a healthier lifestyle; or simply suppressing and avoiding death-related thoughts. Though proximal defenses help diffuse anxiety when death is on one's mind, they do nothing to deal with the knowledge that, regardless of how long one eludes it, death is inevitable. This deeper problem is managed by the distal defenses associated with cultural worldviews and self-esteem that give meaning to life and value to oneself.

Support for the unique roles played by proximal and distal terror management defenses comes from studies showing that distal defenses emerge either when there is a delay or distraction between MS and assessment of defenses or when death reminders are presented subliminally. Proximal defenses, on the other hand, emerge immediately after death reminders but not after a delay or distraction. Research has also shown that distal defenses occur under conditions in which DTA is high and that distal defenses reduce DTA. A few studies have shown that DTA mediates the effect of MS on worldview defense (Das, Bushman, Bezemer, Kerkhof, & Vermeulen, 2009). Additional support for the proximal-distal model comes from research showing that people engage in healthier behavior immediately after reminders of death but self-esteem-promoting behavior after they have been distracted from such thoughts: immediately after MS, women preferred a high-protection sunscreen, presumably due to its health benefits, but after a delay and distraction they preferred a lower protection sunscreen, presumably because of the self-esteem provided by a nice tan (for a review, see Goldenberg & Arndt, 2008).

The finding that distal defenses involving one's worldview and self-esteem emerge only when thoughts of death are on the fringes of consciousness (highly accessible but not in current focal attention) explains why it is not possible to introspectively observe these processes. Though people can become aware of the link between death concerns and health-related behavior, they are not able to observe the impact of thoughts that are accessible but outside of conscious awareness. This lack of access to the effect of accessible but nonconscious death-related thoughts helps people maintain an illusion of objectivity regarding the many beliefs, values, and behaviors affected by existential anxiety (Pyszczynski & Greenberg, 1987).

In sum, TMT posits that the potential for anxiety that results from awareness of the inevitability of death is managed by cultural worldviews that imbue life with meaning, purpose, and significance; self-esteem that is attained by believing that one meets or exceeds the values of one's worldview; and close personal relationships that both validate one's anxiety-buffering beliefs and provide attachment comfort in their own right. Support for TMT hypotheses has been found in studies conducted in over 30 countries, reflecting diverse cultures, religions, and ethnic groups. Though the specific content of cultural affirmations activated by thoughts of death varies somewhat by culture, these studies provide evidence that is consistent with the idea that people use cultural worldviews, self-esteem, and attachments to manage death-related anxiety (Park & Pyszczynski, 2016). In our view, the convergence in findings across different hypotheses, methods, domains of behavior, and cultures is the most

compelling aspect of this literature. Although alternative explanations have been offered for some findings, we have yet to encounter an alternative account of the diverse array of converging evidence supporting the theory.

The Interface Between Existential Psychology and Evolutionary Psychology

Evolutionary psychology and existential psychology emphasize different challenges faced by both early and contemporary humans. Evolutionary theorizing focuses on the adaptive value of behavior that confers advantages in particular environments, which, through natural selection, renders the genes responsible for those behaviors more frequent in later generations. It emphasizes gradual changes in biological structures that underlie behavior, due to the value of that behavior in promoting reproductive success. Existential psychology is focused on how human beings come to grips with their awareness of the fundamental realities of their existence. It explains how people use their evolved capacities to cope with the potential for distress that results from their confrontation with the "givens" of life and reality. Existential psychology focuses on the ideas people generate to understand life and how those ideas affect their behavior rather than selection for physical structures that underlie behavior. Although it is reasonable to focus on one or the other of these approaches, we believe that they provide complementary perspectives and that consideration of their interaction will shed new light on issues important to both.

One of the first existential psychologists, Ludwig Binswanger (1942), distinguished among three environments to which people must adapt: the *umwelt* (physical environment), *mitwelt* (social environment), and *eigenwelt* (internal environment). He argued that people adapt their behavior (over the course of individual lives rather than on a species level) to meet the demands of each of these environments, and emphasized the role of creative problem-solving, both conscious and unconscious, in responding to the challenges of these different aspects of the worlds in which people live. Adaptations that effectively meet these challenges are more likely to be communicated to other people, and spread within communities, thus becoming part of culture. This relatively rapid process of change within the span of individual lives contrasts with the gradual changes to biological structures over many generations that help genes survive.

Existential theories focus on how individuals adapt to their awareness of their internal experience of the givens of existence and how these thoughts are communicated to others and eventually become part of cultural worldviews. However, many of these private thoughts are focused on events in the person's physical and social environments. For example, awareness of the inevitability of death is an internal experience that is undoubtedly tied to experiencing the death of other people and awareness of threats in the physical environment that cause people to die. Individual and cultural solutions to existential challenges often change all three of these environments and can lead to additional challenges. For example, research has shown that MS increases the human pursuit of wealth and dominance over other people

(Kasser & Sheldon, 2000), which play important roles in industrialization, exploitation of natural resources, and pursuit of increasingly lethal weapons. These fruits of human imagination and culture have led some people to realize that our species might eventually be responsible for its own extinction, an existential dilemma that did not exist until the mid-twentieth century.

Evolutionary psychologists generally focus on species-level adaptations to social and physical environments. Adaptations that facilitate group living, such as mate preferences, coalition-maintenance, and cheater-detection, as well as adaptations to aspects of the physical environment involving parasites, predators, and food sources, play central roles in evolutionary analyses of human behavior. Of course, natural selection is also responsive to organisms' internal environments, as when changes in the structure or organization of internal organs are selected for because they improve the functioning of those organs or produce better systemic functioning within the body, thereby enhancing reproductive fitness. Though the emphasis of evolutionary psychology is on adaptations to the physical and social environments, these external forces are mediated through internal experience, and the proximal adaptive value of changes in physical structures (e.g., neural connections) is likely often driven by the subjective experiences they produce. For example, whatever changes in the brain that led to preference for particular features of mates involve responsiveness to certain perceptions that yield particular affective states once they are in place. This raises the question of whether natural selection could occur for neural systems that are particularly effective in quelling distress with ideas or other contents of consciousness.

Existential and evolutionary perspectives offer explanations for many of the same categories of human behavior. For example, there are existential and evolutionary analyses of disgust (Curtis & Biran, 2001; Goldenberg, Pyszczynski, Greenberg, & Solomon, 2000; Rozin & Fallon, 1987; Tybur, Lieberman, Kurzban, & DeScioli, 2013), sexual taboos (Fessler, 2007; Goldenberg et al., 2000), intergroup conflict (Thornhill & Fincher, 2014; Neuberg, Kenrick, & Schaller, 2011), and religion (Boyer, 2001; Norenzayan et al., 2016; Pyszczynski & Landau, in press; Vail et al., 2010). Though sometimes viewed as competing explanations, we view them as complementary and believe that combining these perspectives would provide a more comprehensive understanding of many aspects of human behavior. Here we focus primarily on the idea that evolved cognitive and behavioral proclivities are important building blocks that influenced the ideas that people (both past and present) generate and find appealing to manage existential anxiety.

Evolved Proclivities as Building Blocks of Cultural Worldviews

TMT suggests that one of the major influences on the content of cultural worldviews is the death-denying function they serve. This is easy to see in religious beliefs regarding an afterlife or gods who grant immortality, funeral rituals, artistic depictions of death, and health-related beliefs and practices. But one of the more intriguing things about TMT is that it claims that aspects of culture that bear no

obvious relation to the problem of death, such as political ideology, group identities, sexual attitudes, and culinary preferences, are also part of the meaning system that manages existential anxiety. Though TMT, in and of itself, provides no means of explaining the origins of the specific nature of these elements of culture, adding an evolutionary perspective can shed light on this issue. Similarly, though evolutionary psychology provides plausible accounts of the origins of many human cognitive and behavioral proclivities, considering the creative products of the human imagination sheds lights on aspects of these behavioral domains that cannot be easily explained by natural selection. We turn now to a consideration of several domains of human behavior that have gathered considerable theoretical and empirical attention from both evolutionary and existential psychologists, with a focus on how an integration of these perspectives might enrich our understanding.

Morality

Moral foundations theory (MFT; Haidt & Joseph, 2004) builds on previous evolutionary analyses (Wilson, 1975) to posit that human morality reflects evolved moral intuitions that were later elaborated by cultures to produce the wide variability in moral beliefs and values that nonetheless share some universal themes. Noting behavioral parallels to human morality in other species, including primates, wolves, deer, and even bats (De Waal, 1996), moral foundations theorists argue that a suite of moral emotions evolved to promote cooperation and inhibit conflict within group-living species. Specifically, they suggest that caring for conspecifics, reciprocity and fairness, preference for members of one's group over members of other groups, deference to hierarchy and authority, and concerns with cleanliness and pathogen avoidance were adaptive for individuals in many species because they facilitate group living. These moral intuitions were then refined, differentiated, and altered by cultures to fit their specific environmental niches.

Moral intuitions are an example of how evolved prelinguistic psychological proclivities may have formed the building blocks that early humans used to invent cultural worldviews. These gut-level responses to behaviors that impinged on others were likely pondered, discussed, debated, and elaborated by early humans as their cognitive capacities increased. Ideas that met their psychological needs were especially appealing, widely discussed, broadly accepted, and eventually institutionalized as cultural knowledge. Religious, theological, philosophical, psychological, and political discussions have focused on these moral issues throughout the course of history and continue to do so today. MFT suggests that these discussions changed the content and relative emphasis of the moral values that cultures espouse to guide human behavior. TMT suggests that managing the potential for death-related anxiety was, and is, a particularly important human need that affected thinking about morality; this will be addressed in more detail in the section on religion later in this chapter. As thoughtful analyses of these moral foundations progressed and the social world changed, cultural understandings of morality changed, and continue to change.

However, from a MFT perspective, the evolved moral intuitions persist and continue to influence the moral emotions and behavior of contemporary humans; potential conflicts between gut-level moral intuition and changing cultural moral values would be fertile ground for future research.

TMT research has shown that thoughts of death influence thought and behavior related to all five of these moral foundations. The first TMT study demonstrated that reminders of death influence moral judgments, leading judges to set higher bond for a woman accused of prostitution (Rosenblatt et al., 1989), which can be construed as a violation of the sanctity/degradation foundation. In a related vein, Landau et al. (2006) demonstrated that MS led to more negative evaluations of sexually provocative women. Florian and Mikulincer (1997) found that MS led to more severe ratings and harsher punishments for a diverse array of moral transgressions, most of which involved doing harm to innocent others, thus violating the harm/care foundation; research has also shown that MS increases charitable giving (Jonas, Schimel, Greenberg, & Pyszczynski, 2002). Relevant to the fairness/cheating foundation, death-related cognitions are more accessible in response to harm to innocent victims than to victims whose suffering was caused by their own behavior (Hirschberger, 2006); conversely, MS increases derogation of victims of a random tragedy, thus restoring a sense that the world is just (b; Landau, Greenberg, & Solomon, 2004). Regarding the loyalty/betrayal foundation, Castano and Dechesne (2005) reviewed a multitude of studies showing that MS increases in-group favoritism, out-group hostility, perceptions of group entitativity (i.e., the sense that one's group is a real entity and distinct from other groups), and stereotyping. Relevant to the authority/subversion foundation, MS has been shown to increase support for hypothetical leaders who proclaim the unique value of the in-group (Cohen, Solomon, Maxfield, Pyszczynski, and Greenberg (2004), and support for US presidents George Bush (b; Landau, Greenberg, & Solomon, 2004) and Donald Trump (Cohen, Solomon, & Kaplin, 2017). Regarding the sanctity/degradation foundation, research has shown that MS increases disgust proclivity and that exposure to disgusting pictures increases DTA (Cox, Goldenberg, Pyszczynski, & Weise, 2007; see also Goldenberg et al., 2001). These studies suggest that death concerns influence behavior relevant to a diverse range of culturally valued moral values that likely initially evolved to facilitate group living. This fits well with the MFT claim that morality initially emerged in our prehuman ancestors but later became part of cultural worldviews, and the TMT claim that morality is an especially important part of cultural worldviews that are used to manage existential anxiety.

Disgust

The findings of a relationship between death concerns and disgust suggest another point of possible integration. Evolutionary theories argue that disgust evolved to protect against pathogens, including those contained in decaying meat. Because consuming pathogen-laden meat would lead to a hasty departure from the gene

pool, individuals who were disgusted by rotten flesh were more likely to survive and reproduce. It has also been argued that disgust tendencies were co-opted to promote sexual encounters that were more likely to produce healthy offspring by discouraging mating with less healthy potential partners (Tybur et al., 2013).

Existential theories of disgust center on a motivation to psychologically distance human beings from other animals. From this perspective, the undeniable fact that bodies die inspired our ancestors (and contemporary humans) to construe themselves as minds, bodies, or spirits that continue to exist after physical death and to distance this "human essence" from their physical bodies. Thus mind-body dualism, which may have initially arose as a result of the experience of conscious will instigating bodily action, is a central part of the human strategy for managing death-related anxiety. Elevating the mind or spirit over the body is essential to that strategy. Similarities between humans and other animals challenge this distinction, and consequently lead to disgust with bodily processes, distancing from things that remind us of our corporeal nature, and pursuit of things that distinguish humankind from other animals.

A large and growing literature provides converging evidence for this analysis (for a review, see Goldenberg & Roberts, 2010). Research has shown that MS increases disgust sensitivity regarding both bodily products and animals; other research shows that MS leads to more positive evaluations of an essay arguing that humans are different from other animals and more negative evaluations of one arguing that the humans are similar to other animals (Goldenberg et al., 2001). Research has also shown that disgust sensitivity predicts worldview defense and unrealistic optimism about one's future when people are reminded of death but not under neutral conditions (Kelley, Crowell, Tang, Harmon-Jones, & Schmeichel, 2015).

A large body of research has documented links between death-related thought, awareness of human-animal similarities (creatureliness), and disgust-related sexual ambivalence. Goldenberg, Cox, Pyszczynski, Greenberg, and Solomon (2002) found that, when reminded of similarities between humans and other animals, MS reduces the appeal of the physical but not romantic aspects of sex. Priming human-animal similarities leads to an increase in DTA in response to reminders of the physical but not romantic aspects of sex. Both of these responses to the physical aspects of sex are especially prominent among people high in neuroticism, and are eliminated when these participants are induced to think about love (Goldenberg, Pyszczynski, McCoy, Greenberg, & Solomon, 1999). MS has also been shown to lead to more negative evaluations of and physical distancing from women if they had recently breast-fed but not bottle-fed their children (Cox, Goldenberg, Arndt, & Pyszczynski, 2007); it has also shown that reminders of death and/or creatureliness reduced women's intentions to perform breast self-examinations and led them to spend less time doing such exams on a model of a human breast (Goldenberg, Goplen, Cox, & Arndt, 2007), and that priming thoughts of breast-feeding increased the accessibility of creatureliness-related thoughts after MS but not in the absence of MS (b; Cox, Goldenberg, Arndt, & Pyszczynski, 2007). Priming thoughts of creatureliness also lead to

more negative evaluations of photos of celebrities taken when they are pregnant but not when they are not (Goldenberg et al., 2007).

These and other studies make a compelling case that the problems of death and human corporeality play an important role in disgust, queasiness with the human body, and ambivalence about sex. Given the importance of sex and mating to evolutionary accounts of human behavior, integration of existential and evolutionary theories would increase the explanatory power of both. This line of research has been given scant attention in evolutionary accounts of disgust and, to our knowledge, has not been mentioned in evolutionary analyses of sexual behavior and preferences. Tybur et al. (2013) dismiss the role of creatureliness concerns in disgust by noting that people are not bothered by all similarities between humans and other animals: "non-human animals can be readily observed running and jumping like humans, breathing like humans, sleeping like humans, and caring for their offspring like humans, yet none of these behaviors elicit disgust" (p. 66). This is an important and valid criticism that existential theorists need to address.

We agree with Tybur et al. (2013), Rozin, Haidt, and McCauley (2008), and many other theories that posit that disgust initially evolved as an emotional response to steer animals away from pathogens, such as those inhabiting rotting meat. And we have no qualms with arguments that natural selection affected other aspects of disgust, perhaps encouraging the pursuit of some potential mates and the avoidance of others (Al-Shawaf, Conroy-Beam, Asao, & Buss, 2016). But these theories do not explain the evidence of a connection between existential concerns regarding death and creatureliness, disgust, and sexual ambivalence.

TMT suggests that once awareness of death emerged, elevating the human mind, spirit, or soul over the body was appealing because it detoxified death. One intriguing possibility is that evolved proclivities to be disgusted by, for example, decaying flesh may have played a role in making awareness of human mortality so distressing. Evidence of disgust proneness in other primates and mammals suggests that disgust existed long before the emergence of the cognitive abilities that made death awareness possible. Though TMT posits that awareness of the inevitability of death produces fear and anxiety, this raises the possibility that disgust plays an additional role in existential terror. Our prehuman ancestors likely experienced disgust in response to the decaying bodies of their conspecifics, which was likely especially disturbing when they had strong emotional attachments to the deceased. Dawning awareness that they, too, would eventually become a fetid mass of decaying flesh (recall the quote from the Epic of Gilgamesh, "am I not like Enkidu," his recently deceased friend) was likely even more problematic. Perhaps disgust is another dimension of the emotional response to death we refer to as terror.

Recent findings that even subliminal exposure to putrescine, the chemical that gives rotting flesh its unpleasant odor, increases worldview defense provides initial evidence consistent with this possibility (Wisman & Shrira, 2015). Relative to participants exposed to another noxious odor (ammonia) or neutral controls, those exposed to putrescine exhibited greater vigilance, avoidance, and implicit threat-related cognitions. More intriguingly, subliminal exposure to putrescine increased hostility toward out-groups, a common form of worldview defense found in TMT

research. These findings are consistent with the possibility that disgust is part of the experience that makes awareness of one's own mortality disturbing.

This suggests a possible answer to the question of why some but not all aspects of human-animal similarity increase DTA and worldview defense; though we have not assessed these responses to animal behaviors such as running or sleeping, we suspect that Tybur et al. (2013) are correct in suggesting that they are unlikely to instigate disgust or increase DTA and worldview defense. If our ancestors were already experiencing disgust in response to rotting flesh and aspects of human functioning associated with pathogens, this may have set the stage for distancing from these aspects of the body and animal nature, along with the emergence of soul beliefs as a means of distancing from death. This tendency to elevate one's own kind above other forms of life may have also increased the tendency to distance from and dehumanize other humans who are different from oneself.

Pathogens, Prejudice, and Tribalism

Social psychological theories of prejudice and bias against out-groups typically start with the idea that categorizing people into groups serves useful functions, both by simplifying one's social world and by providing identity and self-esteem through affiliation with one's in-groups. The prototypic example of this line of thinking is social identity theory (Tajfel & Turner, 1979) which has influenced most other contemporary theories of intergroup relations. From this perspective, individual identity and self-esteem are derived from both one's individual behavior and characteristics and those of the groups to which one belongs. Prejudice and in-group bias are viewed as consequences of the benefits to self-esteem that accrue from viewing other groups as inferior to one's own. TMT builds on this approach by focusing on the protection from existential anxiety provided by self-esteem and faith in the worldview espoused by one's culture. Consistent with this view, research has shown that reminders of death increase prejudice and in-group bias, entitativity, support for violence against out-groups, commitment to in-group beliefs and values, and derogation of people with different beliefs and values. Other studies have shown that threats from out-groups increase DTA and that boosting self-esteem eliminates these threats.

From an evolutionary perspective, the tendencies to categorize people and favor one's own group are viewed as products of the cognitive architecture that evolved to facilitate successful group living (Tooby & Cosmides, 1990). For example, preference for in-group members over out-group members is thought to have been selected for because of the greater proportion of genes shared with in-group members and because of the fitness benefits conveyed by success of in-groups over out-groups. Hostility toward those who are different is viewed as rooted in distinct but related evolved systems for *self-protection* and *disease avoidance* (Neuberg et al., 2011).

The threat protection system evolved in response to the fact that early humans lived in small groups that were likely in frequent conflict with each other that often

led to violence and killing. Thus a tendency to be sensitive to cues that differentiate one group from another (and which signal threat), experience fear and perhaps anger in response to these cues, and act aggressively toward those who display them would enhance reproductive fitness. The disease avoidance system is often referred to as a *behavioral immune system*, which consists of a suite of cognitive, emotional, and behavioral proclivities that evolved to reduce exposure to pathogens and works in tandem with the biological immune system that fights them off once they have entered the body (Neuberg et al., 2011; Thornhill & Fincher, 2014, this volume). Since members of out-groups, especially those that appear very different from one's in-group, are more likely to harbor pathogens to which one's own group lacks resistance, sensitivity to cues of otherness, aversive emotional responses to these cues, and avoidance or aggressive behavior toward these others would be adaptive for gene survival. Whereas activation of the threat avoidance system produces fear, activation of the disease avoidance system produces disgust.

Of course, it is possible that evolutionary and existential accounts of in-group bias involve distinct psychological processes, but we think it is fruitful to consider possible relations between them. Given evidence that other species avoid conspecifics displaying signs of disease, and of links between behavioral and biological immune systems (Schaller, Miller, Gervais, Yager, & Chen, 2010), it seems likely that negative reactions to threats of violence and disease from conspecifics existed prior to the cognitive capacities that made awareness of death possible. This suggests that cultural encouragement to cling to one's in-group and derogate out-groups as means of warding off existential anxiety may have been inspired, to some extent, by these more primitive threat and disease avoidance tendencies. Indeed, most cultures explicitly proclaim the superiority of their people and characterize out-groups as inferior, and these tendencies are exacerbated when thoughts of death are salient. It seems likely that prejudice against out-groups is rooted in our evolutionary history, which influenced the ideas that early humans invented that gradually became cultural knowledge, which people use to manage anxiety.

The tendency to infrahumanize out-group members (Leyens et al., 2000), viewing them as less than human, provides an interesting instance in which many of the forces we have been discussing come together. Research shows that subtle forms of infrahumanization, in which out-group members are viewed as being less prone than in-group members to secondary emotions that involve subtle shades of meaning, emerge even in response to out-groups that people like (Cortes, Demoulin, Rodriguez, Rodriguez, & Leyens, 2005). Viewing out-group members as less human than in-group members is consistent with TMT ideas about elevating humankind above other animals as a means of managing death-related concerns. Indeed, research shows that MS increases the tendency to view in-groups but not out-groups as possessing more uniquely human characteristics and to evaluate characteristics of one's in-group as more uniquely human (Vaes, Heflick, & Goldenberg, 2010). Research has also shown that inducing disgust but not sadness increases infrahumanization on an implicit association test, with disgust increasing associations between out-group members and animals and between in-group members and humanity (Buckels & Trapnell, 2013). There is also evidence that violation of local

cultural norms activates the disease avoidance system (Faulkner, Schaller, Park, & Duncan, 2004).

Given the previously discussed findings that disgust increases DTA and that manipulations of DTA increase bias against out-groups, further explication of how these processes combine to produce prejudice would likely be a fruitful direction for research. One approach would be to assess the relationship between a predictor of disgust that has clear biological roots and the sorts of relationships found in TMT research. For example, research shows that pregnant women in their first trimester have weakened immune systems (presumably to prevent spontaneous abortion) that make them especially prone to disgust; they are also especially prone to rejection of out-group members during this period (Navarrete, Fessler, & Eng, 2007). Would relationships between disgust, DTA, denial of human-animal similarity, and worldview defense be especially prominent among pregnant women during their first trimester?

Religion and Spirituality

The origin and function of religion is another domain that has been the focus of considerable theoretical and empirical work from both existential and evolutionary perspectives. Evolutionary theories view religion as originating in the inappropriate application of theory of mind and folk psychology to inanimate entities, and as being maintained by the benefits to individuals or society, and thus reproductive fitness, of watchful gods that promote prosocial behavior and discourage intragroup conflict. Existential theories view religion as a human innovation to manage death-related anxiety that continues to serve this function for contemporary believers. As in other domains, whereas evolutionary theories focus on gene survival (and to some extent societal success in the service of gene survival), existential theories emphasize managing anxiety and distress on an individual level (and to some extent how this affects societal functioning). We suggest that both perspectives tell *part* of the story regarding the origins and functions of religion, and that they provide complementary insights into the psychology of religion.

TMT posits that the potential for terror that resulted from awareness of the inevitability of death led our ancestors (and leads most contemporary humans) to gravitate toward ideas that manage this terror. Perhaps the most straightforward way of accomplishing this involves believing in literal immortality, that life continues after physical death in a spiritual dimension that transcends the mortal limitations of the body. Although cultures vary greatly in the specifics of their afterlife beliefs, these beliefs can be found in the majority of cultures across both time and location, and continue to be espoused by the majority of people today. Because death of the human body is an undeniable fact, most cultures divorce the human essence from the mortal body, and locate the human essence in spirits or souls that live on after their bodies die, in a form not subject to the limitations of nature.

A large body of experimental research documents the role of death concerns in diverse aspects of religious beliefs and behaviors (for reviews, see Soenke, Landau, & Greenberg, 2012; Vail et al., 2010). For example, MS increases belief in supernatural beings and an afterlife, even spiritual entities not associated with one's own culture (e.g., Norenzayan, Dar-Nimrod, Hansen, & Proulx, 2009; Osarchuk & Tatz, 1973) and challenges to religious beliefs increase DTA (e.g., Schimel, Hayes, Williams, & Jahrig, 2007). MS increases distress when people use religious objects in mundane or disrespectful ways (Greenberg, Porteus, Simon, Pyszczynski, & Solomon, 1995). MS increases the impact of recently primed moral values, but only if framed in religious ways (Rothschild, Abdollahi, & Pyszczynski, 2009). Exposure to bogus evidence that near-death experiences imply that life continues after death eliminates the effect of MS on both self-esteem striving and worldview defense (Dechesne et al., 2003). When combined with research documenting the role of existential concerns in distancing from the physical body, this research provides compelling evidence that death denial is an important function of religion.

Evolutionary theories of religion focus on either the misapplication of evolved folk psychology to inanimate entities, leading to the imputation of mind and intention to physical phenomena or to enhanced social cohesion produced by groups of people believing in and attempting to please watchful gods that mete out rewards and punishments for their behavior, *or* the increased reproductive fitness that group cohesiveness provides (Bering, 2006; Boyer, 2001). Norenzayan et al. (2016) proposed an integration of these approaches in which spirit concepts initially emerged as misapplication of theory of mind, and that over time these spirits were increasingly viewed as concerned with human affairs and rewarding or punishing people in accordance with their behavior. From this perspective, religious beliefs took on increasingly adaptive significance over time by enhancing social cohesion, which made it possible for humans to live in larger groups, thus promoting the emergence of civilization.

We recently proposed an *intelligent design theory of the origins and function of religion* (pun intended; Pyszczynski, 2016; Pyszczynski & Landau, in press). Clearly, the fear of death does not operate in a vacuum. The potential for terror that resulted from awareness of the inevitability of death exerts its influence on an animal with particular characteristics that evolved prior to the cognitive capacities that made this awareness possible. Evolutionary insights can enrich existential analyses of religion by providing insight into how ideas of supernatural spirits initially emerged and the later societal consequences of communities of people trying to please such spirits. However, they leave a substantial gap between the emergence of spirit concepts and the broad societal consequences of believing in powerful gods that intervene in human life. What inspired the idea that the gods monitored human behavior and rewarded or punished people depending on whether their behavior pleased them? Specifying the adaptive social consequences of belief in powerful gods does not explain their emergence. Perhaps most importantly, what motivates religious belief and behavior among individuals, in either the earliest believers or the contemporary humans? Group benefits of widely shared behaviors depend on

the actions of individuals. Why do all of the most successful religions that stood the test of time, influenced culture and history, and influence contemporary thought and behavior, include powerful gods or supernatural forces that grant immortality?

Obviously, narratives about gods that demand moral behavior could not have resulted from random mutations in neural structures. Nor is it plausible that religious beliefs were invented as cynical attempts of dominant group members to manipulate the masses to maintain social order. Though this probably occurred later, when societal elites realized that they could maintain their power with promises of a better world after a miserable life, it is highly unlikely that the intelligent designers of religion promoted ideas in which they themselves did not believe. Even if this were the case, it would not explain what motivates the masses to believe in gods they cannot see in the hope that they will someday reap rewards they can only imagine. Integrating evolutionary and existential perspectives on religion suggests answers to these and many other questions.

Our intelligent design analysis suggests that evolved cognitive, emotional, and social proclivities were the building blocks from which early (and later) humans imagined an invisible spirit world, while at the same time giving rise to existential fears that motivated people to elaborate on their intuitions to fashion cosmologies that provided protection against these fears. If our ancestors were extrapolating from their experiences with other humans to imbue nature with spirit, desire, intention, and other human properties, the deities they created would be similar to the people with whom they lived. Benevolent gods and evil demons would be used to explain the good and bad things they experienced in life, respectively. Because of their psychological utility, conceptions of gods who provided means of transcending death would be especially appealing and have greater staying power than impish and capricious ones that were largely inconsequential for human affairs. As reviewed above, a considerable literature supports the role of religious beliefs in managing death-related concerns (e.g., Vail et al., 2010).

To meet their psychological needs, humankind created gods in their own image and imbued them with powers they yearned for but lacked. Toward this end, people created gods that helped them stay alive by protecting them from predators and enemies and granting successful harvests and hunts; as awareness of the inevitability of death emerged, these gods took on the even greater power of granting eternal life. The journey from simply imputing agency to natural phenomena to submitting to all-powerful gods in return for immortality was undoubtedly long and circuitous. Over time, the relief from anxiety provided by immortality-granting gods led them to spread and become the central characters in all religions that stood the test of time.

Powerful gods were fashioned out of experiences with powerful humans, such as parents, tribal leaders, and kings. This explains the obedience, fealty, devotion, and sacrifice people assume their gods demand in return for immortality. Worship is a projection of the submission that powerful humans demand of their subjects onto the gods that people created.

Though the earliest iterations of spiritual ideas were probably vague and highly variable, as culture expanded, these concepts became more elaborate and oriented

toward granting immortality. Extrapolating from observations of contemporary hunter-gatherers, it has been suggested that the spirits imagined by early humans were probably rather capricious and uninterested in human affairs. This is consistent with the idea of a gradual progression from simply imputing mind and agency to natural phenomena to the elaborate system of beliefs that make up modern religion. Perhaps there was a sort of "spiritual arms race" in the powers attributed to the gods, with immortality-granting deities spreading and coming to dominate because of their effectiveness in meeting existential needs.

Importantly, TMT implies that emerging awareness of the inevitability of death changed the dynamics of the moral intuitions and values that control human behavior (Pyszczynski & Kesebir, 2012). Awareness of the inevitability of death changed the motivational impetus for moral behavior from staying in the good graces of others to pleasing the gods to gain immortality. As Norenzayan and colleagues (2013) suggest, the concept of all-powerful, watchful gods was an important civilizing force that motivated moral behavior even in the absence of direct observation by other people; the prospect of transcending death enhanced the impetus for moral behavior far beyond anything that other people could offer, and may be why moral behavior is the most central basis of how people evaluate others and themselves (e.g., Skitka, Bauman, & Sargis, 2005). Of course, people still cared (and continue to care) about how others evaluate them. Indeed, TMT posits that faith in one's worldview and self-esteem requires consensual validation from others. This is why religious practice always involves a community of believers that employs costly displays to demonstrate their faith and virtue to each other.

We agree with adaptationist theories that compelling religious belief systems promote social cohesion and societal success, which facilitates spreading of both worldviews and genes (e.g., Norenzayan et al., 2016). The TMT perspective points out that these societal benefits depend on individual behavior motivated largely by the protection from anxiety that the hope of transcending death provides. Religion promotes cohesive societies because it motivates moral behavior as a way of defeating death.

Concluding Thoughts

The central point of this chapter is that evolutionary and existential perspectives on human behavior are compatible and complementary. Natural selection produced a human animal with a diverse array of psychological capacities and needs that led to problems that other species do not have. Human beings not only exist, but they also know that they exist and that they will someday die. This gave rise to the potential for existential terror, which continues to be a problem for contemporary humans. Early humans manage this terror by using their evolved capacity for imagination and creativity to invent a cultural "reality" in which death is only a temporary setback. Contemporary humans continue to inhabit this imaginary universe.

Evolutionary psychology provides important insights regarding both the roots of this existential dilemma and the psychological tools that humankind deploys to cope with it. It describes important features of the animal that existed before the cognitive abilities that produced awareness of the inevitability of one's own death; our ancestors used these cognitive tools to gradually construct conceptualizations of their world that detoxified death. Evolved emotions such as fear and disgust, moral intuitions that guided human interactions, cognitive architecture and modes of thinking, and various other proclivities that were genetically transmitted provided the raw ingredients that early humans used to think about themselves and their social and physical environments in ways that, over time, were institutionalized as cultural worldviews.

TMT, and existential psychology in general, has empirically documented a multitude of ways that human thought and emotion bias the way people think, feel, and behave. This work has shown the many aspects of human behavior that are influenced by death-related thought. From this perspective, human "solutions" to the problem of death are products of individual imagination, cultural transmission, and emotional forces that motivate people to commit to the ever-changing ways in which cultures construe life, the universe, and their role in it. These processes impinge on many of the behavioral domains of interest to evolutionary psychologists, including sex and interpersonal relationships, fear and disgust, moral intuitions, intergroup conflict and prejudice, and religion. We have discussed the interface of evolutionary and existential psychology in each of these domains. Though it is possible to pursue these areas of interest from one perspective in conceptual isolation from the other, and this has yielded many important ideas and insights, bringing them together raises many interesting questions that will hopefully enhance our understanding of why people behave the way they do.

References

Al-Shawaf, L., Conroy-Beam, D., Asao, K., & Buss, D. M. (2016). Human emotions: An evolutionary psychological perspective. *Emotion Review, 8*, 173–186. https://doi.org/10.1177/1754073914565518

Baumeister, R. F., & Vohs, K. D. (2007). Self-regulation, ego depletion, and motivation. *Social and Personality Psychology Compass, 1*, 115–128. https://doi.org/10.1111/j.1751-9004.2007.00001.x

Becker, E. (1971). *The birth and death of meaning: An interdisciplinary perspective on the problem of man* (2nd ed.). New York, NY: The Free Press.

Becker, E. (1973). *The denial of death*. New York, NY: The Free Press.

Becker, E. (1975). *Escape from evil*. New York, NY: The Free Press.

Bering, J. M. (2006). The cognitive science of souls: Clarifications and extensions of the evolutionary model. *Behavioral and Brain Sciences, 29*, 486–493.

Binswanger, L. (1942). Grundformen und erkenntnis menschlichen daseins. *Hg. v. Herzog M, Braun HJ. Ausgewählte Werke. Bd*, *2*.

Bowlby, J. (1969). *Attachment and loss: Attachment*. New York, NY: Basic books.

Boyer, P. (2001). *Religion explained: The evolutionary origins of religious thought*. New York, NY: Basic Books.

Buckels, E. E., & Trapnell, P. D. (2013). Disgust facilitates out-group dehumanization. *Group Processes & Intergroup Relations, 16*, 771–780. https://doi.org/10.1177/1368430212471738

Burke, B. L., Martens, A., & Faucher, E. H. (2010). Two decades of terror management theory: A meta-analysis of mortality salience research. *Personality and Social Psychology Review, 14*, 155–195.

Buss, D. M. (1997). Human social motivation in evolutionary perspective: Grounding Terror Management Theory. *Psychological Inquiry, 8*, 22. https://doi.org/10.1207/s15327965pli0801_3

Carver, C. S., & Scheier, M. F. (1981). The self-attention-induced feedback loop and social facilitation. *Journal of Experimental Social Psychology, 17*, 545–568. https://doi.org/10.1016/0022-1031(81)90039-1

Castano, E., & Dechesne, M. (2005). On defeating death: Group reification and social identification as immortality strategies. *European Review of Social Psychology, 16*, 221–255.

Cohen, F., Solomon, S., & Kaplin, D. (2017). You're hired! Mortality salience increases Americans' support for Donald Trump. *Analyses of Social Issues & Public Policy, 17*, 339–357. https://doi.org/10.1111/asap.12143

Cohen, F., Solomon, S., Maxfield, M., Pyszczynski, T., & Greenberg, J. (2004). Fatal attraction: The effects of mortality salience on evaluations of charismatic, task-oriented, and relationship-oriented leaders. *Psychological Science, 15*, 846–851.

Cortes, B. P., Demoulin, S., Rodriguez, R. T., Rodriguez, A. P., & Leyens, J.-P. (2005). Infrahumanization or familiarity? Attribution of uniquely human emotions to the self, the ingroup, and the out-group. *Personality and Social Psychology Bulletin, 31*, 243–253. https://doi.org/10.1177/0146167204271421

Cox, C. R., Goldenberg, J. L., Arndt, J., & Pyszczynski, T. (2007). Mother's milk: An existential perspective on negative reactions to breast-feeding. *Personality and Social Psychology Bulletin, 33*, 110–122. https://doi.org/10.1177/0146167206294202

Cox, C. R., Goldenberg, J. L., Pyszczynski, T., & Weise, D. (2007). Disgust, creatureliness and the accessibility of death-related thoughts. *European Journal of Social Psychology, 37*, 494–507.

Curtis, V., & Biran, A. (2001). Dirt, disgust, and disease: Is hygiene in our genes? *Perspectives in Biology and Medicine, 44*, 17.

Das, E., Bushman, B. J., Bezemer, M. D., Kerkhof, P., & Vermeulen, I. E. (2009). How terrorism news reports increase prejudice against out-groups: A terror management account. *Journal of Experimental Social Psychology, 45*, 453–459. https://doi.org/10.1016/j.jesp.2008.12.001

De Waal, F. B. (1996). *Good natured: The origins of right and wrong in humans and other animals*. Cambridge, MA: Harvard University Press.

Dechesne, M., Pyszczynski, T., Arndt, J., Ransom, S., Sheldon, K. M., Knippenberg, v., et al. (2003). Literal and symbolic immortality: The effect of evidence of literal immortality on self-esteem striving in response to mortality salience. *Journal of Personality and Social Psychology, 84*, 722–737.

Faulkner, J., Schaller, M., Park, J. H., & Duncan, L. A. (2004). Evolved disease-avoidance mechanisms and contemporary xenophobic attitudes. *Group Processes & Intergroup Relations, 7*, 333–353. https://doi.org/10.1177/1368430204046142

Fessler, D. M. T. (2007). Neglected natural experiments germane to the Westermarck hypothesis. *Human Nature, 18*, 355–364. https://doi.org/10.1007/s12110-007-9021-1

Festinger, L. (1954). A theory of social comparison processes. *Human Relations, 7*, 117–140.

Florian, V., & Mikulincer, M. (1997). Fear of death and the judgment of social transgressions: A multidimensional test of terror management theory. *Journal of Personality and Social Psychology, 73*, 369–380.

Florian, V., Mikulincer, M., & Hirschberger, G. (2002). The anxiety-buffering function of close relationships: Evidence that relationship commitment acts as a terror management mechanism. *Journal of Personality and Social Psychology, 82*, 527–542. https://doi.org/10.1037/0022-3514.82.4.527

Goldenberg, J. L., & Arndt, J. (2008). The implications of death for health: A terror management health model for behavioral health promotion. *Psychological Review, 115*, 1032–1053. https://doi.org/10.1037/a0013326

Goldenberg, J. L., Cox, C. R., Pyszczynski, T., Greenberg, J., & Solomon, S. (2002). Understanding human ambivalence about sex: The effects of stripping sex of meaning. *Journal of Sex Research, 39*, 310. https://doi.org/10.1080/00224490209552155

Goldenberg, J. L., Goplen, J., Cox, C. R., & Arndt, J. (2007). "Viewing" pregnancy as an existential threat: The effects of creatureliness on reactions to media depictions of the pregnant body. *Media Psychology, 10*, 211–230. https://doi.org/10.1080/15213260701375629

Goldenberg, J. L., Pyszczynski, T., Greenberg, J., & Solomon, S. (2000). Fleeing the body: A terror management perspective on the problem of human corporeality. *Personality and Social Psychology Review, 4*, 200–218. https://doi.org/10.1207/S15327957PSPR0403_1

Goldenberg, J. L., Pyszczynski, T., Greenberg, J., Solomon, S., Kluck, B., & Cornwell, R. (2001). I am not an animal: Mortality salience, disgust, and the denial of human creatureliness. *Journal of Experimental Psychology: General, 130*, 427–435.

Goldenberg, J. L., Pyszczynski, T., McCoy, S. K., Greenberg, J., & Solomon, S. (1999). Death, sex, love, and neuroticism: Why is sex such a problem? *Journal of Personality and Social Psychology, 77*, 1173–1187. https://doi.org/10.1037/0022-3514.77.6.1173

Goldenberg, J. L., & Roberts, T. A. (2010). The birthmark: An existential account of why women are objectified. In R. Calogero, S. Tantleff-Dunn, & J. K. Thompson (Eds.), *The objectification of women: Innovative directions in research and practice* (pp. 77–100). Washington, DC: American Psychological Association.

Greenberg, J., Porteus, J., Simon, L., Pyszczynski, T., & Solomon, S. (1995). Evidence of a terror management function of cultural icons: The effects of mortality salience on the inappropriate use of cherished cultural symbols. *Personality and Social Psychology Bulletin, 21*, 1221–1228. https://doi.org/10.1177/01461672952111010

Greenberg, J., Pyszczynski, T., & Solomon, S. (1986). The causes and consequences of a need for self-esteem: A terror management theory. In R. F. Baumeister (Ed.), *Public self and private self* (pp. 189–212). New York, NY: Springer-Verlag.

Greenberg, J., Pyszczynski, T., Solomon, S., Pinel, E., Simon, L., & Jordan, K. (1993). Effects of self-esteem on vulnerability-denying defensive distortions: Further evidence of an anxiety-buffering function of self-esteem. *Journal of Experimental Social Psychology, 29*, 229–251. https://doi.org/10.1006/jesp.1993.1010

Greenberg, J., Solomon, S., Pyszczynski, T., Rosenblatt, A., Burling, J., Lyon, D., et al. (1992). Why do people need self-esteem? Converging evidence that self-esteem serves an anxiety-buffering function. *Journal of Personality and Social Psychology, 63*, 913–922. https://doi.org/10.1037/0022-3514.63.6.913

Haidt, J., & Joseph, C. (2004). Intuitive ethics: How innately prepared intuitions generate culturally variable virtues. *Daedalus, 133*, 55–66.

Harmon-Jones, E., Simon, L., Greenberg, J., Pyszczynski, T., Solomon, S., & McGregor, H. (1997). Terror management theory and self-esteem: Evidence that increased self-esteem reduced mortality salience effects. *Journal of Personality and Social Psychology, 72*, 24–36. https://doi.org/10.1037/0022-3514.72.1.24

Hayes, J., Schimel, J., Arndt, J., & Faucher, E. H. (2010). A theoretical and empirical review of the death-thought accessibility concept in terror management research. *Psychological Bulletin, 136*, 699–739. https://doi.org/10.1037/a0020524

Hirschberger, G. (2006). Terror management and attributions of blame to innocent victims: reconciling compassionate and defensive responses. *Journal of Personality and Social Psychology, 91*, 832–844.

Jonas, E., Schimel, J., Greenberg, J., & Pyszczynski, T. (2002). The Scrooge effect: Evidence that mortality salience increases prosocial attitudes and behavior. *Personality and Social Psychology Bulletin, 28*, 1342–1353. https://doi.org/10.1177/014616702236834

Kasser, T., & Sheldon, K. M. (2000). Of wealth and death: Materialism, mortality salience, and consumption behavior. *Psychological Science, 11*, 348–351. https://doi.org/10.1111/1467-9280.00269

Kelley, N. J., Crowell, A. L., Tang, D., Harmon-Jones, E., & Schmeichel, B. J. (2015). Disgust sensitivity predicts defensive responding to mortality salience. *Emotion, 15*, 590–602. https://doi.org/10.1037/a0038915

Kirkpatrick, L. A., & Navarrete, C. D. (2006). Reports of my death anxiety have been greatly exaggerated: A critique of terror management theory from an evolutionary perspective. *Psychological Inquiry, 17*, 288–298. https://doi.org/10.1080/10478400701366969

Landau, M. J., Goldenberg, J. L., Greenberg, J., Gillath, O., Solomon, S., Cox, C., et al. (2006). The siren's call: Terror management and the threat of men's sexual attraction to women. *Journal of Personality and Social Psychology, 90*, 129–146.

Landau, M. J., Greenberg, J., & Solomon, S. (2004). The motivational underpinnings of religion. *Behavioral and Brain Sciences, 27*, 743–744.

Landau, M. J., Solomon, S., Greenberg, J., Cohen, F., Pyszczynski, T., Arndt, J., et al. (2004). Deliver us from evil: The effects of mortality salience and reminders of 9/11 on support for President George W. Bush. *Personality and Social Psychology Bulletin, 30*, 1136–1150. https://doi.org/10.1177/0146167204267988

Landau, M. J., Solomon, S., Pyszczynski, T., & Greenberg, J. (2007). On the compatibility of terror management theory and perspectives on human evolution. *Evolutionary Psychology, 5*, 147470490700500300. https://doi.org/10.1177/147470490700500303

Leyens, J.-P., Paladino, P. M., Rodriguez-Torres, R., Vaes, J., Demoulin, S., Rodriguez-Perez, A., et al. (2000). The emotional side of prejudice: The attribution of secondary emotions to ingroups and out-groups. *Personality and Social Psychology Review, 4*(2), 186–197. https://doi.org/10.1207/S15327957PSPR0402_06

Navarrete, C. D., Fessler, D. M. T., & Eng, S. J. (2007). Elevated ethnocentrism in the first trimester of pregnancy. *Evolution and Human Behavior, 28*, 60–65. https://doi.org/10.1016/j.evolhumbehav.2006.06.002

Neuberg, S. L., Kenrick, D. T., & Schaller, M. (2011). Human threat management systems: Self-protection and disease avoidance. *Neuroscience & Biobehavioral Reviews, 35*, 1042–1051. https://doi.org/10.1016/j.neubiorev.2010.08.011

Norenzayan, A., Dar-Nimrod, I., Hansen, I. G., & Proulx, T. (2009). Mortality salience and religion: Divergent effects on the defense of cultural worldviews for the religious and the non-religious. *European Journal of Social Psychology, 39*, 101–113. https://doi.org/10.1002/ejsp.482

Norenzayan, A., Shariff, A. F., Gervais, W. M., Willard, A. K., McNamara, R. A., Slingerland, E., et al. (2016). The cultural evolution of prosocial religions. *Behavioral and Brain Sciences, 39*, e1.

Ochsmann, R., & Mathay, M. (1994). *Depreciating of and distancing from foreigners: Effects of mortality salience*. Unpublished manuscript, Universitat Mainz, Germany.

Osarchuk, M., & Tatz, S. J. (1973). Effect of induced fear of death on belief in afterlife. *Journal of Personality and Social Psychology, 27*, 256–260. https://doi.org/10.1037/h0034769

Park, Y. C., & Pyszczynski, T. (2016). Cultural universals and differences in dealing with death. In L. A. Harvell & G. S. Nisbett (Eds.), *Denying death: An interdisciplinary approach to terror management theory* (pp. 193–213). New York, NY: Routledge/Taylor & Francis Group.

Pyszczynski, T. (2016). God save us: A terror management perspective on morality. In J. P. Forgas, L. Jussim, & P. A. M. von Lange (Eds.), *The social psychology of morality: The Sydney symposium of social psychology*. New York: Routledge.

Pyszczynski, T., & Greenberg, J. (1987). A biased hypothesis-testing model of motivated attributional distortion. In L. Berkowitz (Ed.), *Advances in experimental social psychology*. New York: Academic Press.

Pyszczynski, T., & Kesebir, P. (2012). Culture, ideology, morality, and religion: Death changes everything. In M. Mikulincer & P. Shaver (Eds.), *The social psychology of meaning, mortality, and choice* (pp. 75–91). Washington, DC: American Psychological Association.

Pyszczynski, T., & Landau, M. J. (in press). In his own image: An intelligent design perspective on the origins and function of religion. In C. Routledge & K. Vail (Eds.), *The science of religion, spirituality, and existentialism*. Amsterdam: The Netherlands.

Pyszczynski, T., Solomon, S., & Greenberg, J. (2015). Thirty years of terror management theory: From genesis to revelation. *Advances in Experimental Social Psychology, 52*, 1–70.

Richard, F. D., Bond Jr., C. F., & Stokes-Zoota, J. J. (2003). One hundred years of social psychology quantitatively described. *Review of General Psychology, 7*, 331–363. https://doi.org/10.1037/1089-2680.7.4.331

Rosenblatt, A., Greenberg, J., Solomon, S., Pyszczynski, T., & Lyon, D. (1989). Evidence for terror management theory: I. The effects of mortality salience on reactions to those who violate or uphold cultural values. *Journal of Personality and Social Psychology, 57*, 681–690.

Rothschild, Z. K., Abdollahi, A., & Pyszczynski, T. (2009). Does peace have a prayer? The effect of mortality salience, compassionate values, and religious fundamentalism on hostility toward out-groups. *Journal of Experimental Social Psychology, 45*, 816–827. https://doi.org/10.1016/j.jesp.2009.05.016

Rozin, P., & Fallon, A. E. (1987). A perspective on disgust. *Psychological Review, 94*, 23–41. https://doi.org/10.1037/0033-295X.94.1.23

Rozin, P., Haidt, J., & McCauley, C. R. (2008). Disgust. In I. M. Lewis, J. M. Haviland-Hones, & L. F. Barrett (Eds.), *Handbook of emotions* (3rd ed., pp. 757–776). New York, NY: Guilford Press.

Schaller, M., Miller, G. E., Gervais, W. M., Yager, S., & Chen, E. (2010). Mere visual perception of other people's disease symptoms facilitates a more aggressive immune response. *Psychological Science, 21*, 649–652. https://doi.org/10.1177/0956797610368064

Schimel, J., Hayes, J., Williams, T., & Jahrig, J. (2007). Is death really the worm at the core? Converging evidence that worldview threat increases death-thought accessibility. *Journal of Personality and Social Psychology, 92*, 789–803. https://doi.org/10.1037/0022-3514.92.5.789

Skitka, L. J., Bauman, C. W., & Sargis, E. G. (2005). Moral conviction: Another contributor to attitude strength or something more? *Journal of Personality and Social Psychology, 88*, 895–917.

Soenke, M., Landau, M. J., & Greenberg, J. (2012). Sacred armor: Religion's role as buffer against the anxieties of life and the fear of death. In K. I. Pargament (Ed.), *APA handbook of psychology, religion, and spirituality* (pp. 105–122). Washington, DC: American Psychological Association.

Solomon, S., Greenberg, J., & Pyszczynski, T. (1991). A terror management theory of social behavior: The psychological functions of self-esteem and cultural worldviews. *Advances in Experimental Social Psychology, 24*, 93–159.

Tajfel, H., & Turner, J. C. (1979). An integrative theory of intergroup conflict. In W. G. Austin & S. Worchel (Eds.), *The social psychology of intergroup relations*. Monterey, CA: Brooks/Cole.

Thornhill, R. M., & Fincher, C. L. (2014). *The parasite-stress theory of values and sociality: Infectious disease, history, and human values worldwide*. New York, NY: Springer.

Tooby, J., & Cosmides, L. (1990). On the universality of human nature and the uniqueness of the individual: The role of genetics and adaptation. *Journal of Personality, 58*(1), 17–67. https://doi.org/10.1111/j.1467-6494.1990.tb00907.x

Tybur, J. M., Lieberman, D., Kurzban, R., & DeScioli, P. (2013). Disgust: Evolved function and structure. *Psychological Review, 120*, 65–84. https://doi.org/10.1037/a0030778

Vaes, J., Heflick, N. A., & Goldenberg, J. L. (2010). "We are people": In-group humanization as an existential defense. *Journal of Personality and Social Psychology, 98*, 750–760. https://doi.org/10.1037/a0017658

Vail, K. E., Rothschild, Z. K., Weise, D. R., Solomon, S., Pyszczynski, T., & Greenberg, J. (2010). A terror management analysis of the psychological functions of religion. *Personality and Social Psychology Review, 14*, 84–94. https://doi.org/10.1177/1088868309351165

Wilson, E. O. (1975). *Sociobiology*. Cambridge, MA: Harvard University Press.

Wisman, A., & Shrira, I. (2015). The smell of death: Evidence that putrescine elicits threat management mechanisms. *Frontiers in Psychology, 6*. https://doi.org/10.3389/fpsyg.2015

Evolutionary Perspectives on the Loss of a Twin

Nancy L. Segal

"In the despair of parental bereavement following the loss of a child, we hear 'the wail of frustrated genes.'"

—(Barash, 1979, p. 99)

Introduction

The nature and origin of kin relations, and their implications with respect to familial inheritance, parental favoritism, resource provision, and other social and caretaking behaviors, have been of considerable interest to evolutionary psychologists (Buss, 2019). In contrast, evolutionary perspectives on variation in response to the loss of a relative have received relatively less attention despite arguments favoring such an approach. For example, Hofer (1984) noted that while Bowlby placed attachment and loss in the perspectives of development and evolution, views anticipated by Darwin, we only see "the dim outlines of what the biology of bereavement may turn out to be" (p. 183). It is also the case that adult sibling loss, in general, and twin loss, in particular, have been generally neglected by bereavement researchers (see McIlroy, 2012; Parkes & Prigerson, 2010).

Comparative analysis of the grief intensity ratings of bereaved monozygotic (MZ or identical) and dizygotic (DZ or fraternal) twins, guided by kinship genetic theory, offers a novel approach to understanding the effects of genetic and social relatedness on bereavement (Segal, 1999/2000). The bereavement responses of MZ and DZ twin survivors—namely, the level and duration of the "wail of their frustrated genes"—are expected to mirror what is known about the quality of MZ and DZ twins' social relationships. It is also expected that this approach to the study of bereavement-related behaviors can be extended to other pairs of genetically and socially related individuals.

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T. K. Shackelford, V. Zeigler-Hill (eds.), *Evolutionary Perspectives on Death*,
Evolutionary Psychology, https://doi.org/10.1007/978-3-030-25466-7_2

Twin Method

The classic twin method, first recognized by Sir Francis Galton, is a simple and elegant method for investigating genetic contributions to traits of interest (Galton, 1875). Greater resemblance between MZ than DZ twin pairs is consistent with, although not proof of, genetic effects on trait variation. To date, numerous studies have been conducted along these lines, yielding an average trait heritability (proportion of variation explained by genetic factors) of 49% across human individual difference measures (Polderman et al., 2015). There exists, however, a rich array of variants of the classic twin method, such as twins reared apart from birth, twin-family designs, cotwin control designs, and singleton twin studies, that are well suited to addressing particular questions and issues (Segal, Munson, Marelich, Goetz, & McGuire, 2014; Segal, 2017a; Segal & Montoya, 2018). Singleton twin studies are especially rare even among bereavement researchers, although there are exceptions from investigators working with twins (Segal & Blozis, 2002; Segal et al. Segal, Wilson, Bouchard Jr., & Gitlin, 1995, Segal, Sussman, Marelich, Mearns, & Blozis, 2002; Woodward, 1988; also see a special issue of the journal *Twin Research and Human Genetics, 5*(3), June 2002).

Twin Relationships: MZ and DZ Twins Compared

An important first step is to consider differences in the social relatedness between MZ and DZ twin pairs at the proximal level. To the extent that MZ twins display and express greater within-pair social closeness than DZ twins, it is reasonable to expect greater grief intensity following the loss of that relationship. This MZ-DZ twin distinction has, in fact, been reported across age groups, and across studies applying a range of theoretical backgrounds, methods, and respondents, although there is overlap across twin types (Segal, 1999/2000, 2017a).

MZ twin children show greater cooperation than DZ twins during puzzle completion (Segal, 1984), increased coordination during decision-making (Segal et al., 2013), and more frequent and meaningful interaction in free play settings (Segal, 2017b). Furthermore, reared-apart MZ twins (MZA) recall greater social closeness and familiarity than DZ reared-apart twins (DZA) at the time of their first reunion, and subsequently (Segal, Hershberger, & Arad, 2003).

In a study of high school students, Mowrer (1954) asked twins to name the family member who would be most missed in the event of death. Mothers were selected most often, followed by cotwins and fathers, in that order. However, further analysis showed that the cotwin was selected by 49% of MZ twins, 25% of same-sex DZ twins, and 13% of opposite-sex DZ twins. Foy, Vernon, and Jang (2001) found that adolescent and adult MZ twins were more likely to name each another as their best friend, although similar levels of intimacy were noted between the two twin types. Neyer (2002) found that the quality of adult DZ twins' relationships depended on how often they were in contact, an effect not found among MZ twins.

A twin-family study further illustrates associations between genetic relatedness and social closeness. In these families, MZ twin aunts and uncles become the "genetic mothers and fathers" of their nieces and nephews who become their "genetic children." That is because the children from the two families have a genetically identical parent. In contrast, DZ twin aunts and uncles retain the same relationship to their nieces and nephews as do non-twin aunts and uncles. As anticipated, social closeness, as measured by liking, caretaking, and behavioral/physical resemblance to nieces and nephews, was higher among MZ than DZ twin aunts and uncles (Segal & Marelich, 2011).

Collectively, these studies support greater social closeness between MZ than DZ cotwins. As such, a significant contribution to social relatedness from genetic factors between interactants is demonstrated.

Functions of Grief in Evolutionary Context

Several evolutionary-based theories of why we grieve following the loss of a significant other have been proposed. Reunion theory views grief as a by-product of the loss of a close relationship that augments one's evolutionary fitness. Phrased differently, grief may be the "cost" paid for the benefits offered by a sustained loving relationship (Archer, 1988, 1999). Reorientation theory conceptualizes grief as a way of coping, mainly by motivating one to conserve resources and think about alternative life plans and goals (see Nesse, 1990, 2005; Nesse & Williams, 1994). Most recently, a cognitive-evolutionary model of grief has been proposed in which reunification with the absent partner is and is not possible. In the first case (absence), grief is posited to motivate reunion, whereas in the second case (death) it is thought to disengage and reorient the person away from the deceased, facilitating the formation of new relationships (White & Fessler, 2013).

Kinship genetic theory offers a more general framework for evaluating the nature and quality of social interactions and exchanges between biological relatives, including loss. Hamilton (1964) proposed that natural selection favors alleles that predispose individuals to behave in ways that favor the transmission of those alleles into subsequent generations. An indirect way to pass on one's own genes would be for certain alleles to predispose individuals to favor those who are likely to carry copies of those alleles (i.e., close genetic relatives). As such, altruistic actions are expected to vary as a function of genetic relatedness; of course, altruism directed toward close relatives would be expressed in a relative sense, not in an absolute sense. An individual's fitness would then be reconceptualized as inclusive fitness, i.e., as a product of one's "own reproductive success plus his/her effects on the reproductive success of his/her relatives, each one weighed by the appropriate coefficient of relatedness" (Dawkins, 1982/1992, p. 186).

Grief is clearly a complex, multifaceted process. It is, therefore, likely that elements of these theories vary in usefulness and meaning across different bereavement situations. This chapter focuses on twin analyses, using kinship genetic theory

as a backdrop for generating and testing hypotheses related to differential bereavement reactions between relatives. At the distal (functional) level, a deceased cotwin represents a loss of reproductive potential for the survivor. This is especially true in the case of MZ twins who are genetically identical, as indicated above in reference to the twin-family study of social closeness.

Inclusive fitness theory can be used to generate the following hypotheses:

- MZ twins should grieve more intensely for deceased cotwins than DZ twins.
- Surviving twins should grieve more intensely for deceased cotwins than for other biological relatives, an effect that should be especially strong among MZ twins.

The concept of paternity uncertainty is also relevant in the context of bereavement. Paternity uncertainty refers to the fact that a male can never be certain that he is genetically related to a child delivered by his partner. That is because of hidden ovulation, internal fertilization, and continuous female sexual receptivity. In contrast, mothers can be fully certain that they are genetically related to any child to which they give birth (Bryant & Hazelton, 2009; Buss, 2019). Organizing the twin participants by sex of cotwin yields the following hypothesis:

- Twins, both MZ and DZ, should grieve more intensely for deceased female cotwins than for deceased male cotwins.

The Fullerton Twin Loss Study

The Fullerton Twin Loss Study (FTLS), originally launched at the University of Minnesota in 1983, has been continuing at California State University, Fullerton, since 1991. Analyses are limited to twins whose loss occurred at mid-adolescence and beyond (age 15 years and older) because by then twins would have developed a meaningful relationship and been able to recall their loss experience. Data are collected via a Twin Loss Survey (TLS) composed of a section on participant background, a Grief Intensity Scale (GIS) to assess response to the loss of the cotwin and other relatives (adapted from Littlefield & Rushton, 1986), the Grief Experience Inventory (GEI) to assess behaviors and symptoms during the grief process (Sanders, 1979–1980), and a Coping Scale (Littlefield, 1984) to examine management of responsibilities, relationships, and activities. Additional details about the structure of the study are available in Segal et al. (1995), Segal and Ream (1998), and Segal and Blozis (2002).

Twins are identified through twin loss support groups, twin organizations, attorneys litigating wrongful death suits, members of the media, other twin studies, and personal referrals. Approximately 50% of the twins were identified through twin loss support groups. The majority of twins received a mailed form to return to the study, but materials are currently available for download or for online completion (see drnancysegaltwins.org). The most recent sample includes 747 singleton twins

whose cotwin passed away at age 15 years or later. Mean age at participation was 46.75 years (SD = 15.59, range: 16–96 years), mean age at loss was 40.15 years (SD = 16.28, range: 15–95 years), and mean loss interval (time between loss and study participation) was 6.59 years (SD = 8.81, range: 0–54 years).

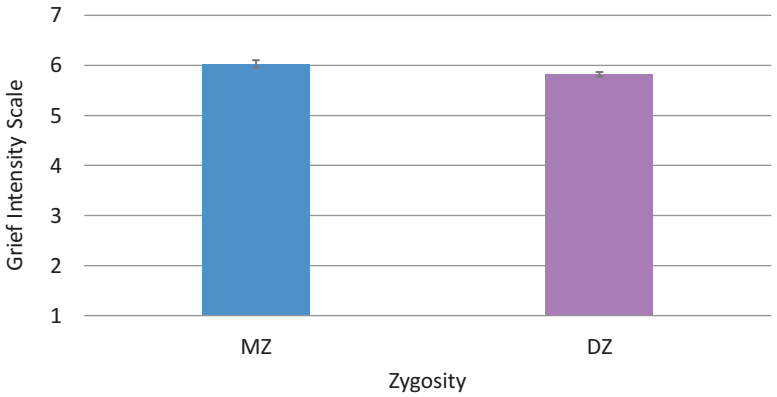
Zygosity (twin type) is determined by a modified version of a standard physical resemblance questionnaire developed for this purpose (Nichols & Bilbro Jr., 1966), although information on blood types and DNA markers is used when available. In some cases, inspection of photographs assisted in twin-type assignment. Twins from male-female pairs are assigned as DZ opposite-sex (DZOS) based on their sex difference. The current sample includes 495 MZ twins (158 males, 337 females), 106 DZ same-sex twins (24 males, 82 females), and 135 twins from male-female pairs (12 males, 123 females); the zygosity of 11 twins could not be determined so were excluded from selected analyses.

This chapter focuses on the Grief Intensity Scale for which data are provided for the deceased cotwin and for any other relative who passed away during the lifetime of the respondent. Ratings are made on a scale from 1 (no grief) to 7 (total devastation, suicide point) with particular reference to the first 2 months following the loss. Ratings of current grief intensity are also provided, but will be examined in a subsequent publication.

Age at loss has been shown to affect grief following the loss of a loved one (Keesee, Currier, & Neimeyer, 2008). In this study, the correlation between these two measures was small, but statistically significant ($r = -0.09$, $p < 0.01$), reflecting increased grief intensity at younger ages. A 2 × 2 ANCOVA was then conducted, with zygosity and cotwin sex as the independent variables, grief for the twin as the dependent variable, and age at loss as the covariate. Paired t-tests comparing grief for the twin with grief in response to the loss of various first-degree and second-degree relatives and other associates were also performed. The loss of children could not be compared, given the small number of twins who had experienced this loss. However, this comparison would be theoretically informative because both MZ and DZ twins share exactly half their genes with their children, but MZ cotwins share 100% of their genes, whereas DZ cotwins share 50% of their genes, on average, by descent. Given the large number of comparisons that were made a Bonferroni correction was applied in this analysis.

The two hypotheses regarding twin loss and zygosity were supported. MZ twins indicated slightly but significantly higher grief intensity than DZ twins [F (1, 725) = 4.24, $p = 0.04$]. Furthermore, twins, in general, experienced greater grief at the loss of their cotwin than the loss of any other relative or associate, findings that were maintained when respondents were organized by zygosity. These findings are summarized in Figs. 1, 2, and 3.

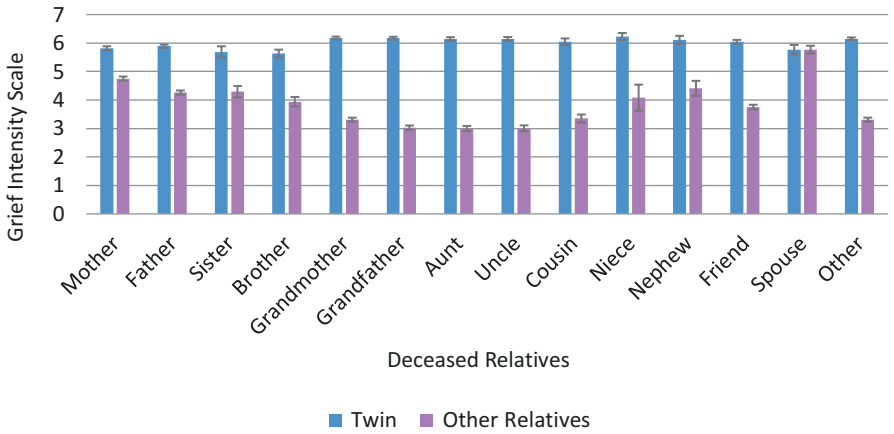
The combined twin group indicated increased grief as a function of cotwin sex, a result that approached statistical significance [F (1,725) = 3.12, $p = 0.078$]. As expected, twins with female cotwins expressed greater grief intensity than twins



MZ: $n = 490$, $M = 6.03$ ($sd = 1.05$) $se = .047$
DZ: $n = 240$, $M = 5.82$ ($sd = 1.15$) $se = .074$
$p < .05$

Grief Intensity Scale:
1 = No Grief
7 = Total Devastation (suicide point)

Fig. 1 Mean score comparison on the Grief Intensity Scale for MZ and DZ twins. MZ: $n = 490$, $M = 6.03$ (SD = 1.05) $SE = 0.047$. DZ: $n = 240$, $M = 5.82$ ($SD = 1.15$) $SE = 0.074$. $p < 0.05$. Grief Intensity Scale: 1 = no grief, 7 = total devastation (suicide point)

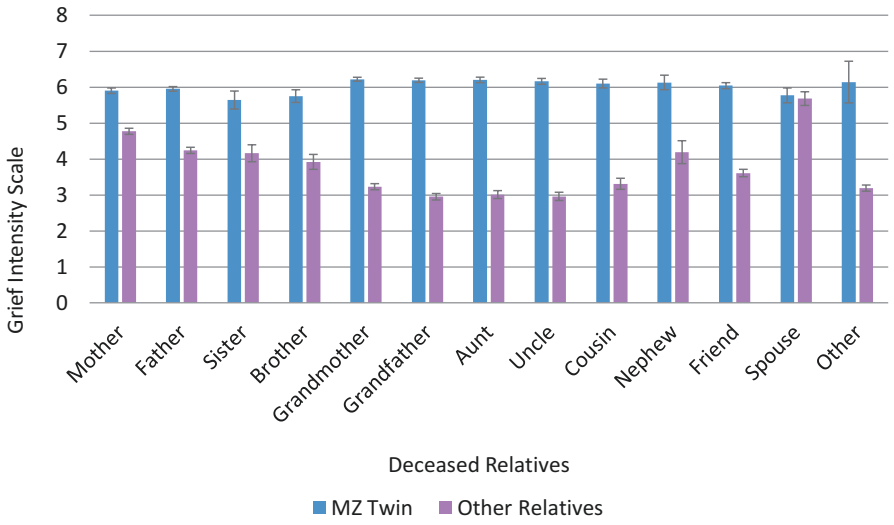


$p < .001$ for all comparisons, excluding spouse
Sample sizes: ($n = 13$ –351)

Grief Intensity Scale:
1 = No Grief
7 = Total Devastation (suicide point)

Fig. 2 Mean score comparisons on the Grief Intensity Scale for twins vs. non-twin relatives and others. $p < 0.001$ for all comparisons, excluding spouse. Sample sizes: $n = 13$–351. Grief Intensity Scale: 1 = no grief, 7 = total devastation (suicide point)

with male cotwins. The zygosity x cotwin sex interaction, while only approaching statistical significance [F (1,725) = 3.55, p = 0.060], was generally consistent with the expectation of greater grief among twins with deceased female cotwins. However, female twins with deceased male cotwins indicated especially high grief following the loss of their twin brother.

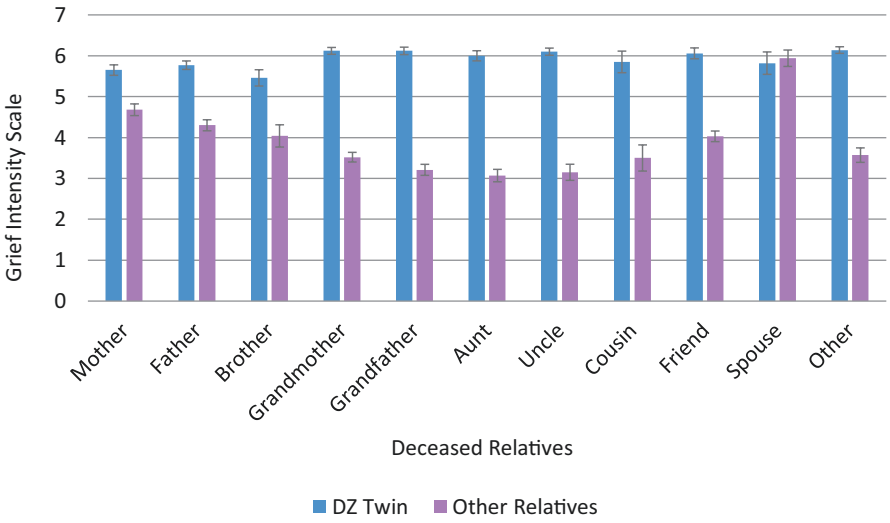


Sample sizes: (n = 16 –230)

p < .001 for all comparisons, excluding spouse; too few nieces were available for comparison

Grief Intensity Scale:
1 = No Grief
7 = Total Devastation (suicide point)

Fig. 3 (**a**) Mean score comparisons on the Grief Intensity Scale for MZ twins versus non-twin relatives and others. Sample sizes: n = 16–230. p < 0.001 for all comparisons, excluding spouse; too few nieces were available for comparison. Grief Intensity Scale: 1 = No grief, 7 = total devastation (suicide point). (**b**) Mean score comparisons on the Grief Intensity Scale for DZ twins vs. non-twin relatives and others. Sample sizes: n = 17–124; too few sisters, nieces, and nephews were available for comparison. p < 0.001 for all comparisons, excluding spouse. Grief Intensity Scale: 1 = no grief, 7 = total devastation (suicide point)



Sample sizes: (n = 17–124); too few sisters, nieces and nephews were available for comparison.

$p < .001$ for all comparisons, excluding spouse

Grief Intensity Scale:
1 = No Grief
7 = Total Devastation (suicide point)

Fig. 3 (continued)

Evolutionary Perspectives on the Loss of a Twin and Other Relatives

Uniting evolutionary perspectives with twin methodology is a fruitful undertaking, generating a range of tests of hypotheses regarding relative genetic commonality and social relatedness. The present analyses showed that genetically identical (MZ) twins express greater grief intensity following the loss of their cotwin than do genetically nonidentical (DZ) twins, consistent with kinship genetic theorizing. Additional support for this view is provided by the finding that twins, both as a group and as MZ and DZ twins separately, provided higher grief intensity ratings for their deceased cotwins than for other relatives who had passed away during their lifetime. Kinship genetic reasoning would not predict greater grief intensity among DZ twins, relative to non-twin siblings, due to equivalent genetic overlap. However, some DZ twins may be socially closer given their greater likelihood of shared social experiences. Finally, the greater grief intensity among twins with deceased female

cotwins, relative to twins with deceased male cotwins, while not statistically significant, was consistent with the evolutionary prediction derived from paternity uncertainty.

Two exceptional results are worth nothing. First, the ratings for spouse did not differ from the ratings for twin. This makes evolutionary sense in that a spouse represents a means by which ones' own genetic transmission takes place. Second, the ratings by surviving females from opposite-sex pairs nearly equaled those of the MZ females and slightly exceeded those of the MZ males. The relationship between DZ opposite-sex cotwins is unique, given that young females mature physically, intellectually, and socially ahead of males, often seeming to mother them (Koch, 1966; also see Segal, 2017a). These female twins' maternal-like attitude toward their brothers may partially drive their response to the loss. Note, however, that the twins in this study were identified on a volunteer basis, so it may be that only those DZ twins (both same-sex and opposite-sex) who were especially bereaved sought research participation. This recruitment method may, in fact, explain the small, although significant, mean difference in grief between twin types.

It is also worth noting that it is likely that the sample included an overrepresentation of bereaved MZ twins, relative to DZ twins. MZ twins represented 67% of the respondents, whereas the natural twinning rate predicts a percentage closer to 30–35%. It is suspected that this difference partly reflects the more devastating consequences of MZ twin loss. It is also the case that there was an unusually high percentage of female twins (74%). This may partly reflect the greater grief experienced upon losing a female cotwin (female twins with deceased male cotwins accounted for just 17% of the sample), the lesser longevity of human males (Gupta, 2003), and/or the greater willingness of females to seek research opportunities tied to love and loss. Volunteer twin samples are typically composed of two-thirds MZ twins and two-thirds female twins (Lykken, Tellegen, & DeRubeis, 1978).

Other studies have reported associations between genetic relatedness and bereavement response. The first study to investigate bereavement with reference to evolutionary predictions found that parental grief was higher for females than males, higher for healthy children than for sick children, and higher among maternal relatives than paternal relatives (Littlefield & Rushton, 1986). However, studies that were not guided by evolutionary perspectives also find that grief response varies with the genetic relatedness to the deceased individual (Parkes & Prigerson, 2010; Sanders, 1979–1980; Woodward, 1988).

A common albeit insensitive response by hospital staff to parents who have lost an infant twin is that "at least you have one living child." This remark raises the distinction between expected fitness and attained fitness (Pianka, 1978). Bereavement reflects a loss in expected fitness, but it is not clear if, and how, it is affected by attained fitness. It is possible to suppose that couples with several children experience the loss of a child less intensely than parents with one child or no children. However, the idea that having one surviving twin or having multiple children reduces depressive symptoms or a sense of loss has not been supported (Littlefield & Rushton, 1986; Wilson, Fenton, Stevens, & Soule, 1982).

Future Research and Applied Directions

An evolutionary perspective enables study of the functional significance of individual differences in bereavement. As such, it brings another level of analysis to bear upon relevant questions and issues. Future analyses will assess twins' current as well as recollected bereavement experiences, and examine age at loss for twins and their various deceased relatives. Given the relative lack of research in this area, greater attention on the part of evolutionary psychologists would be welcome.

At the applied level, findings from twin studies of bereavement have informed legal cases involving wrongful death from accidents and illnesses (Segal, 1993). The findings have also been of assistance to bereavement counselors unfamiliar with the twin loss experience. The twinning rate has increased dramatically over the last four decades in Western nations, due to (1) delayed childbearing that raises the chances of DZ twin conception, and (2) the increased use of assisted reproductive technology which makes multiple pregnancies more likely (Martin, Hamilton, Osterman, Driscoll, & Drake, 2018; Segal, 2017a). In the United States, the twinning rate rose from 18.9 per thousand in 1980 to 33.4 per thousand in 2016 (Martin et al., 2018). More focused attention on twin development, in general, and bereavement issues, in particular, is needed.

Acknowledgments This research was supported, in part, by senior research award to NLS. Graphic artist, an identical twin Kelly Donovan, created the figures and students Franci Niculae and Jamie Nelson assisted with the literature search.

References

Archer, J. (1988). The sociobiology of bereavement: A reply to Littlefield and Rushton. *Journal of Personality and Social Psychology, 55*, 272–278.

Archer, J. (1999). *The nature of grief: The evolution and psychology of reactions to loss*. New York, NY: Routledge.

Barash, D. (1979). *The whisperings within: Evolution and the origin of human nature*. New York, NY: Harper & Row.

Bryant, G., & Hazelton, M. G. (2009). Vocal cues of ovulation in the human female. *Biology Letters, 5*, 12–15.

Buss, D. M. (2019). *Evolutionary psychology: The new science of the mind* (6th ed.). New York, NY: Routledge.

Dawkins, R. (1982/1992). *The extended phenotype: The long reach of the gene*. Oxford: Oxford University Press.

Foy, A. K., Vernon, P. A., & Jang, K. (2001). Examining the dimensions of intimacy in twin and peer relationships. *Twin Research and Human Genetics, 4*(6), 443–452.

Galton, F. (1875). The history of twins as a criterion of the relative powers of nature and nurture. *Journal of the Anthropological Institute, 5*, 391–406.

Gupta, S. (2003). Why men die young. *Time,* May 12, 2004, p. 84.

Hamilton, W. D. (1964). The genetical evolution of human behaviour. *Journal of Theoretical Biology, 7*(1), 1–52.

Hofer, M. A. (1984). Relationships as regulators: A psychobiologic perspective on bereavement. *Psychosomatic Medicine, 46*(3), 183–197.
Keesee, N. J., Currier, J. M., & Neimeyer, R. A. (2008). Predictors of grief following the death of one's child: The contribution of finding meaning. *Journal of Clinical Psychology, 64*(10), 1145–1163.
Koch, H. L. (1966). *Twins and twin relations*. Chicago, IL: University of Chicago Press.
Littlefield, C. H. (1984). *When a child dies: A sociobiological perspective.* (Unpublished doctoral dissertation) Toronto, Ontario, Canada: York University.
Littlefield, C. H., & Rushton, J. P. (1986). When a child dies: The sociobiology of bereavement. *Journal of Personality and Social Psychology, 51*(4), 797–802.
Lykken, D. T., Tellegen, A., & DeRubeis, R. (1978). Volunteer bias in twin research: The rule of two-thirds. *Social Biology, 25*(1), 1–9.
Martin, J. A., Hamilton, B. E., Osterman, M. J. K., Driscoll, A. K., & Drake, P. (2018). Births: Final data for 2016. *National Vital Statistics Reports, 67*(1), 1–55. https://www.cdc.gov/nchs/data/nvsr/nvsr67/nvsr67_01.pdf
McIlroy, E. C. (2012). One half living for two: Cross-cultural paradigms of twinship and twin loss. *Omega, 64*(1), 1–13.
Mowrer, E. (1954). Some factors in the affectional adjustment of twins. *American Sociological Review, 19*, 468–447.
Nesse, R.M. (1990). Evolutionary explanations of emotions. Human Nature, 1(3), 261–289.
Nesse, R. M. (2005). An evolutionary framework for understanding grief. In D. Carr, R. M. Nesse, & C. B. Eortman (Eds.), *Spousal bereavement in late life* (pp. 195–226). New York, NY: Springer.
Nesse, R. M., & Williams, G. C. (1994). *Why we get sick? The new science of Darwinian medicine*. New York, NY: Times Books, Random House.
Neyer, F. J. (2002). Twin relationships in old age: A developmental perspective. *Journal of Social and Personal Relationships, 19*(2), 155–177.
Nichols, R. C., & Bilbro Jr., W. C. (1966). The diagnosis of twin zygosity. *Human Heredity, 16*(3), 265–275.
Parkes, C. M., & Prigerson, H. G. (2010). *Bereavement: Studies of grief in adult life* (4th ed.). London: Routledge.
Pianka, E. R. (1978). *Evolutionary ecology* (2nd ed.). New York, NY: Harper & Row, Publishers.
Polderman, T. J., Benyamin, B., de Leeuw, C. A., Sullivan, P. F., van Bochoven, A., Visscher, P. M., et al. (2015). Meta-analysis of the heritability of human traits based on fifty years of twin studies. *Nature Genetics, 47*(7), 702–709.
Sanders, C. M. (1979–1980). A comparison of adult bereavement in the death of a spouse child and parent. *Omega, 10*, 303–322.
Segal, N. L. (1984). Cooperation, competition and altruism within twin sets: A reappraisal. *Ethology & Sociobiology, 5*(3), 163–177.
Segal, N. L. (1993). Implications of twin research for legal issues involving young twins. *Law and Human Behavior, 17*, 43–58.
Segal, N. L. (1999/2000). *Entwined lives: Twins and what they tell us about human behavior*. New York, NY: Dutton/Plume.
Segal, N. L. (2017a). *Twin myth conceptions: False beliefs, fables, and facts about twins*. San Diego, CA: Elsevier.
Segal, N. L. (2017b). Ethological studies using twins: Doing what comes naturally. *Human Ethology Bulletin, 32*(4), 35–43.
Segal, N. L., & Blozis, S. A. (2002). Psychobiological and evolutionary perspectives on coping and health characteristics following loss: A twin study. *Twin Research, 5*, 175–187.
Segal, N. L., Hershberger, N. L., & Arad, S. (2003). Meeting one's twin: Perceived social closeness and familiarity. *Evolutionary Psychology, 1*, 70–95.
Segal, N. L., & Marelich, W. D. (2011). Social closeness and gift giving by MZ and DZ twin parents toward nieces and nephews: An update. *Personality and Individual Differences, 50*, 101–105.

Segal, N. L., & Montoya, Y. S. (2018). *Accidental brothers: The story of twins exchanged at birth and the power of nature and nurture*. New York, NY: St. Martin's Press.

Segal, N. L., Munson, J. E., Marelich, W. D., Goetz, A. T., & McGuire, S. A. (2014). Meeting of minds: Tacit coordination in monozygotic and dizygotic adolescent and adult twins. *Personality and Individual Differences, 58*, 31–36.

Segal, N. L., & Ream, S. L. (1998). Decrease in grief intensity for deceased twin and non-twin relatives: An evolutionary perspective. *Personality and Individual Differences, 25*(2), 317–325.

Segal, N. L., Sussman, L. S., Marelich, W. D., Mearns, J., & Blozis, S. A. (2002). Monozygotic and dizygotic twins' retrospective and current bereavement-related behaviors: An evolutionary perspective. *Twin Research, 5*(3), 188–195.

Segal, N. L., Wilson, S. M., Bouchard Jr., T. J., & Gitlin, D. G. (1995). Comparative grief experiences of bereaved twins and other bereaved relatives. *Personality and Individual Differences, 18*(4), 511–524.

White, C., & Fessler, D. M. (2013). Evolutionizing grief: Viewing photographs of the deceased predicts the misattribution of ambiguous stimuli by the bereaved. *Evolutionary Psychology, 11*(5), 1084–1100.

Wilson, A. L., Fenton, L. J., Stevens, D. C., & Soule, D. J. (1982). The death of a newborn twin: An analysis of parental bereavement. *Pediatrics, 70*(4), 587–591.

Woodward, J. (1988). The bereaved twin. *Acta Geneticae Medicae et Gemellologiae, 37*(2), 173–l80.

Beyond the Search for *Suigiston*: How Evolution Offers Oxygen for Suicidology

C. A. Soper

From the 1660s until the discovery of oxygen in the 1770s, scientists searched for *phlogiston*, a fiery element believed to be released when substances burn. It is easy to understand why the phlogiston idea persisted for so long: when things burn they emit flames and smoke and give every impression of discharging some elemental material. But despite the intuitive plausibility of the theory and the combined efforts of a scientific community over more than a century, phlogiston was never found.

Suicide researchers, also for more than a century, have sought something that I argue is as elusive as phlogiston—the conditions that predictably lead people to take their own lives. Let us call this hypothetical entity *suigiston*. Challenging a consensus, I offer three reasons to doubt that suigiston will be found. First, there is no empirical evidence that it exists. Second, there is no theoretical foundation for the notion either. Third, beyond absence of evidence, evolutionary theory provides positive evidence of suigiston's non-existence, on the grounds that we can expect natural selection to have exhausted any and all utilizable markers of suicide risk. In other words, suicide is predictably unpredictable. I will begin by drawing attention to the near universality of suigiston as premise in suicidology: so immersive is the assumption that it may be hard initially to perceive.

Suigiston as a Paradigm

The suigiston idea, that suicide follows patterned and discoverable causation, can be traced to some of the earliest scientific work in the domain. Durkheim's sociological study more than a century ago set out to "determine the nature of the social causes" of suicide (1897/1952, p. 52), a mission implicitly founded on the premise that such causes were there to be determined. Although Durkheim claimed that he had

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T. K. Shackelford, V. Zeigler-Hill (eds.), *Evolutionary Perspectives on Death*,
Evolutionary Psychology, https://doi.org/10.1007/978-3-030-25466-7_3

successfully "showed the springs from which the chief suicidogenic currents flow" (p. 373)—he cited extremes of social integration and deregulation as responsible—few researchers would subscribe to the entirety of his model today. Searching for causation at an individual level rather than a societal level, psychoanalytic psychiatry took up conceptually the same challenge in the early decades of the twentieth century, but reached less assured conclusions. Zilboorg (1936) sums 25 years' exploration of supposedly suicidogenic unconscious drives by Freud and his followers by commenting,

> "… it is clear that the problem of suicide from the scientific point of view remains unresolved. Neither common sense nor clinical psychopathology has found a causal or even a strict empirical solution" (p. 271).

Many more theories have been proposed since. Researchers variously argue that the drivers of suicide may be social (e.g., Chandler & Proulx, 2006; Gunn, 2017), cultural (e.g., Chu, Goldblum, Floyd, & Bongar, 2010), psychological (e.g., O'Connor, 2011), psychiatric (e.g., Oquendo & Baca-Garcia, 2014), neurochemical (e.g., Mann & Malone, 1997), genetic (e.g., Roy, Rylander, & Sarchiapone, 1997), sociobiological (deCatanzaro, 1981), a matter of parasite infestation (Aubin, Berlin, & Kornreich, 2013) or economics (e.g., Yeh & Lester, 1987). Some claim that causation is visible to workers with special training (e.g., WHO, 1996), others suggest that it may be more detectable by machine (e.g., De Luc, Fatemi, & Hettige, 2017), while still others say it requires a mix of quantitative and qualitative methods (e.g., Rogers & Apel, 2010). Many hold causation to be a composite of elements; it may be a cocktail of ingredients (e.g., Mann, Waternaux, Haas, & Malone, 1999; Van Orden et al., 2010) or a temporal sequence of conditions (e.g., Baumeister, 1990; Maris, 1991). Some take a typological approach, as Durkheim did, on the grounds that different drivers may apply to different types of suicide.[1] Other theorists advance protective factors that may help predictively to distinguish suicidal from non-suicidal outcomes (e.g., Johnson, Wood, Gooding, Taylor, & Tarrier, 2011). And so on. Despite this abundance of alternatives, Durkheim's model endures as a prominent theoretical framework (Selby, Joiner, & Ribeiro, 2014), but not to the extent that it attracts a consensus of support among researchers. It probably never did, as the early and divergent path of the psychoanalysts indicates. But then, no other proposal has won a consensus either. The pattern, rather, is that rival theories accumulate, to the extent that not far into twenty-first century they can be catalogued by the dozens (Gunn & Lester, 2014). They may indeed be multiplying (Gunn, 2019; O'Connor & Portzky, 2018).

Viewing this plethora of models, Franklin et al. (2017, p. 188) reckon that suicidology is "still in a preparadigmatic phase", alluding to the earliest stage of development of a scientific field, as described by Kuhn (1962), when diverse and unconnected ideas abound about the fundamental nature of the phenomenon in question. I dis-

[1] This chapter accepts the need for a typological approach in that it focuses on personal, solo, self-killings—what Cholbi (2017) calls "run-of-the-mill" suicides. It may be that self-killing is an expectable outcome of physician-assisted suicide (Battin, 1998), voluntary executions (K. L. Johnson, 1980), and perhaps other exceptional forms of homicide.

agree. Notwithstanding their outer diversity, I suggest all suicide theories, or virtually all, follow a seamless conceptual continuity. They retain Durkheim's and Freud's implicit premise that suicide results from identifiable contingencies. The prevailing agenda does not question the existence of proximal causation; rather, it presumes causation, and jumps to asking what that causation is. Franklin et al. themselves remark on this point of unanimity, observing that "Each STB [suicidal thoughts and behavior] theory specifies a unique set of risk factors (or specifies a unique relation among a set of risk factors) that drive STBs" (p. 188). Understandably, the focus on suicide's supposed drivers is intended to save lives: if usefully predictive risk or causal factors could be found, then it may be hoped that deaths could be forestalled by targeted countermeasures. The pervasiveness of this assumptive framework can be inferred from statements such as one by the World Health Organization (WHO) that "identification of risk and protective factors is a key component of a national suicide prevention strategy, and can help determine the nature and type of interventions required" (WHO, 2012, p. 13). Accepted at this international level, the notion that suicide follows from identifiable conditions can be seen to prevail as a fully global paradigm.

It may be unpopular, almost heretical, to suggest that the long-standing theoretical basis of a research community may be misplaced, but, as adverted earlier, this chapter offers three reasons to doubt that suigiston exists. I will discuss, first, the failure to find empirical evidence; second, the failure of suicide theories to offer causal explanation; and third, evolutionary analysis which suggests that natural selection would already have exploited and eliminated available predictors of self-killing.

Absence of Empirical Evidence for Suigiston

Although it is often impossible to prove nonexistence by exhaustive survey, it may be taken as a clue that, despite a broad and concerted search over many decades, no empirical evidence has emerged to justify the idea that suicide is the likely outcome of any particular set of circumstances. This absence of evidence is apparent in a consistent failure of risk assessments to predict suicide. Even among clinical populations of psychiatric patients (i.e., a group of people who may be significantly more prone to suicide than are members of the general population, and about whom a wealth of data is often available), the great majority, some 95%, of those classified as "high risk" do not go on to take their own lives (Large, 2017). Most suicides occur among those who would be assessed as "low risk." Several recent meta-analyses, together covering dozens of longitudinal studies published across half a century, find that effect sizes—the power of risk factors to predict suicidality—are clinically useless and forecast suicides little or no better than would happen by chance (Carter et al., 2017; Chan et al., 2016; Franklin et al., 2017; Large et al., 2016).

That multiple meta-analyses should independently arrive at much the same result is all the more convincing in view of their use of different methodologies; with

different inclusion criteria, they draw on different samples of studies (Large, 2017). It is particularly striking that they find no evidence of progress (Franklin et al., 2017; Large et al., 2016): from their analysis of hundreds of studies into hypothesized drivers of suicidal thoughts and behaviors, Franklin and colleagues track an exponential growth in research, output doubling each decade since the 1960s, and yet risk factor effect sizes have remained consistently weak. There has not even been the discovery of a signpost that might point the way to progress—a cluster of large effects that could suggest hope lies in certain types of factors or moderators (e.g., length or size of study). Larger samples, for example, produce greater statistical confidence, but no better predictive utility.

The conclusions drawn from this protracted, but fruitless, search are interesting. Not unexpectedly, there has been acceptance in some quarters that suicide risk assessments are unproductive (Mulder, Newton-Howes, & Coid, 2016; NICE, 2011). They may be worse than unproductive: futile, laborious procedures in clinical settings incur, among other potential downsides, an opportunity cost in time that health workers could have put to better use. Curiously, a corollary opportunity cost is apparently not perceived, or at least little reported, among researchers engaged in a continuing effort to identify predictors of suicide. Carter et al. (2017, p. 392) describe as "phenomena" the continuing flow of papers arguing in the face of the evidence in favor of the risk assessment approach, alongside a continued recommending of such unproven methods by prominent suicide prevention bodies—up to and including the WHO (2012). It may be a comparable phenomenon that, with few exceptions (Lester, 2019a), the fundamental soundness suicide prediction as a research goal remains largely unquestioned: the failure to date is viewed, rather, as a technical matter, to be addressed by yet more, and yet more sophisticated, empirical research. Franklin et al. (2017) advocate the investigation of novel factors, in combinations, and over shorter timeframes, and for the development of computerized algorithms. Extending the latter idea, Kessler et al. (2019) envision "big data analytics" as a potential adjunct for use alongside other (also unproven) methods. It would not be the first time that hopes have been pinned on a change of technique: Carter et al. note that generations of approaches have gone before, from unaided clinical interviews, through standardized scales and biological tests, to scales built from statistical models. Perhaps we can hope for a methodological breakthrough, but I suggest that suicidology could alternatively take the hint. The aggregate blank drawn from decades of studies could be accepted as indicating at least the possibility that the thing that researchers have tried long and hard to find may not be there.

Unpredictable Because It Is Rare? Or Rare Because It Is Unpredictable?

One often cited explanation for this inability to predict suicide warrants particular scrutiny. Suicide's unpredictability has long been ascribed to its rarity. Carter et al. (2017, p. 391), for example, quote a judgment made decades ago by Rosen (1954)

that "Suicide is an infrequent event and its prediction is subject to the limitations found in the prediction of any infrequent behavior or event" (p. 391). There is indeed a practical limitation inherent in Bayesian risk assessments of rare events, inasmuch as a base rate, an a priori view about their probability, is built into the methodology (Large, 2013). Even with an unrealistically powerful risk assessment tool, an event that starts out being as improbable as suicide becomes only slightly less improbable in the light of the assessment (Large, Ryan, Singh, Paton, & Nielssen, 2011). I suggest, however, that to offer this mathematical point as a reason for the failure of suicide risk assessment does little to advance an understanding of the underlying research problem. Suicide is not infrequent in an epidemiological sense: terminating at least 1.4% of human lives (WHO, 2014), it is not an uncommon way to die. Suicide looks infrequent as a statistical event because we have no means of narrowing the field of vision towards those likely to do it.

To illustrate with a contrast, deaths following diagnoses of certain unusual medical pathologies, such as Lesch-Nyhan syndrome, Ebola, and some late-stage cancers, may in principle be forecast to occur within a definite time span with some grim confidence. Suicide is less predictable than deaths from, say, Ebola not because suicide is less rare—many times more people die by suicide than from Ebola.[2] The difference is that deaths from Ebola are epistemologically known a priori to occur at a high base rate within a definable reference group—i.e., people infected with the Ebola virus: some 40% of those infected die within a few weeks. Unfortunately, no equivalent theoretical criterion or etiological model exists with which to isolate a population with a high base rate of suicide. Indicative of the order of magnitude, although adolescents who self-harm are known to be at a significantly heightened risk of taking their own lives, it is nonetheless the case that, thankfully, of young people presenting to emergency departments due to self-harm, just 1.6% will suicide even over as extended a period as the following year (Carroll, Metcalfe, & Gunnell, 2014). So, if a risk assessment tool were to isolate a pocket of hospitalized adolescent self-harmers who were double or even three times more at risk than the average for that group, it would still be the case that over the following 12 months more than 95% of this "high-risk" subgroup would not take their own lives. In the absence of a medical theory, or any other kind of theory, that points to an identifiable reference group with a high base rate, and in contrast to Ebola, we can predict suicide only in terms of thin dispersals across undifferentiable populations, such as, most broadly, a worldwide annual rate in the order of 11.4 per 100,000 (WHO, 2014). In a practical sense, then, suicide is rare because it is unpredictable.

The point of this detour is to move beyond a formulaic, and circular, alibi that infrequency explains our inability to predict suicide. Suicide's rarity and unpredictability are two sides of the same coin: to understand one, we need to understand the other. An evolutionary model that may shed light on both is discussed later in this chapter. In the meantime it is important to note that suicide's unpredictability, and apparent rarity, is linked to a blind spot in suicide theory.

[2] There were 5157 deaths from Ebola in the 2014 outbreak (Kalra et al., 2014). According to the WHO (2014), there are globally some 800,000 suicides per year.

Absence of Theoretical Evidence for Suigiston

The second reason to doubt the existence of suigiston is that, despite more than a century of theorizing, there remains little if any logical reason to expect it to exist. The criticism may feel harsh to those laboring in the field, but no theory known to this author has yet explained why suicide specifically, as opposed to something else, should result from any particular set of contingencies. Gibbs and Martin (1964) and others have pointed out that Durkheim's posited sociological drivers of suicide could apply to almost any deviant behavior, exemplifying an explanatory gap which Atkinson (1978) identifies in Gibbs and Martin's own theorizing, and finds rife elsewhere:

> … as is usual with almost all post-Durkheimian studies of suicide, it is nowhere spelled out precisely how the independent variable (be it social integration, status integration, lack of external restraint or whatever) is linked with the dependent variable (suicide rates). In other words, a characteristic feature of such works…is the failure to explain why suicide in particular, rather than some other course of action, is a likely consequence of the particular structural condition posited as the independent variable (pp. 14–15).

Atkinson directs this complaint at sociological theorizing, but I suggest that it can also justifiably be levelled at the bulk of psychological, biomedical, and other suigiston models. Suicide theories are often presented with the aid of flow diagrams along the lines of

[Fx, Fy, Fz] → suicide

with the hypothesized suigiston, i.e., [Fx, Fy, Fz], shown in boxes or circles, from which arrows point towards suicidality (e.g., Gunn, 2017; Klonsky & May, 2015; Mann, 1998; Maris, Berman, Maltsberger, & Yufit, 1992; O'Connor, 2011; Turecki, 2005; van Heeringen & Mann, 2014; Van Orden et al., 2010). Flowcharts serve as useful visual aids (Gunn, 2019). But, as Tryon (2016) points out with regard to this style of presentation generally in psychology, arrows are not explanations: "These arrows are proxies for mechanism information, which is claimed but never provided" (p. 277). They thereby skip over the open possibilities that not all everyone with [Fx, Fy, Fz] will try to kill themselves, and/or suicides may occur without detectable [Fx, Fy, Fz].

To take a recent illustration of the problem, the Interpersonal Theory of Suicide (IPTS)[3], a currently prominent model advanced by a leading suicidologist (Joiner, 2005), claims that suicide derives from a combination of three factors: a desire for suicide arising from (1) a thwarted desire to belong together with (2) a feeling of being a burden to loved ones, and (3) a habituation to pain or other acquired capability to carry out a suicide act. These are offered as "three conditions that, when present simultaneously, are sufficient to result in lethal (or near lethal) suicide attempts" (Van Orden et al., 2010, p. 599). It may be true that these states are concomitant with many suicides, and IPTS's developers can be lauded for drawing attention to

[3] For general critiques of IPTS and its variants, see Hjelmeland and Knizek (2019) and Paniagua, Black, Gallaway, and Coombs (2010).

such a pattern. The difficulty is that for each posited input it is possible also to conceive of any number of *non*-suicidal responses. Thwarted belongingness could plausibly induce not suicide but a redoubling of the person's efforts to connect with others, perhaps by joining a dating service, a church, or a sports club; or the isolated individual could adjust to the situation, perhaps to take up solitary pursuits or a meditative lifestyle. Less positively, frustrated interpersonal attachments could lead the way to other, not ordinarily suicidal, deviant behaviors—including substance abuse (Arthur, Hawkins, Pollard, Catalano, & Baglioni, 2003), homicide (Waesche, Clark, & Cropsey, 2016), and other forms of psychopathology and delinquency (Harris, 2000; Hirschi, 1969). IPTS's second causal factor, a feeling of being a burden, could plausibly be relieved by, say, making a resolution to be more helpful, seeking advice or therapy, or distraction in work or recreational pursuits. Real burdensomeness could be resolved—and, as Wright (1994) argues, with better genetic logic—not by suicide but by the troublesome individual wandering away from the people being encumbered, perhaps on the chance, however slim, of being more useful elsewhere. Likewise, IPTS's third component, an acquired capability for suicide, need not translate into a suicidal act. Suicidality can be unlearned as well as learned (Goldney, Smith, Winefield, Tiggeman, & Winefield, 1991), as illustrated by a cohort of 32 young suicide attempters, a third of whom (ten) had apparently forgotten their attempts by the time they were followed up a few years later (Brezo et al., 2007). This forgetting about suicide may explain the statistical paradox that adolescents tend to report more lifetime attempts than adults do (Nock et al., 2012). Missing from IPTS and similar proposals is an explicit account of the implied switching gear which, due to the posited causal factors, supposedly diverts people down the track of suicide as opposed to any other track.

Similarly unaddressed is the question of why suicide can occur seemingly in the absence of the alleged casual factors. My experience as a therapist includes incidents of self-killings by people who showed no evidence to close family, or at least no serviceably clear evidence, of thwarted belongingness or perceived burdensomeness, and whose only acquired capability for suicide was apparently the minimal know-how needed to tie a noose, fire a gun, or crash a car. In other words, relatives had no particular reason to anticipate suicide based on the criteria of IPTS—or any other prominent model for that matter. This is not an abnormal scenario. Indeed, contrary to what suigiston theories would have us believe, it seems to me likely that most suicides are preceded by zero utilizable pre-indication, as can be inferred from the characteristic immediate reactions of the bereaved: shock, disbelief, and confusion (Chow, 2006). Finding few, if any, clues with which to make sense of the act, significant others are typically left bewildered (Jordan, 2001, 2008; Jordan & McIntosh, 2011; Wertheimer, 2014). Granted, family members sometimes report in retrospect a feeling that "things were just not quite right" (Lynn, 2011, p. 145)—there may have been talk of suicide, and/or past incidents of self-harm—but the grounds for such vague unease fall decisively short of constituting reasonable, realistic, portents: rather, suicide strikes "like a bolt of lightning out of clear blue sky" (Dyregrov, Plyhn, & Dieserud, 2012, p. 36). Loved ones are nevertheless tormented, irrationally, by feelings of responsibility and guilt (Cain & Fast, 1966; Miles & Demi,

1992). An intense, irrational, guilt is often also felt by suicides' therapeutic professionals (Greenberg & Shefler, 2014; Hendin, Haas, Maltsberger, Szanto, & Rabinowicz, 2004). I suggest that IPTS and other suigiston models do no service to grieving families, friends, and therapists by implying, with dubious logic, that specific actionable warning signs or causal factors might have been observed but which presumably went unnoticed or disregarded.

For sure, statistically significant correlations between measures of suicidality and hypothesized suicidogenic factors can be found. These are widely proffered as empirical support for sundry suigiston theories, IPTS included (e.g., Cha, Najmi, Park, Finn, & Nock, 2010; Chu et al., 2017; Gunn & Lester, 2014; Joiner et al., 2009; O'Connor & Portzky, 2018; Troister & Holden, 2010; van Heeringen & Mann, 2014). But, recalling Tryon (2016), if arrows do not explain suicide then, in the normal sense of the word "explain," neither do correlations—they too provide no mechanism information. Nor do suigiston theories explain much in a statistical sense, as has already been discussed. With a large enough sample, a great many risk and protective factors emerge as statistically significant, but still uselessly weak, predictive tools. Franklin et al. (2017) count such constructs by the thousands. If statistical significance were the mark of a successful theory then it may be that, to borrow the words of Hankoff and Turner (1980), almost "any theoretical framework is doomed to some success since there is something in suicidal behavior for every point of view" (p. 280).

Lacking explicit causal connectors, suigiston theories hypothesize conditions that *may* lead people to take their own lives—but then again, may not. A situation in which no suicide theory can account specifically for suicide (at least not far beyond the satisfaction of its author's research group) could be expected to produce chronic and observable disarray in suicide research. This indeed is the state of play. As noted earlier, the field is beset by a long-standing, ongoing, and possibly accelerating proliferation of rival theories (Gunn & Lester, 2014; Klonsky, Saffer, & Bryan, 2018; O'Connor & Portzky, 2018), all or almost all variations on the suigiston theme. None has the explanatory power to marshal a consensus of support, and each new theory merely invites ad hoc extensions and yet more competing proposals. Thus it was with phlogiston: Kuhn (1962) observes that, towards the close of the phlogiston paradigm's reign, there were almost as many phlogiston theories as there were chemists studying combustion, each theory being promoted by its author.

Folk Psychology in Suicide Research

The curiosity of suicidology's attachment to suigiston is that science offers no principled objection to the opposite stance; that suicide, like many natural processes, although not random, may nonetheless not be amenable to prediction (Rogers & Lester, 2010). From within suicidology, Rogers (2001, p. 24) makes the point by quoting a psychologist, Lykken (1991, p. 18–19):

> A natural scientist is not embarrassed because he cannot look at a tree and predict which leaves will fall first in the autumn or the exact path of the fall or where the leaf will land. Maybe individual lives are a lot like falling leaves; perhaps there is a very limited amount one can say about the individual case, based on a knowledge of leaves in general or people in general, without detailed, idiographic study of that particular case and even then it is hard to know how the winds will blow from one day to the next.

On the other hand, it is easy to see the psychological appeal of suigiston. To consider suicide as an intrinsically unpredictable, near-random, event, may be a lot to ask of clinicians and researchers, even though the proposition is scientifically plausible. As professionals they have, in a literal sense, a responsibility: they are expected to have the ability to respond. People bereaved by suicide find themselves trapped in what Campbell (2001) describes as the "Canyon of Why," trying, as Myers and Fine (2006, p. 1) put it, to "explain the inexplicable." A central question "*Why* did he/she do it?" characterizes their grieving (Begley & Quayle, 2007; Jordan, 2001). I suggest a generalized form of the same question ultimately transfers onto the agenda of suicidology, which duly generates answers along the lines of "*Why* people kill themselves" (e.g., Joiner, 2005; Lester, 1992; Shneidman, 1996). And then of course, beyond dealing with professional demands, suicidologists are human beings. I hazard that many have been affected by suicide in their personal lives—as many, perhaps most, people are (Cerel et al., 2019; Hom, Stanley, Gutierrez, & Joiner, 2017; Kessler et al., 2012). For some, as Joiner (2005, 2010), O'Connor (2018), and deCatanzaro (Bering, 2018) disclose was the case for them, their dedication to the field may have been galvanized at least in part by a yearning to comprehend the suicide of a loved one. Other writers, like Bering (2018), may have felt called to understand their own suicidality. I suggest that, for experts and laypeople alike, suigiston theories reflect a universal human motivation: we feel impelled, to quote Myers and Fine again, to "make sense of what seems senseless" (p. 1). One can surmise possible functions for such a meaning-making tendency especially in the context of suicide—a "*Why?*" for the "*Why?*" Perhaps we need explanations as an existential anchor, to show that our cause-and-effect mental model of the world remains valid and that order still prevails (W. E. Davis & Hicks, 2013). Perhaps we seek to prevent contagion, inasmuch as if suicide had predictable causation then we could be on better guard: the bereaved are characteristically fearful that another in the family may follow (Begley & Quayle, 2007). Perhaps it is the extraordinary extent of suicide's social deviance and psychic fallout that demands an account. Perhaps these three suggestions are facets of a unitary psychological need.

Whatever the precise motivation, the notion that suicide must have meaning, some identifiable cause, feels simply and self-evidently right and invites no further questioning. The selection of causation appears to be a secondary matter, guided by the codes and worldview of the prevailing culture (J. M. Atkinson, 1978; Brown, 1986; Counts, 1991; Douglas, 1967; Knizek & Hjelmeland, 2007; Lester, 2019b). Suicides in non-Western societies are often attributed to shame, vengeance, and other interpersonal motivations, or to witchcraft, malevolent ancestors, evil spirits, and other supernatural forces (Bohannan, 1960; Hezel, Rubinstein, & White, 1985; Mishara & Tousignant, 2004; Mugisha, Hjelmeland, Kinyanda, & Knizek, 2013;

Syme, Garfield, & Hagen, 2016). Among the Aguaruna in Peru and the Busoga in Uganda, people kill themselves for no passably good reason are said simply to be "stupid" (Brown, 1986) or "with little brain" (Fallers & Fallers, 1960). Popular rationales shift over time with changing social attitudes (Solano, Pizzorno, Pompili, Serafini, & Amore, 2018). Supernatural forces were commonly cited in seventeenth-Century England, supplanted in the eighteenth century by varying notions of illegality and insanity (MacDonald & Murphy, 1990). Today a characteristic, psychosocial style of explaining prevails—observable, as Atkinson (1978) points out, in tidy biographical backstories of suicides constructed and recorded by newspaper reporters, witnesses, and coroners' officers. This commonsense Western-style theorizing tallies with prominent causal themes "discovered" by suicidologists, an accord that is unsurprising given that coroners' and lay observers' intuitions guide the categorizing and justifying of certain sudden deaths as "suicide" and hence generate much of suicidology's statistical and narrative raw material (Douglas, 1967). Suicide attempters, who, as Atkinson observes, are likely familiar with the acceptable scripts, may be inclined to shape their own accounts to fit. From this perspective, suicidologists, coroners, observers, and even the actors themselves appear to be joined in a communal business of post-rationalization. Atkinson concludes,

> *The 'theorizing' which we have observed, then, can be viewed as providing for the social organization of sudden deaths by rendering otherwise disordered and potentially senseless events ordered and sensible*. Our observations also suggest, however, that expert suicidologists, whether they be professional sociologists, psychiatrists or whatever, are engaged in similar practices (p. 173; original italics).

If this assessment is correct, despite their expression in sometimes technical language, suicide theories may be understood as artifacts not so much of science but of folk psychology, the domain of "what we all know" about the workings of our own and others' minds (Bering, 2002; Dennett, 2013). In this respect, too, suigiston resembles phlogiston: a "folk chemistry" observation of combustion is that something is self-evidently being given off (phlogiston)—so, what is it? The commonsense response to suicide may follow a similar path: there self-evidently has to be a reason (suigiston)—so, what is it? I argue, indeed, that a substrate of intuition underlies much of suicide theory, observable in at least three interconnected threads woven into the literature: anthropomorphism, the moralistic fallacy, and the notion of a survival instinct. It is possible, interestingly, to find links to evolutionary thinking in each.

Anthropomorphism, the first of these strands, may be described as "attributing human characteristics—specifically mental states—to nonhuman entities" (Caporael & Heyes, 1997, p. 60). More precisely for this discussion, I suggest that there is a tendency to equate human and nonhuman mental states in ways that do not always help to advance scientific understanding. There is scant empirical or theoretical evidence that suicide—deliberate, intentional self-killing—is, or even could be, anything other than a uniquely human phenomenon (Bering, 2018; Maltsberger, 2003; Preti, 2011b, 2018; Soper, 2018). Notwithstanding appeals for open-mindedness (Peña-Guzmán, 2017) and a heritage of animal suicides in folklore, anecdote, and

outright fakery (Chitty, 1996), and despite an experimental search stretching back at least to the nineteenth century (Ramsden & Wilson, 2010), no animal model of suicide is yet known to science (Comai & Gobbi, 2016; Preti, 2011a). Nonetheless, purportedly suicide-like nonhuman behaviors are widely co-opted, more or less uncritically, as footings for suicide theory (e.g., Chiurliza, Rogers, Schneider, Chu, & Joiner, 2018; Goldney, 1980; Joiner, 2005; Joiner & Stanley, 2016; Lester & Goldney, 1997; O'Connor, 2011; Williams, 1997). A seminal paper by deCatanzaro (1980) titled "Human suicide: A biological perspective" seems to presuppose (despite being unable to pin down) a nonhuman counterpart. Joiner conflates suicidality with the apparently self-destructive tactics by which non-reproducing castes of wasps, ants, and other eusocial species sometimes defend their colonies (Joiner, 2010; Joiner, Buchman-Schmitt, Chu, & Hom, 2017). Rarely discussed in these comparisons are likely categorical differences between nonhuman behaviors and (human) suicide. Challenging the notion of suicidal insects, and towards generally concluding that he "must answer the question of animal suicide with a probable no" (p. 279), W. J. Hamilton (1980)[4] explains an important, often overlooked, discontinuity arising from the special haplodiploid genetics of hymenopterans:

> A worker honeybee is not committing suicide when it stings a bear on the nose, pulls away its stinger, and loses its life, any more than a lizard is doing so when its tail breaks away in the extreme emergency of an attack. Energy is gone, but reproductive potential remains if the evasive tactic is successful. Suicide of a biological individual is not involved (p. 279).

A second, connected, thread of intuition in suicide theory is, I suggest, the moralistic fallacy, the way human emotional responses "present the world to us as having certain value-laden features" (d'Arms & Jacobson, 2000, p. 66), and the way science sometimes conflates these values with facts (B. D. Davis, 2000). Illustrating the pervasiveness of disapproving evaluations in this domain, one might note Hamilton's (1980) *en passant* use, above, of the legalistic term "commit," as in "committing suicide." With its connotations of illegitimacy, deviance, and disapprobation and in spite of the decriminalization of suicide across most of the world, the "C" word (Beaton, Forster, & Maple, 2013) continues to appear in scientific literature (e.g., Peña-Guzmán, 2017). Some form of negative moral outlook on suicide is both a near-universal human feature (Fedden, 1938) and an expectable evolutionary outcome: selection would be anticipated powerfully to favor a stigma against suicide as a socially propagated defense, helping to keep the option of self-killing safely unthinkable for most people most of the time (Humphrey, 2018; Miller, 2008; Soper, 2018). Suicide researchers as members of the community may, despite themselves, be as susceptible as anyone else to view the behavior through these generally protective, culturally informed, dark glasses. The value judgement arguably implicit in modelling suicide as a "derangement" (Joiner et al., 2017) has been called out (Gorelik & Shackelford, 2017), and I would question along similar lines psychiatry's efforts to mark out a suicidal behavior "disorder" (APA, 2013,

[4] Not to be confused with W. D. Hamilton, author of the primary texts on this topic (eg, 1972).

p. 801). I also suggest that the moralistic fallacy (jumping from "ought" to "is") sometimes presents as the inverse—as the naturalistic fallacy, making the leap from an allegedly factual "is" to a moralizing "ought." An ancient and intuitive abhorrence of suicide has been rationalized by the argument "It's unnatural, so it's wrong" at least since the writings of the thirteenth-century theologian Thomas Aquinas (Fedden, 1938; Miller, 2008). Zilboorg (1936) observes that this medieval stance carries forward into the scientific discourse largely intact:

> … the intellectual and moral evaluation has changed comparatively little, and this estimation, humanized and couched in the scientific terms of modern psychopathology, remains negative; to put it in the words of one of the most recent students of suicide: "It is opposed to the instinct of self-preservation and is therefore a typical perversion" (p. 270).

A third related thread, exemplified in the above extract from Zilboorg (1936), is an ages-old assumption that suicide is "opposed to the instinct of self-preservation" (p. 270)[5]. The idea resurfaces in the twenty-first century as a founding premise for IPTS: Joiner et al. (2017) posit factors that may "contribute to an individual's ability to overcome his or her innate biological instinct for survival and to ultimately enact lethal self-harm" on the grounds that suicide "is in direct opposition to a fundamental biological imperative (i.e., strong instinct for self-preservation)" (pp. 240, 242). This supposed instinct is well described as "one of the most hallowed notions of human nature" (Beck, Kovacs, & Weissman, 1975, p. 1146) but not everyone finds its deployment in suicide theory helpful—such as Chandler and Proulx (2006), who censure "easy talk of some sort of 'survival instinct'" (p. 127). In their words,

> Long ago social scientists learned that the bad habit putting "instinct to …" in front of every behavior in need of explanation amounts to no more than an annoying verbal tic—one that does nothing to advance the cause of better understanding (p. 127).

Joiner (2005) presents the "instinct for self-preservation" as a premise with evolutionary credentials:

> The simple but compelling idea here is that the first step to death by suicide is to grapple with the results of eons of evolution, to grapple with one of nature's strongest forces—self-preservation (p. 48).

But there are problems with this invoking of evolution. Talk of a self-preservation instinct long predates Darwin—Joiner (2010) himself finds that the idea was discussed as far back as the first century, by the Romano-Jewish scholar Josephus. Modern evolutionary theory holds, rather, that no organism, human or nonhuman, would plausibly feature a "self-preservation drive," "survival instinct," or like expression, for at least three principled reasons (Buss & Penke, 2015; Kirkpatrick & Navarrete, 2006). First, the Darwinian rule of thumb for success in natural selection is not "survive" but "survive and reproduce," on which basis a superordinate drive for survival or longevity would expectably be maladaptive. Many organisms endanger their somas in the interests of reproduction (Darwin, 1859; G. C. Williams, 1966; G. C. Williams & Williams, 1957), humans included. Human male lives are

[5] Zilboorg (1936) cites Achille-Delmas (1932) as the author of this quotation.

characterized by a hazardous struggle for status, resources, and opportunities for reproduction, competitive risk-taking that may help to explain why male life expectancy is typically years shorter than female (Buss, 1997; Daly & Wilson, 1988). For women, mortal danger lies in the obstetrics of childbirth (Wells, DeSilva, & Stock, 2012). Second, Navarrete and Fessler (2005) note a logical self-contraction in the idea of a survival instinct as ancient force of nature: a generalized urge to avoid death would require organisms to possess a generalized preconception of what it is they need to avoid—that is, it presupposes a grasp of personal mortality. As only humans appear to develop the intellectual capacity for such an understanding (Buss, 1997; Preti, 2011b; Soper, 2018) a survival instinct would not be a universal biological drive as Joiner suggests, but an evolutionary novelty. Third, a survival instinct would be underspecified, therefore redundant, and therefore probably unevolvable (Navarrete, Kurzban, Fessler, & Kirkpatrick, 2004). Buss (1990) argues that no organism would be expected to be motivated by a general-purpose drive such as "Survive!" or "Spread your genes!" for the same reason that no chess-playing computer programs contain a simple generalized instruction such as "Win!" or "Make good moves!"—containing no information on how to achieve such a goal, it would serve no useful purpose. Rather, the consensus in evolutionary psychology[6] is that selection favors special-purpose motivational systems—multitudinous aversions and appetites which respond to bits of proximal information that correlated with fitness[7] threats and opportunities in the evolutionary past, and which spur specific behavioral responses (Pinker, 1997; Symons, 1987, 1992; Tooby & Cosmides, 1992). Hence Cosmides and Tooby (1994) argue that the human mind can be visualized not as a unitary all-purpose blade but as a Swiss army knife of specialist tools.

It is hard to argue against the percept of a survival instinct from an intuitive, folk, perspective: evolved special-purpose defenses are so comprehensive and effective in keeping us alive that they may, as an emergent property, give the appearance of constituting a singular, motivating force (Tybur & Navarrete, 2018). The illusion may be likened to misperceiving a single trunk from what are actually "[b]ranches of a twisting tree" (Holbrook, 2016, p. 1). But the distinction between an all-purpose drive and an assemblage of special-purpose psychological mechanisms is important for this discussion because a human mind that has evolved to detect and respond to specific cues of suicide risk is, in effect, already programmed to fulfil the task that suicidology has sought to take on—to find markers that predict suicide with enough sensitivity usually to stop it happening, and with enough specificity to leave most people not in danger to get on with their lives. We will return to this point.

This section has argued that the bulk of current suicide theory may be born more of folk psychology than of logic or science. Recalling the "phenomena" word used by Carter et al. (2017, p. 392) to describe the insistent promotion of suicide risk assessments despite overwhelming evidence of their inutility, it may be a comparable phenomenon worthy of study in itself that suicidology should remain committed

[6] There are critics: e.g., A. P. Atkinson and Wheeler (2004); Samuels (1998).

[7] "Fitness" carries its evolutionary meaning in this chapter, referring to the propagation of genetic material across subsequent generations.

to discover empirically any predictive factor without a coherent a priori rationale for expecting such a factor in principle to be discoverable. Although there may well be a powerful intuitive impetus, alongside a humanitarian longing, to find causal explanation in suicide, I suggest that a productive research program requires firmer theoretical foundations.

Evidence of Absence: The Evolutionary Argument Against Suigiston

The third reason why I suggest that the actuality of suigiston should be doubted is that there are evolutionary grounds for believing that its existence is unlikely. The theoretical framework, a "pain-and-brain" model of suicide, covered at length by Soper (2018), can be summarized for current purposes in the following ten propositions:

1. The affective experience of pain, an evolutionarily ancient and protective biological alarm signal, is necessary for any animal successfully to navigate fitness threats in its external and internal environments (Brand & Yancey, 1993).
2. Pain, whether physical or purely emotional, is intrinsically aversive: it is designed to motivate the organism to take action to end or escape it (Klein, 2007; Lieberman, 2013).
3. Any animal that perceived that it can escape pain by extinguishing itself would be expected to seize the opportunity (Soper & Shackelford, 2018). Self-killing would predictably occur as a proximally adjustive, but genetically maladaptive, response to pain, unless and until adaptations emerged to block that exit.
4. Humans appear to be the only extant species to have evolved an intellect that, as a noxious by-product, is capable of conceiving of suicide: a cognitive developmental threshold for suicidality is typically crossed in early adolescence (Baechler, 1975/1979).
5. For humans, probably uniquely, suicide therefore presents a severe and recurring adaptive problem, for which adaptive solutions have emerged by a process of trial and success. Over the course of thousands of generations, the offspring of humans protected by heritable defenses against suicide would be strongly favored by natural selection.
6. Selection would be expected to respond to the fitness threat of suicide not, for reasons already discussed, via a general-purpose self-preservation instinct, but by the promotion of special-purpose mechanisms that exploit available cues of suicide risk, and which operate in adolescents and adults specifically to forestall self-killing.
7. These evolved antisuicide defenses would tactically attenuate, rather than fully disable, the affective ("pain") and intellectual ("brain") faculties that created suicide as a species-universal adaptive problem. Defenses would not be expected to eradicate suicide altogether in humans because to do so would require a com-

mensurate annulling of these incidentally suicidogenic, but overall adaptive, "pain" and "brain" capabilities. Defenses would evolve only up to a balance of marginal trade-offs—a point at which the incremental fitness benefit gained by a further reduction in actuarial risk matches the incremental fitness cost of obtaining that reduced risk. In other words, a balance is struck between (imperfectly) stopping suicides among those who are in imminent danger and (imperfectly) leaving alone those who are not.

8. Within this balance of trade-offs, a group that is subject to a higher or demographically destabilizing rate of suicide would expectably be supplanted by a group with a lower and sustainable rate.
9. Human populations are expected, therefore, to display low, demographically sustainable, but above-zero, rates of suicide: suicide is predicted to be rare.
10. It is also expected, given propositions 1 to 7, that the residual occurrences of suicide would be those least amenable to prediction, at least from the markers detectable by the organism's own systems: suicide is predicted to be unpredictable.

By the light of this evolutionary analysis, suicide appears not as a special product of suicidogenic drivers but as a default outcome of mature human cognition, in the same way that "crashed" is the default outcome of heavier-than-air flight. Airplanes stay aloft not because that is their natural resting state, from which a particular stimulus is required to dislodge them: they stay airborne because of the continuous interventions of pilots, crews, and multifarious propulsion, control, communication, navigation, and other systems whose job it is, in various ways, to maintain that state. Almost all of the time they work, but they are not infallible, hence the occasional crash. To make sense of wreckage, crash investigators need a prior grasp of the principles of aviation and the many special-purpose devices which usually keep planes flying: only with this background information can they perceive evidence of possible malfunction, if any, and opportunities to improve air safety. For similar reasons, I suggest that progress in suicidology will be largely predicated on gaining understanding of evolved mechanisms that operate in diverse ways specifically to avert suicide. Empirical and clinical pointers, although rarely from an evolutionary position, have arguably been available for many years (e.g., Hendin, 1975; Himmelhoch, 1988; Hundert, 1992; Linehan, Goodstein, Nielsen, & Chiles, 1983; Rogers, Ringer, & Joiner, 2018; Simpson, 1976; von Andics, 1947), but as yet there is little acknowledgement that special-purpose antisuicide adaptations may be important, or even exist. We can expect them to exist, and be important, because the intense selective pressure that presumably applies (the termination of the possibility of reproduction, direct or indirect, brought about by suicide) would have powerfully advanced them in human evolutionary history. It is hard to see how, to follow the metaphor of heavier-than-air flight, *Homo sapiens sapiens* would otherwise have got off the ground (Soper, 2019).

The likely nature of antisuicide defenses is discussed more broadly in other literature (Humphrey, 2018; Soper, 2018). The narrow point to register for now, and the general problem for suigiston theories, is that our species is probably finely

adapted to what could be called the "suicidal niche" (Soper, 2019). Evolved antisuicide mechanisms would be expected to have capitalized on available predictive information, mobilizing in adolescents and adults as a psychological immune system in precise response to utilizable markers of threat. Completed suicides can be understood as attacks that found a way through the defenses because, at least in part, they evaded detection: they progressed beyond latency because, as products of statistical residuals, they lacked informational cues to which the organism's protective systems could have responded. Completed suicides comprise the biological filtrate left after any and all potential self-killings that *could* have been foreseen and forestalled already *have* been foreseen and forestalled. By analogy, if information were to hand that reliably indicated where and when planes were going to crash, then preventative measures would presumably already have been taken: so, we can expect aviation disasters to be unpredictable.

Perhaps a better analogy for the problem of suicide prediction is the difficulty that amateur traders have in trying to keep one step ahead of a near-perfectly competitive commodities or securities market. Lay speculators may scour the historical graphs for a pattern that would forewarn of a stock market crash. It is an alluring dream, but it is just a dream because whatever information is available to private investors is probably already in the price. Tomorrow's drop in the Dow Jones is intrinsically hard to foresee because it reflects surprises that the world's experts and their forecasting systems did not see coming: if not even Wall Street can anticipate these vagaries, then there is little chance that we will either, at least not consistently. Suicidologists face a comparable obstacle: whatever potentially predictive factors they can observe, a biological system fine-tuned over countless generations of selection has probably got there first. The human organism, in other words, is likely to be pre-equipped with, and is already making use of, conceptually the same kind of risk-assessing algorithm that some researchers seek to build by computer (Ribeiro et al., 2016; Walsh, Ribeiro, & Franklin, 2017). Success would presumably require them not only to replicate the evolved antisuicide system operated by the human brain ("the most sophisticated computer in the known universe"—Lieberman, 2013, p. 200), but also then systematically to beat it. Machine learning and "big data" might, at best, help with the actuarial modelling of risk within certain populations (Kessler et al., 2019). But the evolutionary argument suggests that to produce a clinically useful tool by this (or any other currently imaginable) method may be an unrealistic goal.

Conclusion and Implications

This chapter argues that suicidology's prevailing research program, which seeks to identify patterned conditions that supposedly result in suicide, may be misconceived due to the nature of the evolutionary process. Evolution by natural selection operates at the boundary between order and chaos (Kauffman, 1993): it responds to recurring fitness threats and opportunities by favoring mechanisms that tend to

exhaust the available predictive information. There is no reason to believe that an anticipated array of evolved antisuicide defenses would be an exception. There is, then, theoretical weight behind what some researchers have inferred from observation: that individual incidents of suicide may arise from the chaos inherent in the human biological system (Large, 2013; Lester, 1994; Stelmachers & Sherman, 1992). An evolutionary stance may share some common ground with the views of suicidologists such as Hjelmeland and Knizek (2019), who question the utility of the "linear causal thinking" (p. 10) that they see dominating suicide research. There is also evolutionary logic in Neuringer's (1974) conception of self-killing as a general avoidance response, potentially triggered by any of an immeasurably wide variety of aversive stimuli—by his assessment, a "non-theory" of suicide.

Some readers may, at first sight, find this conclusion disheartening or distasteful. I would urge them to reconsider: an evolutionary perspective, one that accepts suicide to be unpredictable at the level of the individual, is not a counsel of despair. It is quite the opposite. It provides a cogent, and much-needed, basis for assuring those bereaved by suicide that their characteristic sense of guilt—the feeling that they could or should have seen it coming and done something to intervene—is psychologically understandable but factually groundless. It could help to end a current ethical injustice whereby large numbers of people labelled "high risk" may be stigmatized and subjected to potentially injurious interventions for suicides that were never going to happen (Large, 2017; Mulder et al., 2016; Murray & Devitt, 2017). It could help to lift the counterpart injustice that psychiatrists are routinely expected (St John-Smith, Michael, & Davies, 2009) and expect themselves (Gale, Hawley, Butler, Morton, & Singhal, 2016) to perform the virtually impossible task of usefully assessing risk. Evolutionary analysis could help researchers, clinicians, and policymakers to identify and prioritize more promising opportunities for suicide prevention. As argued elsewhere (Soper, 2018), it would support the notion that progress may lie in identifying, understanding, and working with a predicted battery of defenses which, for most people, most of the time, successfully keep suicide at bay. It would suggest, for example, that resources may be better redirected into restricting access to lethal means, thereby capitalizing on a psychological immune system—cognitive deficits that expectably shield people in suicidal crises. More broadly, it could guide more theoretically grounded mental health practices. It could, for example, provide a novel, and compassionate, framework for understanding the suicide stigma, which, painfully distancing though it is for the bereaved, may be vitally protective at a community level. Broader still, it could open up new connections between suicidology and wider biological and behavioral sciences. I am suggesting in other words that, by reframing suicide in the context of the natural history of our species, suicide researchers could look forward not only to making long overdue progress in suicide prevention, but also to taking a leading role in furthering science's understanding of the human psyche.

The story of phlogiston, in which a research community spent more than a century looking for something that transpired not to be there, may be taken as a lesson from history. I have argued in this chapter that the past may be repeating itself in an equally erroneous quest to isolate what could be called suigiston—the contingen-

cies that predictably lead to suicide. I have offered three reasons to believe that suigiston may not exist: first, the failure of more than 50 years of empirical studies to find evidence of its existence; second, the failure of more than 100 years of theoretical work to converge on a coherent rationale for its existence; and third, an evolutionary argument that suggests that we can expect suicides to be intrinsically unpredictable. Generations of investigators searching for suigiston have returned empty-handed, and I am not aware of a reason to anticipate a change in fortune. The bind is that, as Kuhn (1962) explains, no scientist can let go of a theory, however defective, without having a perceptibly better one to take its place. Suicidology may be facing the prospect of a continuing, and fruitless, pursuit of proximal causation unless and until a sufficiently attractive alternative framework appears on the scene. It was the discovery of oxygen that finally broke the phlogiston idea's hold, thereby sparking a new and transformational era in chemistry: progress required combustion to be seen in a wholly different way, one that felt counterintuitive at the time, so that when something burns, an essential element is perceived to be captured, not released. Progress in suicide research may need a comparably contrarian reassessment: one, I suggest, that sees suicide not as a perversion, a disorder, or a deranged product of special contingencies, but as an unfortunate, individually unpredictable, but regular, concomitant of the human condition. Evolution could be the oxygen of a new suicidology.

I thank John Gunn III, Matthew Large, and Ron Maris, for their comments on earlier drafts of this chapter.

References

APA. (2013). *Diagnostic and statistical manual of mental disorders: DSM-5*. New York, NY: American Psychiatric Association.

Achille-Delmas, F. (1932). *Psychologie pathologique du suicide*. Paris, France: Librairie Félix Alcan.

Arthur, M., Hawkins, J., Pollard, J. A., Catalano, R. F., & Baglioni, A. J. J. (2003). Measuring risk and protective factors for substance use, delinquency, and other adolescent problem behaviors: The Communities That Care Youth Survey. *Evaluation Review*, *26*, 575–601.

Atkinson, J. M. (1978). *Discovering suicide: Studies in the social organization of sudden death*. London: MacMillan.

Atkinson, A. P., & Wheeler, M. (2004). the grain of domains: The evolutionary-psychological case against domain-general cognition. *Mind & Language, 19*(2), 147–176.

Aubin, H.-J., Berlin, I., & Kornreich, C. (2013). The evolutionary puzzle of suicide. *International Journal of Environmental Research & Public Health, 10*(12), 6873–6886.

Baechler, J. (1975/1979). *Les Suicides* (B. Cooper, Trans.). New York, NY: Basic Books.

Battin, M. P. (1998). Physician–assisted suicide: Safe, legal, rare? In M. Battin, R. Rhodes, & A. Silvers (Eds.), *Physician assisted suicide: Expanding the debate* (pp. 63–72). New York, NY: Routledge.

Baumeister, R. F. (1990). Suicide as escape from self. *Psychological Review, 97*(1), 90–113.

Beaton, S., Forster, P., & Maple, M. (2013). Suicide and language: Why we shouldn't use the 'C' word. *InPsych, 35*(1), 30–31.

Beck, A. T., Kovacs, M., & Weissman, A. (1975). Hopelessness and suicidal behavior: An overview. *JAMA, 234*(11), 1146–1149.
Begley, M., & Quayle, E. (2007). The lived experience of adults bereaved by suicide: A phenomenological study. *Crisis, 28*(1), 26–34.
Bering, J. M. (2002). The existential theory of mind. *Review of General Psychology, 6*(1), 3–24.
Bering, J. M. (2018). *A very human ending: How suicide haunts our species*. London, UK: Transworld.
Bohannan, P. (Ed.). (1960). *African homicide and suicide*. Princeton, NJ: Princeton University Press.
Brand, P. W., & Yancey, P. (1993). *Pain: The gift nobody wants*. New York, NY: HarperCollins.
Brezo, J., Paris, J., Barker, E. D., Tremblay, R., Vitaro, F., Zoccolillo, M., et al. (2007). Natural history of suicidal behaviors in a population-based sample of young adults. *Psychological Medicine, 37*(11), 1563–1574.
Brown, M. F. (1986). Power, gender, and the social meaning of Aguaruna suicide. *Man, 21*(2), 311–328.
Buss, D. M. (1990). Toward a biologically informed psychology of personality. *Journal of Personality, 58*(1), 1–16.
Buss, D. M. (1997). Human social motivation in evolutionary perspective: Grounding terror management theory. *Psychological Inquiry, 8*(1), 22–26.
Buss, D. M., & Penke, L. (2015). Evolutionary personality psychology. In M. Mikulincer, P. R. Shaver, M. L. Cooper, & R. J. Larsen (Eds.), *APA handbook of personality and social psychology: Vol. 4. Personality processes and individual differences* (pp. 3–39). Washington, DC: American Psychological Association.
Cain, A. C., & Fast, I. (1966). The legacy of suicide: Observations on the pathogenic impact of suicide upon marital partners. *Psychiatry, 29*(4), 406–411.
Campbell, F. (2001). Living and working in the Canyon of Why. *Proceedings of the Irish Association of Suicidology Ireland, 6*, 96–97.
Caporael, L. R., & Heyes, C. M. (1997). Why anthropomorphize? Folk psychology and other stories. In R. W. Mitchell, N. S. Thompson, & H. L. Miles (Eds.), *Anthropomorphism, Anecdotes, and Animals* (pp. 59–73). Albany, NY: State University of New York Press.
Carroll, R., Metcalfe, C., & Gunnell, D. (2014). Hospital presenting self-harm and risk of fatal and non-fatal repetition: Systematic review and meta-analysis. *PloS One, 9*(2), e89944.
Carter, G., Milner, A., McGill, K., Pirkis, J., Kapur, N., & Spittal, M. J. (2017). Predicting suicidal behaviours using clinical instruments: Systematic review and meta-analysis of positive predictive values for risk scales. *The British Journal of Psychiatry, 210*(6), 387–395.
Cerel, J., Brown, M. M., Maple, M., Singleton, M., van de Venne, J., Moore, M., et al. (2019). How many people are exposed to suicide? Not six. *Suicide and Life-Threatening Behavior, 49*(2), 529–534.
Cha, C. B., Najmi, S., Park, J. M., Finn, C. T., & Nock, M. K. (2010). Attentional bias toward suicide-related stimuli predicts suicidal behavior. *Journal of Abnormal Psychology, 119*(3), 616.
Chan, M. K., Bhatti, H., Meader, N., Stockton, S., Evans, J., O'Connor, R. C., et al. (2016). Predicting suicide following self-harm: Systematic review of risk factors and risk scales. *The British Journal of Psychiatry, 209*(4), 277–283.
Chandler, M., & Proulx, T. (2006). Changing selves in changing worlds: Youth suicide on the fault-lines of colliding cultures. *Archives of Suicide Research, 10*(2), 125–140.
Chitty, D. (1996). *Do lemmings commit suicide? Beautiful hypotheses and ugly facts*. New York, NY: Oxford University Press.
Chiurliza, B., Rogers, M. L., Schneider, M. E., Chu, C., & Joiner, T. E. (2018). Evolutionary processes in suicide. *Current Opinion in Psychology, 22*, 84–88.
Cholbi, M. (2017). Suicide. *The Stanford Encyclopedia of Philosophy.* Fall 2017. Retrieved 8 October 2018 from https://plato.stanford.edu/archives/fall2017/entries/suicide/

Chow, A. Y. M. (2006). The day after: Experiences of bereaved suicide survivors. In C. L. W. C. Chan & A. Y. M. Chow (Eds.), *Death, dying and bereavement: A Hong Kong Chinese experience* (Vol. 1, pp. 293–308). Aberdeen, HK: Hong Kong University Press.

Chu, J. P., Goldblum, P., Floyd, R., & Bongar, B. (2010). The cultural theory and model of suicide. *Applied and Preventive Psychology, 14*(1–4), 25–40.

Chu, C., Buchman-Schmitt, J. M., Stanley, I. H., Hom, M. A., Tucker, R. P., Hagan, C. R., et al. (2017). The interpersonal theory of suicide: A systematic review and meta-analysis of a decade of cross-national research. *Psychological Bulletin, 143*(12), 1313–1345.

Comai, S., & Gobbi, G. (2016). Translational research in suicide: Is it possible to study suicide in animal models? In P. Courtet (Ed.), *Understanding suicide: From diagnosis to personalized treatment* (pp. 177–188). Cham, Switzerland: Springer International.

Cosmides, L., & Tooby, J. (1994). Beyond intuition and instinct blindness: Toward an evolutionarily rigorous cognitive science. *Cognition, 50*(1), 41–77.

Counts, D. (1991). Suicide in different ages from a cross-cultural perspective. In A. A. Leenaars (Ed.), *Life span perspectives of suicide* (pp. 215–228). New York: Plenum.

d'Arms, J., & Jacobson, D. (2000). The moralistic fallacy: On the 'appropriateness' of emotions. *Philosophical and Phenomenological Research, 61*, 65–90.

Daly, M., & Wilson, M. (1988). *Homicide*. New Brunswick, NJ: Transaction.

Darwin, C. (1859). *On the origin of species by means of natural selection, or the preservation of favoured races in the struggle for life*. London, UK: John Murray.

Davis, B. D. (2000). The scientist's world. *Microbiology and Molecular Biology Reviews, 64*(1), 1–12.

Davis, W. E., & Hicks, J. A. (2013). Judgments of meaning in life following an existential crisis. In J. A. Hicks & C. Routledge (Eds.), *The experience of meaning in life* (pp. 163–174). New York, NY: Springer.

De Luc, V., Fatemi, A. B., & Hettige, N. (2017). Clinical prediction of suicide attempt in schizophrenia using a machine learning approach. *European Psychiatry, 41*, S95–S96.

deCatanzaro, D. (1980). Human suicide: A biological perspective. *Behavioral and Brain Sciences, 3*(02), 265–272.

deCatanzaro, D. (1981). *Suicide and self-damaging behavior: A sociobiological perspective*. New York, NY: Academic Press.

Dennett, D. C. (2013). *Intuition pumps and other tools for thinking*. New York, NY: Norton.

Douglas, J. D. (1967). *Social meanings of suicide*. Princeton, NJ: Princeton University Press.

Durkheim, E. (1897/1952). *La suicide* (J. Spaulding & G. Simpson, Trans.). Henley, UK: Routledge.

Dyregrov, K., Plyhn, E., & Dieserud, G. (2012). *After the suicide: Helping the bereaved to find a path from grief to recovery*. London, UK: Jessica Kingsley.

Fallers, L. A., & Fallers, M. C. (1960). Homicide and suicide in Busoga. In P. Bohannan (Ed.), *African homicide and suicide* (pp. 65–93). Princeton, NJ: Princeton University Press.

Fedden, R. (1938). *Suicide; a social and historical study*. London: Peter Davies.

Franklin, J. C., Ribeiro, J. D., Fox, K. R., Bentley, K. H., Kleiman, E. M., Huang, X., et al. (2017). Risk factors for suicidal thoughts and behaviors: A meta-analysis of 50 years of research. *Psychological Bulletin, 143*(2), 187–232.

Gale, T. M., Hawley, C. J., Butler, J., Morton, A., & Singhal, A. (2016). Perception of suicide risk in mental health professionals. *PloS One, 11*(2), 1–12.

Gibbs, J. P., & Martin, W. T. (1964). *Status Integration and Suicide*. Eugene, OR: Oregon University Press.

Goldney, R. D. (1980). Attempted suicide: An ethological perspective. *Suicide and Life-Threatening Behavior, 10*(3), 131–141.

Goldney, R. D., Smith, S., Winefield, A., Tiggeman, M., & Winefield, H. (1991). Suicidal ideation: Its enduring nature and associated morbidity. *Acta Psychiatrica Scandinavica, 83*(2), 115–120.

Gorelik, G., & Shackelford, T. K. (2017). Suicide and the moralistic fallacy: Comment on Joiner, Hom, Hagan, and Silva (2016). *Evolutionary Psychological Science*, 1–3. https://doi.org/10.1007/s40806-017-0087-7

Greenberg, D., & Shefler, G. (2014). Patient suicide. *Israel Journal of Psychiatry and Related Sciences, 51*(3), 193–198.
Gunn, J. F. (2017). The Social Pain Model. *Crisis, 38*(5), 281–286.
Gunn, J. F. (2019). The importance of conceptual and theoretical frameworks. In D. Lester (Ed.), *The end of suicidology: Can we ever understand suicide?* (pp. 135–145). New York, NY: Nova Science.
Gunn, J. F., & Lester, D. (2014). *Theories of suicide: Past, present and future*. Springfield, IL: Charles C Thomas.
Hamilton, W. D. (1972). Altruism and related phenomena, mainly in social insects. *Annual Review of Ecology and Systematics, 3*(1), 193–232.
Hamilton, W. J. (1980). Do nonhuman animals commit suicide? *Behavioral and Brain Sciences, 3*(02), 278–279.
Hankoff, L. D., & Turner, W. J. (1980). A nontheory of suicide. *Behavioral and Brain Sciences, 3*(02), 279–280.
Harris, T. O. (Ed.). (2000). *Where inner and outer worlds meet: Psychosocial research in the tradition of George W Brown*. London: Routledge.
Hendin, H. (1975). Growing up dead: Student suicide. *American Journal of Psychotherapy, 29*(3), 327–338.
Hendin, H., Haas, A. P., Maltsberger, J. T., Szanto, K., & Rabinowicz, H. (2004). Factors contributing to therapists' distress after the suicide of a patient. *American Journal of Psychiatry, 161*(8), 1442–1446.
Hezel, F. X., Rubinstein, D. H., & White, G. M. (Eds.). (1985). *Culture, youth and suicide in the Pacific*. East-West Center, Honolulu: Pacific Island Studies Program.
Himmelhoch, J. M. (1988). What destroys our restraints against suicide? *Journal of Clinical Psychiatry, 49*(9 (Suppl)), 46–52.
Hirschi, T. (1969). *Causes of delinquency*. Berkeley, CA: University of California Press.
Hjelmeland, H., & Knizek, B. L. (2019). The emperor's new clothes? A critical look at the interpersonal theory of suicide. *Death Studies*, 1–11. https://doi.org/10.1080/07481187.2018.1527796. Retrieved 24 July 2019 from https://www.tandfonline.com/doi/full/10.1080/07481187.2018.1527796?af=R
Holbrook, C. (2016). Branches of a twisting tree: Domain-specific threat psychologies derive from shared mechanisms. *Current Opinion in Psychology, 7*, 81–86.
Hom, M. A., Stanley, I. H., Gutierrez, P. M., & Joiner, T. E. (2017). Exploring the association between exposure to suicide and suicide risk among military service members and veterans. *Journal of Affective Disorders, 207*, 327–335.
Humphrey, N. K. (2018). The lure of death: Suicide and human evolution. *Philosophical Transactions of the Royal Society*. https://doi.org/10.1098/rstb.2017.0269
Hundert, E. M. (1992). The brain's capacity to form delusions as an evolutionary strategy for survival. In M. Spitzer, F. Uehlein, M. A. Schwartz, & C. Mundt (Eds.), *Phenomenology, Language & Schizophrenia* (pp. 346–354). New York, NY: Springer.
Johnson, K. L. (1980). The death row right to die: Suicide or intimate decision? *Southern California Law Review, 54*, 575–631.
Johnson, J., Wood, A. M., Gooding, P., Taylor, P. J., & Tarrier, N. (2011). Resilience to suicidality: The buffering hypothesis. *Clinical Psychology Review, 31*(4), 563–591.
Joiner, T. E. (2005). *Why people die by suicide*. Cambridge, MA: Harvard University Press.
Joiner, T. E. (2010). *Myths about suicide*. Cambridge, MA: Harvard University Press.
Joiner, T. E., & Stanley, I. H. (2016). Can the phenomenology of a suicidal crisis be usefully understood as a suite of antipredator defensive reactions? *Psychiatry, 79*(2), 107–119.
Joiner, T. E., Van Orden, K. A., Witte, T. K., Selby, E. A., Ribeiro, J. D., Lewis, R., et al. (2009). Main predictions of the interpersonal-psychological theory of suicidal behavior: Empirical tests in two samples of young adults. *Journal of Abnormal Psychology, 118*(3), 634–646.
Joiner, T. E., Buchman-Schmitt, J. M., Chu, C., & Hom, M. A. (2017). A sociobiological extension of the interpersonal theory of suicide. *Crisis, 38*(2), 69–72.

Jordan, J. R. (2001). Is suicide bereavement different? A reassessment of the literature. *Suicide and Life-Threatening Behavior, 31*(1), 91–102.
Jordan, J. R. (2008). Bereavement after suicide. *Psychiatric Annals, 38*(10), 679–685.
Jordan, J. R., & McIntosh, J. L. (Eds.). (2011). *Grief after suicide: Understanding the consequences and caring for the survivors*. New York, NY: Routledge.
Kalra, S., Kelkar, D., Galwankar, S. C., Papadimos, T. J., Stawicki, S. P., Arquilla, B., et al. (2014). The emergence of Ebola as a global health security threat: From 'lessons learned' to coordinated multilateral containment efforts. *Journal of global infectious diseases, 6*(4), 164–177.
Kauffman, S. A. (1993). *The origins of order: Self organization and selection in evolution*. Oxford, UK: Oxford University Press.
Kessler, R. C., Aguilar-Gaxiola, S., Borges, G., Chiu, W. T., Fayyad, J., Browne, M. O., et al. (2012). Persistence of suicidal behaviors over time. In M. K. Nock, G. Borges, & Y. Ono (Eds.), *Suicide: Global perspectives from the WHO world mental health surveys* (pp. 75–85). Cambridge, UK: Cambridge University Press.
Kessler, R. C., Bernecker, S. L., Bossarte, R. M., Luedtke, A. R., McCarthy, J. F., Nock, M. K., . VanderWeele, T. J. (2019). The role of big data analytics in predicting suicide. In I. Passos, B. Mwangi, & F. Kapczinski (Eds.), *Personalized psychiatry* (pp. 77–98). Cham, Switzerland: Springer.
Kirkpatrick, L. A., & Navarrete, C. D. (2006). Reports of my death anxiety have been greatly exaggerated: A critique of terror management theory from an evolutionary perspective. *Psychological Inquiry, 17*(4), 288–298.
Klein, C. (2007). An imperative theory of pain. *The Journal of Philosophy, 104*(10), 517–532.
Klonsky, E. D., & May, A. M. (2015). The three-step theory (3ST): A new theory of suicide rooted in the "ideation-to-action" framework. *International Journal of Cognitive Therapy, 8*(2), 114–129.
Klonsky, E. D., Saffer, B. Y., & Bryan, C. J. (2018). Ideation-to-action theories of suicide: A conceptual and empirical update. *Current Opinion in Psychology, 22*, 38–43.
Knizek, B. L., & Hjelmeland, H. (2007). A theoretical model for interpreting suicidal behaviour as communication. *Theory & Psychology, 17*(5), 697–720.
Kuhn, T. S. (1962). *The structure of scientific revolutions*. Chicago, IL: University of Chicago Press.
Large, M. M. (2013). The relevance of the early history of probability theory to current risk assessment practices in mental health care. *History of Psychiatry, 24*(4), 427–441.
Large, M. M. (2017, 21 March). Emerging consensus on the positive predictive (and clinical) value of suicide risk assessment. *British Journal of Psychiatry, Letter.* Retreived 17 May 2017 from http://bjp.rcpsych.org/content/emerging-consensus-positive-predictive-and-clinical-value-suicide-risk-assessment.
Large, M. M., Ryan, C. J., Singh, S. P., Paton, M. B., & Nielssen, O. B. (2011). The predictive value of risk categorization in schizophrenia. *Harvard Review of Psychiatry, 19*(1), 25–33.
Large, M. M., Kaneson, M., Myles, N., Myles, H., Gunaratne, P., & Ryan, C. J. (2016). Meta-analysis of longitudinal cohort studies of suicide risk assessment among psychiatric patients: Heterogeneity in results and lack of improvement over time. *PLoS One, 11*(6), e0156322.
Lester, D. (1992). *Why people kill themselves: A 1990s summary of research findings on suicidal behavior*. Springfield, IL: Charles C Thomas.
Lester, D. (1994). Reflections on the statistical rarity of suicide. *Crisis 15*(4), 187–188.
Lester, D. (2019a). *The end of suicidology: Can we ever understand suicide?* New York, NY: Nova Science.
Lester, D. (2019b). *How culture shapes suicidal behavior*. New York, NY: Nova Science.
Lester, D., & Goldney, R. D. (1997). An ethological perspective on suicidal behavior. *New Ideas in Psychology, 15*(1), 97–103.
Lieberman, M. D. (2013). *Social: Why our brains are wired to connect*. Oxford, UK: OUP.
Linehan, M. M., Goodstein, J. L., Nielsen, S. L., & Chiles, J. A. (1983). Reasons for staying alive when you are thinking of killing yourself: The reasons for living inventory. *Journal of Consulting and Clinical Psychology, 51*(2), 276–286.

Lykken, D. T. (1991). What's wrong with psychology anyway? In D. Cicchetti & W. M. Grove (Eds.), *Thinking clearly about psychology* (Vol. 1, pp. 3–39). Minneapolis, MN: University of Minnesota Press.

Lynn, C. W. (2011). *The lived experience of mothers bereaved by the suicide death of a child* (PhD dissertation). Johnson City, TN: East Tennessee State University.

MacDonald, M., & Murphy, T. R. (1990). *Sleepless souls: Suicide in early modern England*. Oxford, UK: Clarendon Press.

Maltsberger, J. T. (2003). Can a louse commit suicide? *Crisis, 24*(4), 175–176.

Mann, J. J. (1998). The neurobiology of suicide. *Nature Medicine, 4*(1), 25.

Mann, J. J., & Malone, K. M. (1997). Cerebrospinal fluid amines and higher-lethality suicide attempts in depressed inpatients. *Biological Psychiatry, 41*(2), 162–171.

Mann, J. J., Waternaux, C., Haas, G. L., & Malone, K. M. (1999). Toward a clinical model of suicidal behavior in psychiatric patients. *American Journal of Psychiatry, 156*(2), 181–189.

Maris, R. W. (1991). The developmental perspective. In A. A. Leenaars (Ed.), *Life span perspectives of suicide* (pp. 25–38). New York, NY: Plenum.

Maris, R. W., Berman, A. L., Maltsberger, J. T., & Yufit, R. I. (1992). *Assessment and prediction of suicide*. New York, NY: Guilford Press.

Miles, M. S., & Demi, A. S. (1992). A comparison of guilt in bereaved parents whose children died by suicide, accident, or chronic disease. *Omega: Journal of Death and Dying, 24*(3), 203–215.

Miller, M. B. (2008). *Suicide and Evolution.* (Thesis). Tallahassee, FL: Florida State University.

Mishara, B. L., & Tousignant, M. (2004). *Understanding suicide*. Montréal, Canada: Press of the Université de Montréal.

Mugisha, J., Hjelmeland, H., Kinyanda, E., & Knizek, B. L. (2013). Religious views on suicide among the Baganda, Uganda: A qualitative study. *Death Studies, 37*(4), 343–361.

Mulder, R., Newton-Howes, G., & Coid, J. W. (2016). The futility of risk prediction in psychiatry. *British Journal of Psychiatry, 209*(4), 271–272.

Murray, D., & Devitt, P. (2017, March 28). Suicide risk assessment doesn't work. *Scientific American*. Retrieved 14 July 2019 from https://www.scientificamerican.com/article/suicide-risk-assessment-doesnt-work/

Myers, M. F., & Fine, C. (2006). *Touched by suicide: Hope and healing after loss*. New York, NY: Penguin.

Navarrete, C. D., & Fessler, D. M. (2005). Normative bias and adaptive challenges: A relational approach to coalitional psychology and a critique of terror management theory. *Evolutionary Psychology, 3*(1), 279–296.

Navarrete, C. D., Kurzban, R., Fessler, D. M., & Kirkpatrick, L. A. (2004). Anxiety and intergroup bias: Terror management or coalitional psychology? *Group Processes & Intergroup Relations, 7*(4), 370–397.

Neuringer, C. (1974). Conclusion. In C. Neuringer (Ed.), *Psychological Assessment of Suicidal Risk* (pp. 225–229). Springfield, IL: Charles C Thomas.

NICE. (2011). *Self-harm in over 8s: Long-term management (CG133)*. London, UK: National Institute for Health and Clinical Excellence.

Nock, M. K., Borges, G., Bromet, E. J., Cha, C. B., Kessler, R. C., & Lee, S. (2012). The epidemiology of suicide and suicidal behavior. In M. K. Nock, G. Borges, & Y. Ono (Eds.), *Suicide:Global perspectives from the WHO World Mental Health Surveys*(pp. 5–32). Cambridge, UK: Cambridge University Press.

O'Connor, R. C. (2011). Towards an integrated motivational-volitional model of suicidal behaviour. In R. C. O'Connor, S. Platt, & J. Gordon (Eds.), *International handbook of suicide prevention: Research, policy and practice* (pp. 181–198). Chichester, UK: John Wiley and Sons.

O'Connor, R. C. (2018). *Things I now know: Rory O'Connor*. Retrieved 23 July 2019 from https://www.mqmentalhealth.org/news-blog/post/TINK-rory-o-connor.

O'Connor, R. C., & Portzky, G. (2018). Looking to the future: A synthesis of new developments and challenges in suicide research and prevention. *Frontiers in Psychology, 9*(2139), 1–14.

Oquendo, M. A., & Baca-Garcia, E. (2014). Suicidal behavior disorder as a diagnostic entity in the DSM-5 classification system: Advantages outweigh limitations. *World Psychiatry, 13*(2), 128–130.

Paniagua, F. A., Black, S. A., Gallaway, M. S., & Coombs, M. A. (2010). *The interpersonal-psychological theory of attempted and completed suicide*. Bloomington, IN: AuthorHouse.
Peña-Guzmán, D. M. (2017). Can nonhuman animals commit suicide? *Animal Sentience, 2*(20), 1.
Pinker, S. (1997). How the mind works. *Annals of the New York Academy of Sciences, 882*(1), 119–127.
Preti, A. (2011a). Animal model and neurobiology of suicide. *Progress in Neuro-Psychopharmacology and Biological Psychiatry, 35*(4), 818–830.
Preti, A. (2011b). Do animals commit suicide? Does it matter? *Crisis, 32*(1), 1–4.
Preti, A. (2018). Animal suicide: Evolutionary continuity or anthropomorphism? *Animal Sentience, 2*(20), 10.
Ramsden, E., & Wilson, D. (2010). The nature of suicide: Science and the self-destructive animal. *Endeavour, 34*(1), 21–24.
Ribeiro, J., Franklin, J., Fox, K., Bentley, K., Kleiman, E., Chang, B., et al. (2016). Letter to the Editor: Suicide as a complex classification problem: Machine learning and related techniques can advance suicide prediction—a reply to Roaldset (2016). *Psychological Medicine, 46*(9), 2009–2010.
Rogers, J. R. (2001). Theoretical grounding: The "missing link" in suicide research. *Journal of Counseling & Development, 79*(1), 16–25.
Rogers, J. R., & Apel, S. (2010). Revitalizing suicidology: A call for mixed methods designs. *Suicidology Online, 1*, 92–94.
Rogers, J. R., & Lester, D. (2010). *Understanding suicide: Why we don't and how we might*. Cambridge, MA: Hogrefe.
Rogers, M. L., Ringer, F. B., & Joiner, T. E. (2018). The association between suicidal ideation and lifetime suicide attempts is strongest at low levels of depression. *Psychiatry Research, 270*, 324–328.
Rosen, A. (1954). Detection of suicidal patients: An example of some limitations in the prediction of infrequent events. *Journal of Consulting Psychology, 18*(6), 397.
Roy, A., Rylander, G., & Sarchiapone, M. (1997). Genetics of suicide. *Annals of the New York Academy of Sciences, 836*(1), 135–157.
Samuels, R. (1998). Evolutionary psychology and the massive modularity hypothesis. *The British Journal for the Philosophy of Science, 49*(4), 575–602.
Selby, E. A., Joiner, T. E., & Ribeiro, J. D. (2014). Comprehensive theories of suicidal behaviors. In M. K. Nock (Ed.), *The Oxford handbook of suicide and self-injury* (pp. 286–307). Oxford, UK: Oxford University Press.
Shneidman, E. S. (1996). *The suicidal mind*. New York, NY: Oxford University Press.
Simpson, M. A. (1976). Self-mutilation and suicide. In E. Shneidman (Ed.), *Suicidology: Contemporary developments* (pp. 281–316). New York, NY: Grune & Stratton.
Solano, P., Pizzorno, E., Pompili, M., Serafini, G., & Amore, M. (2018). Conceptualizations of suicide through time and socio-economic factors: A historical mini-review. *Irish Journal of Psychological Medicine, 35*(1), 75–86.
Soper, C. A. (2018). *The evolution of suicide*. Cham, Switzerland: Springer.
Soper, C. A. (2019). Adaptation to the suicidal niche. *Evolutionary Psychological Science*. https://doi.org/10.1007/s40806-019-00202-3
Soper, C. A., & Shackelford, T. K. (2018). If nonhuman animals can suicide, why don't they? *Animal Sentience, 2*(20), 14.
St John-Smith, P., Michael, A., & Davies, T. (2009). Coping with a coroner's inquest: A psychiatrist's guide. *Advances in Psychiatric Treatment, 15*(1), 7–16.
Stelmachers, Z. T., & Sherman, R. E. (1992). The case vignette method of suicide assessment. In R. W. Maris, A. L. Berman, J. T. Maltsberger, & R. I. Yufit (Eds.), *The assessment and prediction of suicide*. New York, NY: Guilford Press.
Syme, K. L., Garfield, Z. H., & Hagen, E. H. (2016). Testing the bargaining vs. inclusive fitness models of suicidal behavior against the ethnographic record. *Evolution and Human Behavior, 37*(3), 179–192.

Symons, D. (1987). If we're all Darwinians, what's the fuss about? In C. Crawford, M. Smith, & D. Krebs (Eds.), *Sociobiology and psychology: Ideas, issues and applications* (pp. 121–146). Hillsdale, NJ: Erlbaum.

Symons, D. (1992). On the use and misuse of Darwinism in the study of human behavior. In J. Barkow, L. Cosmides, & J. Tooby (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 137–162). New York, NY: Oxford University Press.

Tooby, J., & Cosmides, L. (1992). The psychological foundations of culture. In J. H. Barkow, L. Cosmides, & J. Tooby (Eds.), *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 19–136). New York, NY: Oxford University Press.

Troister, T., & Holden, R. R. (2010). Comparing psychache, depression, and hopelessness in their associations with suicidality: A test of Shneidman's theory of suicide. *Personality and Individual Differences, 49*(7), 689–693.

Tryon, W. W. (2016). Transtheoretic transdiagnostic psychotherapy. *Journal of Psychotherapy Integration, 26*(3), 273.

Turecki, G. (2005). Dissecting the suicide phenotype: The role of impulsive-aggressive behaviours. *Journal of Psychiatry & Neuroscience, 30*(6), 398–408.

Tybur, J. M., & Navarrete, C. D. (2018). Interrupting bias in social psychology: Evolutionary psychology as a guide. In J. T. Forgas & L. Jessum (Eds.), *The politics of social psychology* (pp. 247–264). New York, NY: Psychology Press.

van Heeringen, K., & Mann, J. J. (2014). The neurobiology of suicide. *The Lancet Psychiatry, 1*(*1*), 63–72.

Van Orden, K. A., Witte, T. K., Cukrowicz, K. C., Braithwaite, S. R., Selby, E. A., & Joiner, T. E. (2010). The interpersonal theory of suicide. *Psychological Review, 117*(2), 575–600.

von Andics, M. (1947). *Suicide and the meaning of life*. London, UK: Hodge.

WHO. (1996). *Prevention of suicide: Guidelines for the formulation and implementation of national strategies*. Geneva, Switzerland: World Health Organization.

WHO. (2012). *Public health action for the prevention of suicide: A framework*. Geneva, Switzerland: World Health Organization.

WHO. (2014). *Preventing suicide: A global imperative*. Geneva, Switzerland: World Health Organization.

Waesche, M. C., Clark, C. B., & Cropsey, K. L. (2016). The connection between thwarted belongingness, alcohol consumption, suicidal, and homicidal ideation in a criminal justice sample. *Journal of Addiction Medicine, 10*(6), 437–442.

Walsh, C. G., Ribeiro, J. D., & Franklin, J. C. (2017). Predicting risk of suicide attempts over time through machine learning. *Clinical Psychological Science, 5*(3), 457–469.

Wells, J. C., DeSilva, J. M., & Stock, J. T. (2012). The obstetric dilemma: An ancient game of Russian roulette, or a variable dilemma sensitive to ecology? *American Journal of Physical Anthropology, 149*(S55), 40–71.

Wertheimer, A. (2014). *A special scar: The experiences of people bereaved by suicide* (3rd ed.). Abingdon, UK: Routledge.

Williams, G. C. (1966). *Adaptation and natural selection: A critique of some current evolutionary thought*. Princeton, NJ: Princeton University Press.

Williams, J. M. G. (1997). *Cry of pain: Understanding suicide and self-harm*. London, UK: Penguin.

Williams, G. C., & Williams, D. C. (1957). Natural selection of individually harmful social adaptations among sibs with special reference to social insects. *Evolution, 11*, 32–39.

Wright, R. (1994). *The moral animal: Why we are, the way we are: The new science of evolutionary psychology*. New York, NY: Vintage.

Yeh, B. Y., & Lester, D. (1987). An economic model for suicide. In D. Lester (Ed.), *Suicide as a learned behavior* (pp. 51–57). Springfield, IL: Charles C Thomas.

Zilboorg, G. (1936). Differential diagnostic types of suicide. *Archives of Neurology & Psychiatry, 35*(2), 270–291.

Animacy and Mortality Salience: New Directions for the Adaptive Memory Literature

Jeanette Altarriba and Stephanie A. Kazanas

The past decade has produced great strides in understanding the functional aspects of human cognition. One prolific area of research asserts that memory is optimized when information is processed for its fitness, or "survival relevance" (Nairne, Pandeirada, & Thompson, 2008; Nairne, Thompson, & Pandeirada, 2007). Early work conducted in this area used a simple recall paradigm, with participants first reading a set of instructions that vary among survival relevance rating, moving relevance rating, and so on. In the survival relevance condition, participants are given the following scenario:

> In this task, we would like you to imagine that you are stranded in the grasslands of a foreign land, without any basic survival materials. Over the next few months, you'll need to find steady supplies of food and water and protect yourself from predators. We are going to show you a list of words, and we would like you to rate how relevant each of these words would be for you in this survival situation. Some of the words may be relevant and others may not be—it's up to you to decide.

Participants in the moving relevance condition read a similarly constructed set of instructions, with a description of the tasks related to moving (e.g., purchasing a new home, transporting all belongings). All participants then rate a series of concrete nouns for their survival or moving relevance (e.g., screwdriver, stone, cathedral), complete a brief filler task, and are surprised with a memory task. Dozens of independent researchers and laboratories have confirmed an adaptive or survival memory advantage: a memory benefit for words processed for their survival relevance, relative to other encoding instructions (Kazanas & Altarriba, 2015;

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Evolutionary Psychology, https://doi.org/10.1007/978-3-030-25466-7_4

Schwartz, Howe, Toglia, & Otgaar, 2014). Importantly, these ratings appear to proffer a similar or better memory benefit than well-known mnemonic strategies (e.g., pleasantness, imagery, self-relevance; Kazanas & Altarriba, 2015; Scofield, Buchanan, & Kostic, 2018). A wide range of replication efforts have shown the survival advantage to also extend to memory for pictures (Otgaar, Smeets, & van Bergen, 2010) and locations (Nairne, VanArsdall, Pandeirada, & Blunt, 2012), as well as to the recollection processes involved in recognition (Cho, Kazanas, & Altarriba, 2018).

Explanations for these data range from the proximate to ultimate, and from cognitive to evolutionary. Among these potential explanations, researchers have theorized the role of self-reference (Klein, 2012a, 2014), item-specific and relational processing (Burns, Burns, & Hwang, 2011; Burns, Hart, Griffith, & Burns, 2013), richness/elaborative encoding (Kroneisen & Erdfelder, 2011; Kroneisen, Erdfelder, & Buchner, 2013; Kroneisen, Rummel, and Erdfelder, 2014, 2016), and planning (Klein, Robertson, & Delton, 2010, 2011). These cognitive explanations contrast with evolutionary explanations provided by Nairne and his colleagues (e.g., Nairne, 2014; Nairne & Pandeirada, 2010, 2016), as well as other researchers. Among these, Weinstein, Bugg, and Roediger (2008) have found larger memory benefits from survival scenarios describing ancestral environments, relative to modern, urban environments.

Together, these mixed findings suggest that this survival advantage could be the result of some cognitive explanations (i.e., aspects of the scenario's construction), evolutionary explanations (i.e., elements of our evolutionary history embedded in the scenario itself), or a combination of these explanations. Most recently, Nairne and Pandeirada (2016) have hypothesized a general survival optimization system that can reconcile *both* cognitive and evolutionary explanations. According to this theory, survival processing activates a variety of fight-or-flight simulations, recruiting the cognitive components underlying each one (e.g., predator avoidance; Kazanas & Altarriba, 2018).

Additionally, while these investigations continue, some have found important limitations to the survival advantage. Interestingly, the advantage does not extend to memory for faces (Savine, Scullin, & Roediger, 2011) or abstract concepts (Bell, Röer, & Buchner, 2013), nor does it appear in implicit memory tasks (e.g., word-stem completion; McBride, Thomas, & Zimmerman, 2013; Tse & Altarriba, 2010) or in the *n*-back task (Altarriba & Kazanas, 2014). Further, taxing the working memory load of participants can also eliminate or weaken the magnitude of the advantage (Kazanas, Van Valkenburg, & Altarriba, 2015; Kroneisen et al., 2014, 2016). Researchers have also begun to extend their work to related areas—including animacy and mortality salience—to which we turn for the remainder of this chapter. The success of these related areas indicates that survival relevance may largely be a function of threat and ultimately death avoidance. Survival itself relies on an animal prioritizing its well-being, which includes both implicit and explicit animacy and mortality processing. We discuss these areas in detail, with an emphasis on the mechanisms they share with survival processing. We conclude our chapter with some general remarks on these areas of research and provide a series of suggestions for future work.

The Animacy Effect and Animacy Advantages

One of these relatively new areas of research that extend the original efforts of Nairne et al. (2007) investigates the relationship between animacy and memory. Using an evolutionary explanation for the survival advantage, we might expect that this advantage would generalize to other fitness-related domains. For example, we know from the attentional capture literature that animate objects (e.g., animals) are less susceptible to inattentional blindness than inanimate objects (e.g., tools; Calvillo & Jackson, 2014). Recognizing that this was an empirical question, VanArsdall, Nairne, Pandeirada, and Blunt (2013) tested memory for nonwords that were presented with either a living property (e.g., dislikes tomatoes) or a nonliving property (e.g., requiring a key). For example, the nonword FRAV was presented with the property "has a round shape" presented below it. Participants decided whether each nonword was living or nonliving and were instructed to remember the words for a later memory test. Recognition (Experiment 1) and recall (Experiment 2) memory were higher for nonwords presented with living properties. Work with children as young as four shows similar results (e.g., Aslan & John, 2016). However, it is important to note that the living properties were largely those of human behaviors. Thus, their initial results may have described the effects of self-reference, rather than animacy.

Research in this area has certainly continued. Later, Nairne, VanArsdall, Pandeirada, Cogdill, and LeBreton (2013) reexamined results originally presented by Rubin and Friendly (1986): What characteristics best contribute to recall? Rubin and Friendly reported predictors including imagery, availability, and emotionality, but not animacy. Nairne et al. (2013) collected ratings related to animacy and found that animacy may be the best predictor of recall. In fact, the positive correlation with recall was twice that of imagery. They extended these findings with an intentional learning task for animate and inanimate words, matching these word types on nearly a dozen lexical variables. Recall was higher for the animate words, lending support to the earlier findings they had reported with nonwords (VanArsdall et al., 2013). Additional results from Li, Jia, Li, and Li (2016) have also shown the benefit of animacy informing judgments of learning (Koriat, 1997).

Further support for this animacy advantage comes from a series of experiments conducted by Bonin, Gelin, and Bugaiska (2014). Their first two experiments included categorization and surprise free recall tasks. In these experiments, participants categorized French words (Experiment 1) or pictures (Experiment 2) as either animate or inanimate. In both experiments, participants categorized the animate stimuli faster than the inanimate stimuli. In addition, recall was higher for animate stimuli than for inanimate stimuli (with no differences in the number of intrusions). Experiment 3 used a recognition task, with the words from Experiment 1. Participants also indicated whether they "remembered," "knew," or "guessed" when responding. Overall, animate words were recognized faster, with participants being more confident that they remembered the animate words from the categorization task. Finally, in Experiment 4, the authors tested the possibility that this animacy effect may be due, in part, to animate words being more semantically

rich. For example, semantically rich concepts may have more features or contexts, evoke more sensations, or have more dense semantic neighborhoods (Pexman, Siakaluk, & Yap, 2013). Although the words had been originally matched on imagery ratings, Bonin et al. collected a set of independent ratings for sensory experience: Participants rated each word according to its ability to evoke taste, touch, sight, sound, or smell, from 1 (*no sensorial experience*) to 7 (*high sensorial experience*). These ratings were equivalent for animate and inanimate words, reducing the likelihood that differences in memory for animate and inanimate words are a function of sensory experience.

Bonin, Gelin, Laroche, Méot, and Bugaiska (2015) then investigated additional explanations for these animacy effects, after an initial Experiment 1 replicated Nairne et al.'s (2013) findings with a new set of words. Their subsequent experiments further examined the role of richness/elaborative encoding and interactive imagery. Experiments 2 and 3A tested a richness/elaborative encoding explanation for the animacy effect and found greater recall with animate words, despite a cognitively-demanding categorization task during encoding. The authors replicated the animacy effect in Experiment 3B as well, with the addition of a dual-task procedure. Together, these results suggest that animacy advantages are largely independent of cognitive resources; that is, they do not rely on richness or elaborative encoding, unlike the survival advantage (Kroneisen et al., 2013, 2014, 2016). In Experiment 4, Bonin et al. asked participants to create interactive situations for the animate and inanimate words. Animate words were again more memorable, but the interactive imagery task did not promote any memory benefit relative to a baseline animacy rating task. Additional data are needed to examine this interactive imagery hypothesis.

Leding (2018, Experiment 1) explored a similar hypothesis, testing whether a deeper level of processing underlies the animacy effect. Participants processed animate and inanimate words either shallowly or deeply. Those in the shallow condition indicated whether each word contained an "e," whereas those in the deep condition rated each word according to its pleasantness. In both conditions, participants recalled significantly more animate words. The lack of a significant interaction reduces the likelihood that deeper processing promotes these animacy effects. Participants may not need any explicit tasks or encoding instructions to show this memory advantage. This animacy advantage was replicated in a second experiment, after participants rated each word according to its survival or moving relevance. These results support previous animacy advantages with free recall tasks and hint of their generalizability to other encoding tasks.

Gelin and colleagues have also examined the generalizability of the animacy effect to different sets of encoding instructions (Gelin, Bugaiska, Méot, & Bonin, 2017) and types of contextual information (Gelin, Bonin, Méot, & Bugaiska, 2018). In the first of these, Gelin et al. (2017) replicated the animacy effect across a range of scenario-based encoding instructions, including Nairne et al.'s (2007) survival and moving scenarios and a novel tour guide scenario, as well as the control pleasantness rating task (see also Leding, 2018). These results are important because they show a reliable recall advantage across four experiments. Their additional replication efforts have shown animacy advantages for a word's spatial information

(i.e., its position on a computer screen) and temporal information (i.e., its presentation at the beginning, middle, or end of a list; Gelin et al., 2018). Thus, improved recall rates with animate words and their contexts are a reliable finding in the memory literature.

Studies with cued recall tasks are not as consistent. In one example, VanArsdall, Nairne, Pandeirada, and Cogdill (2015) used animate and inanimate Swahili-English word pairs to test animacy effects in paired-associate learning (i.e., learning a second language). Memory for both animals and people was greater than memory for furniture and general objects. These effects with paired-associate learning contrast those previously reported by Schwartz and Brothers (2014), who failed to replicate the survival advantage with Swahili-English and Lithuanian-English word pairs. Meanwhile, Popp and Serra (2016) found a *reverse* animacy effect with their word pairs, with their results showing better memory for object-object word pairs, relative to animal-animal word pairs. This reverse animacy effect was replicated in a second experiment, with additional results showing null effects between Swahili-English and English-Swahili animal- and object-based word pairs. Finally, in the last experiment, recall was higher for object-object word pairs than for animal-animal word pairs, as well as for mixed word pair types (animal-object and object-animal). Popp and Serra's (2016) results suggest a specific memory impairment for animate words: one that occurs in cued recall tasks. They surmise that attentional capture may underlie these results with cued recall, as participants' attention is drawn to processing individual, animate words, rather than encoding the entire word pair.

Recent work conducted in our laboratory has shown similar reverse animacy effects (Kazanas, Altarriba, & O'Brien, under review). We had similar aims as Popp and Serra (2016)—to examine animacy with cued recall tasks—though we approached our study from the perspective of language learning, with survival, moving, and pleasantness rating encoding instructions. The survival instructions read as follows:

> In this task, we would like you to imagine that you are stranded in the grasslands of a foreign land, without any basic survival materials. Over the past few months, you've had to find steady supplies of food and water and protect yourself from predators. Today, you encountered a stranger and you must work together to guarantee your chances of survival. This stranger speaks Spanish, but you do not, so you will have to learn some words in their language. We are going to teach you a list of Spanish-English translations. We would like you to try to remember the new Spanish words for a future memory test.

The moving instructions differed from previous work, as we aimed to better match our scenarios on their complexity *and* structural similarity. These instructions read as follows:

In this task, we would like you to imagine that you are planning to study abroad next semester in Spain. Over the next few months, you'll need to locate and rent a new apartment and transport your belongings overseas. Today, you learned that you will be getting a new roommate who only speaks Spanish. You must learn some

words in their language to improve your living situation and study abroad experience. We are going to teach you a list of Spanish-English translations. We would like you to try to remember the new Spanish words for a future memory test.

All participants were tasked with learning a series of Spanish-English word pairs across a number of animate and inanimate categories. Words were presented visually and auditorily, along with an image, and then tested three ways: sentence completion, picture naming, and matching. We selected and designed these tests to extend previous work with cued recall, using these three new tasks (e.g., Popp & Serra, 2016; VanArsdall et al., 2015). We found reliable reverse animacy effects across all conditions and tasks: In each one, participants' memory for inanimate words was significantly greater than their memory for animate words. Thus, vocabulary learning and processing, measured across shallow (matching, picture naming) and deep (sentence-completion) testing formats, did not support the animacy advantages reported with free recall testing formats (e.g., Bonin et al., 2014; VanArsdall et al., 2013). Future work is needed to better understand the mechanisms underlying the animacy effect, as they do not appear to be the result of elaborative encoding (Bonin et al., 2015) or mental arousal (Popp & Serra, 2018); nor can they be attributed to relational processing (VanArsdall, Nairne, Pandeirada, & Cogdill, 2017). Nevertheless, there remain reliable differences between data gathered from free recall and cued recall designs.

Mortality Salience

Although the animacy literature highlights the prioritization of living things in human cognition, another area of research has found similar effects when participants process information related to their mortality. Death processing, or mortality salience, involves thinking about your own death, the circumstances that might bring about death, and the afterlife. Mixed findings from this literature suggest that mortality salience—and the memory benefit from information processed for its mortality salience—could share some of the mechanisms underlying the survival advantage, or rely on another set of mechanisms entirely (Burns & Hart, 2014; Hart & Burns, 2012).

One set of studies has examined the role of the "predator" described in Nairne et al.'s (2007) survival relevance rating task. The predator represents one of the elements of survival processing that may heighten a participant's sense of mortality. In one of these studies, Soderstrom and McCabe (2011) investigated the impact of scenario location (i.e., comparing ancestral and modern survival processing; see also Weinstein et al., 2008), as well as other types of predators in the survival scenario. Soderstrom and McCabe included five conditions in their study: the standard survival scenario (Nairne et al., 2007), a survival scenario with a zombie predator, a modern (city) survival scenario with attackers, a modern (city) survival scenario with zombies, and a pleasantness rating control condition. With their two zombie conditions, their study was the first to manipulate death processing. In what

was initially described as a controversial finding, recall with the zombie predator scenarios was greater than recall with the predator and attacker scenarios, regardless of whether the scenario was described as ancestral or modern. These findings challenged the role of ancestral priorities underlying the survival advantage, as supernatural predators were not a likely foe for our Pleistocene ancestors. In addition, previous manipulations of context (ancestral versus modern) had found a larger survival advantage with ancestral survival scenarios (e.g., Nairne & Pandeirada, 2010; Weinstein et al., 2008).

Other work from our laboratory has shown similar findings (Kazanas & Altarriba, 2017). Using a supernatural, demon predator (i.e., replacing *predator* with *demon* in the survival scenario), participants recalled more words than the standard predator version of the scenario. We originally wanted to examine the predator's function in enhancing memory, testing whether more dominant predators, such as a demon, could produce larger memory advantages. Predators were pilot-tested, with demons rated as significantly more negative than zombies and other creatures, although still possessing traits consistent with actual, living predators. The magnitude of the survival advantage, relative to pleasantness ratings, was equivalent across the demon and predator scenarios. These results support previous work, like that of Soderstrom and McCabe (2011), showing that the survival advantage may not be rooted in ancestral priorities. Otherwise, we originally argued that a supernatural predator could not have promoted a similar survival advantage.

However, these studies differed in a number of important ways that may limit their comparisons. For example, our work and the work by Soderstrom and McCabe (2011) used a between-subjects design, whereas both Weinstein et al. (2008) and Nairne and Pandeirada (2010) used a within-subjects design. Perhaps the design is crucial when comparing the effects of setting (ancestral versus modern) on the survival advantage; researchers have found an ancestral survival advantage with a within-subjects design, and a modern survival advantage with a between-subjects design. This conclusion is tentative, and requires replication to be more definitive. With regard to the significant zombie advantage, the controversy may instead support the survival optimization system suggested by Nairne and Pandeirada (2016). Zombies and demons could represent "super predators" that increase the magnitude of the effect (Nairne, 2014). Consider the way in which we characterize zombies in films and television shows: They represent the undead, with an insatiable appetite for human brains. Demons have a similar reputation, with additional religious implications. Thus, presenting a survival scenario that describes a super predator is perhaps an even more effective mnemonic technique than the standard version of the scenario.

Hart and Burns (2012) considered whether results described by Soderstrom and McCabe (2011) may be a function of mortality salience: We anticipate that death processing is both complex and meaningful. Thus, we should expect that considering our own death will enhance encoding and long-term retention. Hart and Burns (2012) and Burns, Hart, and Kramer (2014a) have investigated this "dying to remember" hypothesis (Burns & Hart, 2014) with several experiments.

In Experiment 1, Hart and Burns (2012) assessed recall following a priming phase, instead of the typical rating task. In this priming phase, participants were asked to describe their emotions as they considered either their own death or watching television. Then, they completed the Positive and Negative Affect Schedule (PANAS; Watson, Clark, & Tellegen, 1988), a questionnaire selected to assess the impact of positive or negative affect on performance. Finally, they rated a list of words on their pleasantness. Recall for these words was greater following the mortality salience prime than the television prime. In addition, recall performance was not mediated by either PANAS score or pleasantness ratings for the list of words.

Experiment 2 replicated these findings with several modifications. First, the authors removed all words related to death (e.g., corpse, sorrow). Second, they used a more closely matched control condition: considering physical paralysis. Finally, their experiment was conducted online, with a larger and more diverse sample. Their findings were also replicated in Experiment 3, using a dental pain control condition. In addition, participants were instructed to learn the words for a later recall task (i.e., an intentional learning paradigm), instead of pleasantness ratings. Thus, mortality salience as a prime promotes better recall than several control conditions (for a replication of these findings, see Bugaiska, Mermillod, & Bonin, 2015). Follow-up analyses from Experiments 2 and 3 indicated that participants wrote more complex responses to the mortality salience prime, and this additional complexity did mediate recall performance.

These findings led Burns et al. (2014a) to ask whether there is a functional connection between the survival advantage and the mortality salience effect. The authors created a mortality salience scenario that closely resembled their survival scenario, with the mortality salience reading:

> In this task, we would like you to imagine that you have just been diagnosed as terminally ill, with no hope of surviving or extending your life. Over the next few months, you'll need to settle your affairs, give away your belongings, say goodbye to loved ones, find ways to ease your suffering, and prepare for your death. We are going to show you a list of words and we would like you to rate how relevant each of these words would be for you when preparing emotionally, mentally, and physically for your death. Some of the words may be relevant and others may not be. It is up to you to decide.

Their survival scenario varied a bit from others, reading:

> In this task, we would like you to imagine that you have just been stranded in the grasslands of a foreign land without any basic survival materials. Over the next few months, you'll need to find steady supplies of food and water and protect yourself from predators. We are going to show you a list of words and we would like you to rate how relevant each of these words would be for you when preparing emotionally, mentally, and physically for your survival. Some of the words may be relevant and others may not be. It is up to you to decide.

These scenarios differ from others, particularly in instructing participants to prepare "emotionally, mentally, and physically": demanding a greater depth of processing than the standard survival scenarios. They also piloted their words to ensure that ratings were equally survival- and death-relevant and they used a pleasantness control condition. In Experiment 1, the authors found equivalent recall in the survival and mortality salience conditions, which were significantly greater than pleasantness ratings. These findings were replicated in both Experiments 2 and 3, after refining the mortality salience scenario to better match the survival scenario, and using a larger, online sample and a new set of words. The authors questioned whether the survival and mortality salience conditions promoted better memory than pleasantness ratings because of self-referential processing. To test whether self-referential processing was responsible for the memory advantage, they replaced the pleasantness control condition with the television-watching scenario used by Hart and Burns (2012, Experiment 1). Recall was significantly greater in the survival and mortality salience conditions, relative to the control condition. This finding indicates that the advantage cannot be attributed to self-reference alone. Moreover, with survival and mortality salience conditions generating similar memory advantages, they have reduced the likelihood that these conditions rely on different mechanisms (for a recent replication, see Zhao, Li, Zhang, & Yang, 2018).

Burns, Hart, Kramer, and Burns (2014b) then replicated these results in a second set of experiments. In Experiment 1, Burns et al. replicated the mortality salience advantage using an orienting task, rather than the more typical pleasantness rating task. These manipulations are important, as previous work conducted in their laboratory has noted the importance of equating encoding tasks on item-specific and relational processing (e.g., Burns et al., 2011, 2013). Experiments 2 and 3 also replicated previous work, suggesting that mortality salience and survival advantages both rely on item-specific processing, and with some recall data indicating that they also rely on relational processing. Thus, their mechanisms may not only overlap, but they also may activate the same cognitive processes. Naturally, these complex, meaningful processes are at their highest when participants are asked to consider information relevant to death, and related death-avoidance situations.

Other work has suggested different mechanisms underlying the survival and mortality salience advantages (Bell et al., 2013; Klein, 2012b). These authors have found some memory advantages for survival and mortality salience processing, but they have differed in magnitude. In one of these studies, Klein (2012b) considered whether there was a functional relationship between survival processing and mortality salience. Klein's "death condition" was written very similarly to the survival condition:

> In this task, I would like you to imagine that you are about to die. I am going to show you a list of words, and I would like you to rate how relevant each of these words would be to the circumstances surrounding your death. Some words may be relevant and others may not be—it is up to you to decide.

Recall from this condition did not differ from the pleasantness rating condition and recall rates were significantly lower than those following survival processing.

Ratings collected from participants indicated significantly more thoughts of planning while survival processing, relative to mortality processing, suggesting some role of planning in the survival advantage, but not in mortality salience effects (these results were replicated by Bugaiska et al., 2015, Experiment 4). One might also consider the role of the scenario itself, as it did not ask participants to consider a number of tasks or situations related to death explicitly, as is the case with the survival scenario. Considering these differences, Klein (2012b) concluded that survival and death relevance may rely on different processes and activities.

Bell et al. (2013) then considered whether some amount of negativity contributes to these effects. Their results indicate that negativity is not likely contributing to the survival advantage, as the survival scenario—rated lower in negativity—promoted a larger memory advantage over the control moving and pleasantness conditions than the more negatively-rated suicide scenario. Pate (2013) reported some similar findings, with more negative grief processing reducing memory performance. With these scenarios, there is a delicate balance between aspects of emotion enhancing (Fiacconi, Dekraker, & Köhler, 2015) and hindering (Bell et al., 2013; Pate, 2013) memory performance.

Clearly, research in this area has been mixed, with some studies finding greater recall following survival processing than death processing (Bell et al., 2013; Klein, 2012b) and others finding equivalent recall between the two scenarios (Burns et al., 2014a, b). These mixed findings have led researchers to question whether survival and mortality salience memory advantages rely on different cognitive mechanisms. Although Bugaiska et al. (2015) and others have suggested that survival and death processing do not completely overlap, future research should seek to determine the specific mechanisms that survival and death processing may share.

Summary and Future Directions

The animacy and mortality salience literatures have extended what we know about survival processing and the function of human memory. Encoding information for its fitness-relevance likely engages both animacy and mortality salience, to some degree. This conjecture is supported by several experiments showing memory advantages similar to the survival advantage (e.g., Burns et al., 2014a; Gelin et al., 2017; Leding, 2018). Some researchers have argued otherwise, finding smaller effects than those reported with survival processing (e.g., Klein, 2012b; Pate, 2013), or finding that these encoding strategies can sometimes produce the opposite effect, such as a reverse animacy effect (e.g., Kazanas et al., under review; Popp & Serra, 2016).

As common as these mixed findings appear to be, other studies have helped to clarify the mechanisms underlying these effects, as they could differ from those driving the survival advantage. For one, the animacy effect does not appear to be the result of lexical characteristics (Nairne et al., 2013), sensory experience (Bonin et al., 2014), elaborative encoding (Bonin et al., 2015; Leding, 2018), or interactive imagery (Bonin et al., 2015). Moreover, mortality salience is not likely a function of

negative affect or negativity (Hart & Burns, 2012), self-reference (Burns et al., 2014a), or planning (Klein, 2012b). Despite ruling out these factors—or at the very least minimizing their theoretical roles—many questions remain.

Beginning with the animacy literature, further research and theory are needed to understand the discrepancy between animacy advantages with free recall and reverse animacy effects with cued recall. Popp and Serra (2016) refer to the attention capture literature, but more data are needed. Perhaps additional work with a variety of nonverbal stimuli can also enhance our understanding of the animacy effect: Are pictures of animate objects also more memorable than those of inanimate objects? How do faces fare within the memory literature, such as real versus computer-generated?

Both the animacy and mortality salience literatures could also benefit from additional work with new tasks, such as those measuring implicit memory and other levels of processing. Future work should ensure that all stimuli and encoding instructions are matched on important characteristics, including those pertaining to lexical dimensions, but also richness, complexity, imagery, and arousal. Better matched scenarios can help us understand whether differences in memory performance have some functional value or are the result of other, confounding aspects of the scenarios themselves. Finally, Scofield et al.'s (2018) recent meta-analysis of the survival advantage provided important insights regarding the magnitude and relative importance of this area of work. Additional meta-analyses of the animacy and mortality salience literatures would be equally helpful in examining these issues, as well as those of methodology and power.

Acknowledgement The authors would like to thank Christen A. Carter for her assistance in preparing this work.

References

Altarriba, J., & Kazanas, S. A. (2014). Survival processing, attention, and interference. In B. Schwartz, M. Howe, M. Toglia, & H. Otgaar (Eds.), *What is adaptive about adaptive memory?* (pp. 123–138). New York, NY: Oxford University Press.

Aslan, A., & John, T. (2016). The development of adaptive memory: Young children show enhanced retention of animacy-related information. *Journal of Experimental Child Psychology, 152*, 343–350.

Bell, R., Röer, J. P., & Buchner, A. (2013). Adaptive memory: The survival-processing memory advantage is not due to negativity or mortality salience. *Memory & Cognition, 41*, 490–502.

Bonin, P., Gelin, M., & Bugaiska, A. (2014). Animates are better remembered than inanimates: Further evidence from word and picture stimuli. *Memory & Cognition, 42*, 370–382.

Bonin, P., Gelin, M., Laroche, B., Méot, A., & Bugaiska, A. (2015). The "how" of animacy effects in episodic memory. *Experimental Psychology, 62*, 371–384.

Bugaiska, A., Mermillod, M., & Bonin, P. (2015). Does the thought of death contribute to the memory benefit of encoding with a survival scenario? *Memory, 23*, 213–232.

Burns, D. J., & Hart, J. (2014). Lying, dying, and remembering: The encoding processes involved in survival processing. In B. Schwartz, M. Howe, M. Toglia, & H. Otgaar (Eds.), *What is adaptive about adaptive memory?* (pp. 53–73). New York, NY: Oxford University Press.

Burns, D. J., Burns, S. A., & Hwang, A. J. (2011). Adaptive memory: Determining the proximate mechanisms responsible for the memorial advantages of survival processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 37*, 206–218.

Burns, D. J., Hart, J., Griffith, S. E., & Burns, A. D. (2013). Adaptive memory: The survival scenario enhances item-specific processing relative to a moving scenario. *Memory, 21*, 695–706.

Burns, D. J., Hart, J., & Kramer, M. E. (2014a). Dying scenarios improve recall as much as survival scenarios. *Memory, 22*, 51–64.

Burns, D. J., Hart, J., Kramer, M. E., & Burns, A. D. (2014b). Dying to remember, remembering to survive: Mortality salience and survival processing. *Memory, 22*, 36–50.

Calvillo, D. P., & Jackson, R. E. (2014). Animacy, perceptual load, and inattentional blindness. *Psychonomic Bulletin & Review, 21*, 670–675.

Cho, K. W., Kazanas, S. A., & Altarriba, J. (2018). Survival processing in recognition memory: Separating recollection from familiarity. *American Journal of Psychology, 131*, 19–32.

Fiacconi, C. M., Dekraker, J., & Köhler, S. (2015). Psychophysiological evidence for the role of emotion in adaptive memory. *Journal of Experimental Psychology: General, 144*, 925–933.

Gelin, M., Bugaiska, A., Méot, A., & Bonin, P. (2017). Are animacy effects in episodic memory independent of encoding instructions? *Memory, 25*, 2–18.

Gelin, M., Bonin, P., Méot, A., & Bugaiska, A. (2018). Do animacy effects persist in memory for context? *The Quarterly Journal of Experimental Psychology 71*(4), 965–974..

Hart, J., & Burns, D. J. (2012). Nothing concentrates the mind: Thoughts of death improve recall. *Psychonomic Bulletin & Review, 19*, 264–269.

Kazanas, S. A., & Altarriba, J. (2015). The survival advantage: Underlying mechanisms and extant limitations. *Evolutionary Psychology, 13*, 360–396.

Kazanas, S. A., & Altarriba, J. (2017). Did our ancestors fear the unknown? The role of predation in the survival advantage. *Evolutionary Behavioral Sciences, 11*, 83–91.

Kazanas, S. A., & Altarriba, J. (2018). Predators as attention-grabbing. In T. Shackelford & V. Weekes-Shackelford (Eds.), *Encyclopedia of evolutionary psychological science*. New York, NY: Springer International Publishing.

Kazanas, S. A., Van Valkenburg, K. M., & Altarriba, J. (2015). Survival processing and the Stroop task: Does the survival advantage depend on deeper processing during encoding? *Evolutionary Psychology, 13*, 1–8.

Kazanas, S. A., Altarriba, J., & O'Brien, E. G. (under review). Paired-associate learning, animacy, and imageability effects in the survival advantage. *Memory & Cognition*.

Klein, S. B. (2012a). A role for self-referential processing in tasks requiring participants to imagine survival on the savannah. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 38*, 1234–1242.

Klein, S. B. (2012b). The effects of thoughts of survival and thoughts of death on recall in the adaptive memory paradigm. *Memory, 22*, 65–75.

Klein, S. B. (2014). Evolution, memory, and the role of self-referent recall in planning for the future. In B. Schwartz, M. Howe, M. Toglia, & H. Otgaar (Eds.), *What is adaptive about adaptive memory?* (pp. 11–34). New York, NY: Oxford University Press.

Klein, S. B., Robertson, T. E., & Delton, A. W. (2010). Facing the future: Memory as an evolved system for planning future acts. *Memory & Cognition, 38*, 13–22.

Klein, S. B., Robertson, T. E., & Delton, A. W. (2011). The future-orientation of memory: Planning as a key component mediating the high levels of recall found with survival processing. *Memory, 19*, 121–139.

Koriat, A. (1997). Monitoring one's knowledge during study: A cue-utilization approach to judgments of learning. *Journal of Experimental Psychology: General, 126*, 349–370.

Kroneisen, M., & Erdfelder, E. (2011). On the plasticity of the survival processing effect. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 37*, 1553–1562.

Kroneisen, M., Erdfelder, E., & Buchner, A. (2013). The proximate memory mechanism underlying the survival-processing effect: Richness of encoding or interactive imagery? *Memory, 21*, 494–502.

Kroneisen, M., Rummel, J., & Erdfelder, E. (2014). Working memory load eliminates the survival processing effect. *Memory, 22*, 92–102.

Kroneisen, M., Rummel, J., & Erdfelder, E. (2016). What kind of processing is survival processing? Effects of different types of dual-task load on the survival processing effect. *Memory & Cognition, 44*, 1228–1243.

Leding, J. K. (2018). The animacy advantage in memory: Manipulations of levels of processing and survival processing. *American Journal of Psychology, 131*, 273–281.

Li, P., Jia, X., Li, X., & Li, W. (2016). The effect of animacy on metamemory. *Memory & Cognition, 44*, 696–705.

McBride, D. M., Thomas, B. J., & Zimmerman, C. (2013). A test of the survival processing advantage in implicit and explicit memory tests. *Memory & Cognition, 41*, 862–871.

Nairne, J. S. (2014). Adaptive memory: Controversies and future directions. In B. Schwartz, M. Howe, M. Toglia, & H. Otgaar (Eds.), *What is adaptive about adaptive memory?* (pp. 308–321). New York, NY: Oxford University Press.

Nairne, J. S., & Pandeirada, J. N. S. (2010). Adaptive memory: Ancestral priorities and the mnemonic value of survival processing. *Cognitive Psychology, 61*, 1–22.

Nairne, J. S., & Pandeirada, J. N. S. (2016). Adaptive memory: The evolutionary significance of survival processing. *Perspectives on Psychological Science, 11*, 496–511.

Nairne, J. S., Thompson, S. R., & Pandeirada, J. N. S. (2007). Adaptive memory: Survival processing enhances retention. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 33*, 263–273.

Nairne, J. S., Pandeirada, J. N. S., & Thompson, S. R. (2008). Adaptive memory: The comparative value of survival processing. *Psychological Science, 19*, 176–180.

Nairne, J. S., VanArsdall, J. E., Pandeirada, J. N. S., & Blunt, J. R. (2012). Adaptive memory: Enhanced location memory after survival processing. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 38*, 495–501.

Nairne, J. S., VanArsdall, J. E., Pandeirada, J. N. S., Cogdill, M., & LeBreton, J. M. (2013). Adaptive memory: The mnemonic value of animacy. *Psychological Science, 24*, 2099–2105.

Otgaar, H., Smeets, T., & van Bergen, S. (2010). Picturing survival memories: Enhanced memory after fitness-relevant processing occurs for verbal and visual stimuli. *Memory & Cognition, 38*, 23–28.

Pate, S. (2013). *Comparing grief as a negative emotion to survival for memory enhancement*. (Unpublished honor's thesis). University at Albany, State University of New York.

Pexman, P. M., Siakaluk, P. D., & Yap, M. J. (2013). Introduction to the research topic: Meaning in mind: Semantic richness effects in language processing. *Frontiers in Human Neuroscience, 7*, 5–7.

Popp, E. Y., & Serra, M. J. (2016). Adaptive memory: Animacy enhances free recall but impairs cued recall. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 42*, 186–201.

Popp, E. Y., & Serra, M. J. (2018). The animacy advantage for free-recall performance is not attributable to greater mental arousal. *Memory, 26*, 89–95.

Rubin, D. C., & Friendly, M. (1986). Predicting which words get recalled: Measures of free recall, availability, goodness, emotionality, and pronounceability for 925 nouns. *Memory & Cognition, 14*, 79–94.

Savine, A. C., Scullin, M. K., & Roediger, H. L. (2011). Survival processing of faces. *Memory & Cognition, 39*, 1359–1373.

Schwartz, B. L., & Brothers, B. R. (2014). Survival processing does not improve paired-associates learning. In B. L. Schwartz, M. L. Howe, M. P. Toglia, & H. Otgaar (Eds.), *What is adaptive about adaptive memory?* (pp. 159–181). New York, NY: Oxford University Press.

Schwartz, B. L., Howe, M. L., Toglia, M. P., & Otgaar, H. (2014). *What is adaptive about adaptive memory?* New York, NY: Oxford University Press.

Scofield, J. E., Buchanan, E. M., & Kostic, B. (2018). A meta-analysis of the survival-processing advantage in memory. *Psychonomic Bulletin & Review, 25*, 997–1012.

Soderstrom, N. C., & McCabe, D. P. (2011). Are survival processing memory advantages based on ancestral priorities? *Psychonomic Bulletin & Review, 18*, 564–569.

Tse, C.-S., & Altarriba, J. (2010). Does survival processing enhance implicit memory? *Memory & Cognition, 38*, 1110–1121.

VanArsdall, J. E., Nairne, J. S., Pandeirada, J. N. S., & Blunt, J. R. (2013). Adaptive memory: Animacy processing produces mnemonic advantages. *Experimental Psychology, 60*, 172–178.

VanArsdall, J. E., Nairne, J. S., Pandeirada, J. N. S., & Cogdill, M. (2015). Adaptive memory: Animacy effects persist in paired-associate learning. *Memory, 23*, 657–663.

VanArsdall, J. E., Nairne, J. S., Pandeirada, J. N. S., & Cogdill, M. (2017). A categorical recall strategy does not explain animacy effects in episodic memory. *The Quarterly Journal of Experimental Psychology, 70*, 761–771.

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect. The PANAS scales. *Journal of Personality and Social Psychology, 54*, 1063–1070.

Weinstein, Y., Bugg, J. M., & Roediger, H. L. (2008). Can the survival recall advantage be explained by basic memory processes? *Memory & Cognition, 36*, 913–919.

Zhao, X., Li, H., Zhang, X., & Yang, J. (2018). Both the survival scenario and the death scenario improve memory recall regardless of the processing/priming paradigm. *Frontiers in Psychology, 9*, 793.

Nonhuman Primate Responses to Death

Sarah F. Brosnan and Jennifer Vonk

Introduction

Humans are preoccupied with death. In art and literature, there is a fascination with supernatural beings, specifically those that are immortal or "undead," such as vampires and zombies (more recently adapted for TV and movies). We celebrate Halloween with depictions of death, and are so obsessed with tragic news stories involving mass deaths, suicides, and disasters that there are dedicated cable networks covering both news and criminal cases, largely focused on murder cases. The awareness and fear of one's own eventual demise have inspired countless traditions, ranging from religious and spiritual beliefs to mourning and burial rituals. The fear of death has also been posited as an explanation for in-group biases and other cultural prejudices (e.g., terror management theory; Harvell & Nisbette, 2016; Rosenblatt, Greenberg, Solomon, Pyszczynski, & Lyon, 1989). In cases like this in which a trait is widespread across cultures and contexts, biologists begin to consider whether the trait evolved. Although there are many ways to answer this question, one approach is to examine whether other species share the trait. This comparative approach not only sheds light on whether a trait evolved, but may also indicate for what purpose and in what context it did so, which helps us to better understand the trait in humans as well. To what degree, then, do other species share our fascination with death? Given the significance attributed to the inevitability of death in shaping human cognition and behavior, it is surprising that research on how other species, particularly other primates, conceptualize and respond to death is severely lacking.

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T. K. Shackelford, V. Zeigler-Hill (eds.), *Evolutionary Perspectives on Death*, Evolutionary Psychology, https://doi.org/10.1007/978-3-030-25466-7_5

Understanding this will not only help us to better understand the question at hand—how other species understand death—but also more generally inform our understanding of the evolution of other behaviors and cognitive abilities.

A systematic study of primate responses to death can paint a fuller picture of the continuity, or lack thereof, between humans and other primates. A fundamental goal of comparative psychology is to isolate the role of particular processes in evolved tendencies, biases, and attributes by comparing multiple species (Eaton et al., 2018). This is of particular importance when attempting to determine which traits are unique to a specific species, most commonly humans. For example, language has long been considered to be a core capacity underpinning much of what appears to be uniquely human cognition, such as abstraction, theory of mind, and metacognition. If researchers are able to show that animals without humanlike language, or even a symbolic communication system, have abstract concepts, metacognition, or theory of mind, then language is not an essential building block for these capacities. Similarly, demonstrating that humans are unique in the way they conceptualize death may help to explain why humans alone engage in practices related to death (e.g., burial rituals and preservation of bodies) as well as organized religion, which also appears to be uniquely human.

In this chapter, we explore what (little) we know about primate conceptions of death. In addition to exploring what this tells us about the evolution of human conceptions of death, we will also consider what other primates' behaviors might reveal about their cognition and social behavior. We begin with a discussion of the cognitive capacities that may be required for a full representation of death and all that it entails. We then review the sparse literature regarding behaviors that result from the death of conspecifics. In addition, we report the results of an informal questionnaire in which we asked our colleagues about their experiences in working with captive primates to gather anecdotal evidence of differences in response to death among various primate groups. We end with a discussion of the challenges in interpreting primate responses to death, which parallel challenges faced in other areas of comparative psychology that require researchers to speculate about the internal workings of other minds.

Cognitive Capacities Required to Understand Death

Before considering how primates respond to death, we first must address the degree to which other species have the capacity to think about death. This is admittedly a black box, in that we can never know with certainty what another species (or, arguably, even another individual) thinks. However, we can understand the parameters of what is feasible based on the capacities species do or do not show (and, conversely, we might learn something about these capacities based on how primates respond to death and dying). Therefore, prior to introducing the evidence of how primates behave around dying or deceased individuals, we summarize a variety of cognitive capacities related to understanding death and dying to properly

place our interpretations of their behaviors into perspective. For each of these, we provide a brief summary of the state of the field and a consideration of why it is important in the context of death and dying.

Are Nonhuman Primates Capable of Abstraction?

An ongoing quest within comparative psychology is to understand the nature of concepts held by other species and, in particular, the extent to which they can reason about unobservables. Unobservables are hypothetical constructs that cannot, in principle, assume physical form and cannot be directly perceived (Vonk and Povinelli 2006). Death is one such construct. Although we can observe the process of dying and the physical remains of the deceased individual, we cannot perceive death itself. The construct of death involves other equally abstract ideas including the absence of life, agency, animacy, and "being." Humans have conjured the notion of a "soul," or a sense of self that provides us with an individual identity that continues across time and space. The idea of cessation of this self, including all thoughts and memories, is difficult to imagine and unsettling to most humans (Greenberg, Pyszczynski, Solomon, Simon, & Breus, 1994). Yet, humans can put voice or pen to such reflections, indicating that they understand the absence of existence, the finality of death, and its inevitability.

There is little empirical evidence that nonhumans represent these kinds of constructs. The lack of evidence is in part due to the challenges of studying abstractions. That is, it is premature to conclude that nonhuman primates lack such concepts; it may instead be the case that scientists have not yet broken through the barrier that precludes our access to the internal mental states of other beings. In this case, then, rather than our current understanding of nonhuman primate cognition constraining interpretations of behavior, it may be that a better understanding of observable responses to death can contribute to the larger corpus of data allowing us to make inferences about the internal states and concepts giving rise to such observable behavior.

Inevitability

A humanlike concept of death involves an appreciation of the inevitability of death—no one escapes, no matter how hard he or she tries to do so. Inevitability is a hypothetical, unobservable construct in its own right. Furthermore, understanding the certainty of an event that has not yet happened encompasses additional abstractions like the capacity to imagine the future and to calculate probabilities. The question of whether primates reason about the probability of events has barely been investigated (although see Eckert, Rakoczy, & Call, 2017; Tecwyn, Denison, Messer, & Buchsbaum, 2017), and the work that does exist does not address the prediction of future events never before experienced. As with any abstraction, part

of the challenge is in designing experiments to test the question, and it is likely that many primates can reason about the likelihood of future events based on previous experiences. For example, they may know that food will become scarcer as temperatures drop and day length shortens, or even that conspecifics will disappear if they hear an alarm call. However, the question of whether they anticipate their inevitable cessation of being is equivalent to asking them to imagine something that they have never directly experienced and may not have the capacity to comprehend (for reasons outlined in subsequent sections).

For humans, the certainty of death contributes to the anxiety it provokes. The question of whether other species ponder their eventual demise factors into discussions of animal ethics. One can suffer through the knowledge that one is going to die, but this suffering may be reduced or absent if an organism is unaware of its own death (Benatar, 2017). As such, a better understanding of how nonhumans think about death (if at all) may be critical to evaluating ethical practices in animal husbandry, especially in the food industry. Unfortunately, we are not aware of any empirical work that addresses this question. There are anecdotal reports that Koko, a gorilla that learned sign language, could communicate about death and loss, and even that she was sad upon hearing of the death of a celebrity she once met (Robin Williams; https://www.koko.org/koko-tribute-robin-williams), but these claims are unsubstantiated and anecdotal.

Finality/Absence

To properly represent death, an individual must comprehend the finality that comes with it. It is possible to imagine a number of constructs that together comprise the capacity to conceive of death. For example, first one must appreciate that physical objects—including living beings—continue in time and space; that is, they continue to exist when they are not observable (i.e., object permanence). Conversely, one must appreciate that objects can also cease to exist. A first test of this construct is to examine whether nonhumans can appreciate an absence of objects for a given category. This notion can then be extended to incorporate the idea that objects once present are now absent. To imagine death, one must then understand that this absence is permanent at some point. Lastly, one must generalize this idea of the disappearance of objects to understand the cessation of life in a living being.

Perhaps the most straightforward way to evaluate whether nonhumans appreciate absence at the most basic level is to test their understanding of a true zero concept (Nieder, 2016). Although the number of species tested for such a concept is negligible, Beran (2016) argues that monkeys, like humans, have a concept of zero as part of the analog number line that can be differentiated from other numerosities. This argument stems from recent findings of parietal lobe activation in response to zero (Okuyama, Kuki, & Mushiake, 2015). In this study, Japanese macaques (*Macaca fuscata*) added or subtracted stimuli from an array on a computer screen to match the number presented in a target stimulus. Brain activity was measured as the

monkeys performed the task. These results have been corroborated by studies in other monkey species. For example, Merritt, Rugani, and Brannon (2009) found that rhesus macaques (*Macaca mulatta*) treated empty sets like values along a numerical continuum in both matching and ordering tasks. Evidence of a zero concept has also been reported in a single grey parrot (*Psittacus erithacus*; Pepperberg, 2006*;* Pepperberg & Gordon, 2005), and in honeybees (Howard, Avarguès-Weber, Garcia, Greentree, & Dyer, 2018), suggesting that it may be an evolutionarily ancient capacity.

Outside the lab, additional behaviors suggest that some animals appreciate when objects cease to exist. For example, animals recognize when a food source has been depleted, as evidenced by discontinuation of searches for food at particular sites. However, an understanding of how nonhumans conceptualize the disappearance of objects is complicated by questions about the extent to which they exhibit object permanence. Many species struggle with the notion that objects continue to exist when they are no longer observable, and it has been suggested that only "more intelligent" species exhibit object permanence (Etienne, 1984). Thus, if an individual dies, and is removed from their group, their conspecifics may not continue to think about that individual. There is some evidence of object permanence in at least great apes (e.g., de Blois, Novak, & Bond, 1998; Jaakkola, 2014), but there is little evidence that they search for individuals that are missing. Some primates have grouping calls that function to minimize or maintain distance and keep the group together, but the extent to which these calls are under conscious control or lead to searches for missing group members is unknown. There is some evidence that primates do recognize when an individual is not returning to the group. For instance, orphaned infants are sometimes adopted (Cäsar & Young, 2008; Dunham & Opere, 2016; Thierry & Anderson, 1986) and group members recognize that a new alpha has assumed control of the group if the former alpha disappears (Pruetz et al., 2017; Scarry & Tujague, 2012). Even then, however, it is difficult to know whether they recognize that the individual has ceased to exist, or simply alter their behavior because the individual is no longer present. And, of course, alphas assume control of a troop after winning an altercation regardless of whether the deposed leader dies or drops in rank. Overall, whereas the evidence indicates little reason to question that nonhuman primates have a concept of absence with respect to physical objects, it is less clear that they can imagine the absence of self or nonexistence as it pertains to the mental lives of individuals.

Sense of Self

Comprehension of what death means for a living thing hinges upon an understanding of the continuation or extension of the self through time. If one exists only in the present, never reflecting on the past or anticipating the future, one is unlikely to represent the self as a being that extends through time with a past that is inextricably tied to the future. Despite the centrality of time in motivating planning, teaching,

and many other potentially uniquely human endeavors, the manner in which time, especially the future, is conceptualized is poorly understood in human children, and even more sparsely researched in nonhumans (Vonk 2016). Most researchers that have tackled this question have done so by examining planning abilities in animals like corvids (Kabadayi & Osvath, 2017) and apes (Bourjade, Call, Pele, Maumy, & Dufour, 2014; Osvath & Persson, 2013), but these studies typically allow for the subjects to form associations between future states and locations or objects, which does not require abstract planning (although it could; Hampton, 2018). In addition, the experiments often fall short of revealing a sense of autonoetic consciousness or a self that continues in time (e.g., Povinelli, Landry, Theall, Clark, & Castille, 1999; Povinelli & Simon, 1998). Thus, the corpus of data is currently mute on the question of whether animals anticipate themselves existing at some future point of time. Without such a reflection, the concept of death—of ceasing to exist—is less relevant.

In the preceding section, we contemplated whether nonhumans appreciate when some*thing* ceases to exist. However, a full understanding of death involves understanding when some*one* ceases to exist as well. This distinction would exist only for those that are capable of differentiating between animate and inanimate beings and identify themselves as the former. That is, an organism cannot understand the significance of ceasing to exist without first appreciating the existence of self and others as mental beings. Although an understanding of the mental states of others (i.e., theory of mind; Premack & Woodruff, 1978) is one of the most enthusiastically studied constructs in comparative psychology, the understanding of self has been more limited. The majority of empirical studies on self-concept have utilized Gallup's mirror self-recognition (MSR) paradigm (Anderson & Gallup Jr., 2015). However, this paradigm has been criticized on various grounds, with many researchers questioning the extent to which it reveals anything beyond an appreciation of body awareness (Anderson & Gallup Jr., 2011; de Veer & Van den Bos, 1999; Swartz, 1997). More recently, researchers have used video techniques to investigate whether nonhumans have a sense of self that extends in time (Hirata, Fuwa, & Myowa, 2017), although these tests have also been subjected to scrutiny (Vonk, 2018).

The construct of metacognition, or the ability to think about thoughts, may be more informative regarding self-awareness to the extent that it reflects an individual's understanding of one's own mental states. Research in this area has focused on attempts to reveal that animals know when they are experiencing uncertainty (e.g., Smith, Shields, & Washburn, 2003) or the extent to which they know what they know (e.g., Call & Carpenter, 2001). If animals can indicate that they know when they do (or do not) know information, and selectively work to access information they are lacking, they can be said to have achieved a level of self-awareness. Although the growing body of research on this topic suggests that many animals can make metacognitive judgments, the abilities demonstrated so far do not require consciousness (Kornell, 2009) and, thus, may not be sufficient to infer self-concepts.

Mental Time Travel

Like metacognition, episodic memory may depend on some level of self-awareness. Episodic memory is also relevant to the concept of death, given that it allows individuals to imagine future states. Episodic memory is sometimes defined as the ability to bind what-where-when components of a single event—the memory of which is evoked through cues linked to the event (Clayton, 2017), thus connecting past, present, and future. This construct might be extended to include an awareness that one exists and can shape the future. However, there is a consensus that existing studies of episodic-like memory cannot fully reveal a sense of autonoetic self that is similar to that expressed by humans when they write memoirs and reflect on their experiences (Schwartz & Evans, 2001; Shettleworth, 2012). The construct is coined "episodic-*like* memory" to express this limitation. As such, the current evidence of episodic-like memory in nonhuman primates is not sufficient to argue that primates can comprehend the limitations of their own existence into time.

Theory of Mind

There are distinct theoretical perspectives regarding the relationship between self-awareness and other-awareness, with some suggesting that self-awareness precedes other-awareness, and some suggesting that the latter occurs through simulation and projection (for reviews, see Apperly, 2008; Flavell, 1999). Regardless of how one conceives the relationship, it seems apparent that both abilities rest on the capacity to represent mental states, and simultaneously represent perspectives that may conflict with each other. Thus, the acid test for theory of mind has often been considered the false belief test, which has only recently been applied to nonhumans, with mostly negative results (Andrews, 2018). Although some species, including some nonhuman primates, have provided evidence suggestive of understanding some mental states, such as seeing, they have routinely failed to produce evidence indicative of false belief understanding (e.g., Call and Tomasello 1999; Marticorena, Ruiz, Mukerji, Goddu, & Santos, 2011 although see Buttelmann, Buttelmann, Carpenter, Call, & Tomasello, 2017; Krupenye, Kano, Hirata, Call, & Tomasello, 2016), leaving a high level of disagreement as to whether other species are capable of theory of mind (Burge, 2018; Heyes, 2017; Kano, Krupenye, Hirata, Call, & Tomasello, 2017).

If humans are alone in representing others' mental states, it follows that humans alone may have concepts of others as mental beings with distinct mental lives. If so, this might negate the ability of other species to conceive of the death of an animate being. One could argue that a fundamental divide between humans and nonhumans in the capacity to reason about mental states need not preclude nonhumans from conceptualizing death. Although this is true, it would mean that their concept of death is limited to an understanding of cessation of physical animacy and an absence of one's body. This is a restricted concept of death compared to the notion of death that grips

human imagination, although still quite useful for understanding how the human conception of death may have evolved (i.e., as a precursor to the human conception that may help us understand the steps through which it may have evolved).

Animacy/Agency Concepts

The human concept of death is restricted to animate beings. Although humans are prone to animistic thinking, and human children in particular often refer to cars, dolls, and other objects as if they are alive (Lillard, Zeljo, Curenton, & Kaugars, 2000), once adult, we distinguish between the death of, for example, a computer and the death of a pet or a loved one. It is not clear whether nonhumans perceive the death and decay of a conspecific's body any differently than that of a rotting fruit or burned-out tree stump. Furthermore, it is unclear whether they perceive the correspondence between a corpse and the individual that inhabited the body as humans do, or whether corpses are simply treated like strange and novel objects due to alterations in appearance, odor, and self-propelled movement (although see below for an argument that mothers hold on to the corpses of offspring because they cannot tell that they are no longer the same as their living offspring). Although it would be difficult to design an empirical study, future work could clarify the extent to which primates view corpses as synonymous with the living being that once occupied them.

There is evidence that monkeys see self-propulsion as an important component of animacy (Hauser, 1998; Tsutsumi, Ushitani, Tomonaga, & Fujita, 2012), just as infants do (Poulin-Doubois, Lepage, & Ferland, 1996). Additionally, squirrel monkeys can distinguish chasing movements from random movements by geometric objects (Atsumi & Nagasaka, 2015). Furthermore, primates distinguish between stimuli depicting live animals and inanimate objects in categorization tasks (Vonk, Jett, Mosteller, & Galvan, 2013; Vonk & MacDonald, 2002, 2004). However, in our own work, we have not observed that apes respond differently to images of living versus dead individuals when discriminating natural categories (Vonk et al., 2013; Vonk & MacDonald, 2002, 2004). Moreover, it is not necessary to differentiate between animate and inanimate to differentiate photos of animals from photos of foods, plants, manmade objects, or landscapes, so these somewhat artificial tasks may not provide much insight into how primates perceive dead individuals.

A better understanding of how primates conceive of death will inform several related lines of inquiry involving their capacity for abstraction. On the flipside, a better understanding of primate conceptions of various abstractions will inform our understanding of their conception of death. A deeper probing of how other minds view these aspects of their worlds will help us determine the similarities and differences between human and other primate minds, but there are other aspects of human existence that can be informed by studying parallels (or the lack thereof) between human and nonhuman primate minds.

Attachment Bonds

Studies of animals' responses to death may also tell us about the depth of their attachment bonds. This is an argument by analogy with humans, which we do not know for certain is appropriate, but in humans, the strength of a negative reaction to death seems to be proportional to the strength of the bond. This is true for conspecifics (other humans) as well as for heterospecifics, such as pets. Indeed, humans can feel deep loss even about a person they barely knew or never met, but feel bonded with through a cause (e.g., people who mourn the death of a celebrity). Thus, understanding the relationship between degree of attachment and intensity of negative reaction to death for other species can help clarify the extent to which there may be parallels between human and animal grief.

For instance, like us, other species may experience emotions surrounding an individual with whom they have formed an attachment, so understanding their responses to that individual's death provides access to understanding their emotional capacity. Although emotion in animals has been studied for years (Darwin, 1998/1899), the recent resurgence in interest (de Waal, 2011) includes attempts to find other ways to triangulate what is involved in the emotions of animals (see, for example, King, 2013). Relatedly, other species are argued to show prosocial concern for one another in some circumstances (Brosnan et al., 2010; Claidière et al., 2015; Hernandez-Lallement, van Wingerden, Marx, Srejic, & Kalenscher, 2015; Horn, Scheer, Bugnyar, & Massen, 2016; Horner, Carter, Suchak, & de Waal, 2011; House, Silk, Lambeth, & Schapiro, 2014; Schmelz, Grueneisen, Kabalak, Jost, & Tomasello, 2017), a behavioral outcome argued to be driven by empathy (Bartal, Decety, & Mason, 2011; Campbell & de Waal, 2011; Chen, Panksepp, & Lahvis, 2009; Langford et al., 2006; Yamamoto & Takimoto, 2012). If this is the case, might we expect to find empathetic responses to death? For example, we might find evidence of adults providing additional grooming or support (comfort?) to mothers who recently lost an offspring or adults who recently lost a partner with whom they had a close bond (e.g., a higher than average rate of grooming). Such findings would provide evidence that they not only feel their own loss, but are also able to conceptualize that others feel loss as well, even when they do not personally experience it as such.

Finally, finding group differences in grieving behaviors might indicate something about the groups' cultures (Whiten et al., 1999). Most documented cultural differences have involved instrumental behaviors, such as tool use (Whiten, Horner, & De Waal, 2005) or food acquisition (Byrne, 2007), possibly due to the fact that these are the easiest to test experimentally in the lab (Bonnie, Horner, Whiten, & de Waal, 2006). There is, however, evidence of cultural differences in social behavior (e.g., grooming styles; de Waal & Seres, 1997), and it would be important to document whether there are differences in social relationships as well. As noted, human cultures exhibit a vast array of distinct burial rituals and traditions, so studying primate reactions to death offers an opportunity to explore potential cultural differences further.

Empirical Studies of Primate Responses to Death

Primates are not the only species to respond to a dead conspecific as if there were something awry. Indeed, even insects do so. Worker myrmicine ants rapidly remove deceased group members from the nest, presumably to avoid the spread of potential pathogens (Wilson, Durlach, & Roth, 1958). This system appears to be driven entirely by chemical signals, however. For instance, in the species *Linepithema humile*, individuals who die cease producing two key chemicals, and their absence apparently triggers removal behavior. What most researchers who study death are interested in, however, is not these relatively stereotyped responses that are genetically or chemically controlled, but emotional responses that indicate something akin to grief.

Although the literature is relatively sparse, reported responses to death in primates follow the same general patterns.[1] Subjects who experience the death of a close conspecific are reported to show an increase in exploratory behavior of the corpse, a short-term failure to reduce behaviors not appropriate for a deceased individual (e.g., mothers carrying their babies' corpses after they have died and are, in some cases, substantially decomposed), and changes in their own behavior patterns (e.g., avoiding the area of the death, restless sleep). The alternative to this response appears to be an absence of change in behavior rather than changes of a different sort. Unfortunately, there is no research that we know of on hormonal or neural changes, which would be useful for cross-species comparisons and would provide an additional measure for documenting changes. Nonetheless, the current literature does indicate some patterns that are worth exploring in more detail.

One of the challenges of studying primate responses to death is that there are not many carefully documented examples. Part of this may be due to the fact that, until recently, reactions to conspecifics' deaths were not reported, so it is difficult to determine the extent to which the absence of these reports is due to the lack of behavioral changes versus a lack of experimental effort. Moreover, the opportunity to study reactions to death is a rare occurrence in the course of most studies. Primates, depending on the species, may live as long as five or six decades, and even the longest running field sites are less than four decades old (and many are just a few years old). Moreover, when primates do die, there is no guarantee that the death will be in the presence of either conspecifics or experimenters who can record others' reactions. In captivity, where it is easier to observe subjects' reactions, individuals may be removed at the time of, or very soon after, death. In the wild, subjects may be absent from the group when they die or experimenters may not be present.

There are additional challenges relating to captivity. There may be fewer reports from captivity, because most captive facilities, including zoos and sanctuaries, are often reluctant to discuss primates' deaths, even in cases of natural deaths. Even

[1] Whether this is because they are consistent with one another or because they are consistent with what we know as humans, and therefore project on to what we see in other species, is a different question that we will ignore in this chapter.

when we do have data, there is substantial human involvement in captive settings due to regulations associated with health and well-being. In captive groups, subjects may not have been with the same conspecifics long enough to form close relationships; even in zoos, they can be moved relatively frequently for reasons that are related to the species' well-being (e.g., the Species Survival Plan), and transportation to other facilities, such as sanctuaries, may separate individuals from long-term companions, breaking these close relationships. In addition, veterinary regulations may make it impossible to leave a corpse with the group for them to explore it. Finally, if an animal dies of a long-term illness, at the end they may be separated from their group.

In addition, it is not clear what we should be measuring, so most studies are either descriptive, summarizing all events surrounding the death, or are based on hypotheses focused on what we have come to expect to occur during and after a typical death. The former is problematic because it can be difficult to unpack what is important from the large amount of data, whereas the latter is insidiously dangerous, as it risks missing key elements surrounding the event, and our hypotheses are often biased by what we expect from our experience as humans. Nonetheless, despite these challenges, this is an important area of work to explore further. Below, we synthesize what is known about primate responses to death and what these results tell us about the underlying theory.

Infant Death

The most widely reported phenomenon is how adults, typically mothers, respond to the death of their infants. It is notable, therefore, that there is no published evidence of maternal nurturing of dead infants in prosimians (Santini, 2011; there is also not much evidence of any sort of postmortem behavior in prosimians). However, this oddity may hide a deeper point: postmortem attention is not always possible and, in lemurs, basic anatomy means that mothers cannot carry dead offspring (Nakamichi, Koyama, & Jolly, 1996; Rosenson, 1977). Thus, their lack of postmortem maternal care cannot be described as indicative of lack of attachment without evidence that it is not due to their inability to carry the corpse (Nakamichi et al., 1996; Santini, 2011). Indeed, supporting this hypothesis, Santini (2011) reports a case in which a baby fell off its mother's back and she attempted to stay with it for several hours, but when the group moved on she had to choose whether to stay with the baby or follow the group (and she chose to follow the group). This situation highlights one of the challenges of studying behavioral responses to death (or any behavior): individuals have conflicting needs and the absence of an apparent behavioral response could be due to greater pressure from another need rather than an absence of a response to a conspecific's death.

Unfortunately, there is not much evidence from New World monkeys, making broader generalizations about the primate order premature. In the only formal report we could find that, in an experimental setting, squirrel monkey mothers did carry

corpses of infants, but this depended on context (Kaplan, 1974). Females whose infants were stillborn or died within a day of birth showed maternal responses to all infant bodies they were presented with, whereas mothers whose infants survived longer than 2 weeks were more likely to respond to their own infant's body than those of others. However, this was a somewhat unnatural study, making it difficult to extrapolate, especially in the absence of more data about New World monkeys.

The only report from the wild that we found regards an 8-month-old capuchin (*Cebus capucinus*) male who was orphaned when his mother was killed by a poacher at the long-term study site of Lomas Barbudal in Costa Rica. Perry and Manson (2008) report that he spent the entire day "near her body, cooing and trilling piteously, and nursing futilely from her dead body" (p. 236). What may be more intriguing is his behavior after her death. Despite both being separated from his group that day and being young enough that he should nurse as often as once an hour, he was allo-mothered by the adult females in the group and survived. His behavior changed, however, in ways atypical for his developmental stage; he more than quadrupled the percentage of time he spent alone, dropped to 2% of his former rate of play, and, out of necessity, learned to forage. However, despite being more effective at foraging than other yearlings, he spent twice as much time foraging as he had prior to his mother's death, which concomitantly reduced his social time. Although many of these changes can be explained by necessity, his life was deeply impacted by the death of his mother. Similar effects have also been reported for orphaned chimpanzees (Botero, MacDonald, & Miller, 2012), with two orphaned juvenile chimpanzees spending less time in play and more time exhibiting anxious behaviors compared to four peers that still had their mothers. Whereas the lack of information on New World monkeys is largely due to the relatively lesser experimental effort as compared to Old World monkeys and apes, this example indicates that more information is needed to determine the degree to which patterns seen in apes and Old World monkeys extend across all primates.

Even in Old World monkeys and great apes, the record is spotty and often based on very small sample sizes. The most comprehensive primate study we could find is an analysis of 157 cases of deceased infants being carried by their mothers among a group of Japanese macaques over the first 24 years of study at the Takasakiyama research site in Japan (Sugiyama, Kurita, Matsui, Kimoto, & Shimomura, 2009). Their survey results present a compelling case that bonding is critical in generating post-death carrying behavior, but that there is a trade-off with the infant's age at death. Seventy-four percent of carried infants were live born. Considered from another angle, of the infants carried, only 23% of those that were stillborn were carried, whereas nearly 90% of those that lived only 1 day were carried, so there is a striking increase in carrying behavior based on a fairly short amount of potential bonding time. The greatest likelihood of carrying was for infants that died between 1 and 30 days after birth: about 50% of corpses of babies who died within the first 10 days were carried, and fewer than 5% of corpses of babies who died after 30 days were carried. Deceased babies were carried on average 3.3 days, with a range of 1–17 days. About a third were carried only a single day, and about 80% were carried for no more than 5 days. Together, these data indicate that some bonding with a

living infant is important for postmortem carrying, but also that older infants are rarely carried, despite presumably greater bonding.

Indeed, most studies of responses to death focus on the importance of the relationship between the mother and baby. A report of Yunnan snub-nosed monkeys in China discussed three cases of infant death, one born live and two stillborn (one at term, one preterm). The mother whose baby was born live carried it for 4 days following the death, whereas the mother of the term stillborn carried it for only a day and the mother of the preterm stillborn did not carry it. The authors suggest that duration of relationship strongly impacts infant-carrying behavior (Li, Ren, Li, Zhang, & Li, 2012). However, a long-term relationship is clearly not essential, as mothers will carry stillborn infants, and even try to retrieve the body if others claim it (chimpanzees: Kooriyama, 2009).

Moreover, not only mothers carry infants. In the above examples, non-mothers sometimes interacted with the corpses, and Warren and Williamson (2004) report prolonged carrying of two infant mountain gorilla corpses by both mothers and other females. They propose that the non-mothers gain parenting practice from interacting with the corpses. Indeed, this may not be surprising; in many contexts, females, especially young ones, try to get access to infants, for reasons that are not entirely clear (Small, 1993). We wonder if one reason why non-mothers are so interested in these corpses is that it is easier to get access to deceased infants than live infants. If this is the case, it might suggest that, despite mothers' efforts to retrieve stolen corpses of their infants, they are not as protective of them as they are of their live infants. Trying to quantify the frequency of theft of corpses versus live infants might provide more insight into the mothers' attachment to the corpse relative to the live infant and, in particular, whether her attachment decreases as time passes.

If mothers start carrying a corpse, what factors affect when they stop? One possibility is that mothers (and other group members) are simply confused, and initially do not understand that the corpse is lifeless. After all, initially it *looks* like the baby, even though it does not move or vocalize. If primates do not understand the concept of death, the combination of familiar olfactory and visual cues, even in the absence of familiar behavioral and vocal cues, may lead the mother to treat the corpse as her infant until further information can be gathered (Hrdy, 1999; Santini, 2011). The slow decomposition in extreme environments (i.e., very cold, very dry) may elongate this process in some species. Chimpanzees in Bossou, New Guinea, regularly carry and groom their infants for extended periods (19–68 days), which may be facilitated by the fact that the babies' corpses appear to mummify (Matsuzawa, 1997; despite the smell of decay; Biro et al., 2010). Fashing et al. (2011) report a high rate of carrying in gelada over extended periods, and suggest that this is due to an extreme environment that promotes mummification of the babies. Finally, the attachment bond between mothers and infants may be difficult to break (Li et al., 2012), potentially due to a combination of emotional attachment and an endocrine system that takes time to catch up with the mother's new reality (Biro et al., 2010; Kaplan, 1974).

One possibility that we have not seen reference to in the literature is that females may be loath to give up the baby if they are getting extra attention because of its presence. Babies are widely sought after in primate societies, and low-ranking females may in particular benefit by the extra attention they receive for having an offspring (this is primarily a benefit, but can be a problem when it results in kidnapping of low-ranking mothers' babies; reviewed in Small, 1993). It may be that these mothers are particularly likely to continue to carry the corpse because the benefits remain even after the baby has died. If this is the case, we predict that individuals who get more benefits from having babies will be more likely to carry the corpses, and for longer. This would include lower ranking individuals, but also individuals who receive a higher-than-average amount of grooming or other social support from females who wish to access their infant.

Care of Dying and Dead Adults

There is less evidence of subjects' responses to dead and dying adults than to infants. In this case, some of the best evidence comes from captivity. One of the best documented examples is from a small zoo group at Blair Drummond Safari Park in England (Anderson, Gillies, & Lock, 2010). The alpha female of a group of four adult chimpanzees, Pansy, died after an illness, and the caregivers documented how the others' behavior changed in the time surrounding her death. Conveniently for the report, the authors had been performing a nighttime sleep study prior to her death and therefore had good before-death and after-death data on subjects' baseline behavior. They note that Pansy's adult daughter slept with her the night she died despite having never been seen sleeping in that particular location on the sleeping platform in the 29 previous nights of the study, and the daughter went to sleep more than 90 min later than any of her previously recorded times. In addition, the three surviving adults' postural changes during the night rose from a range of 0–14 over the 29 nights of the study to 11, 15, and 42 times the night of Pansy's death. Curiously, none of the other adults groomed Pansy after death, which is in contrast to most of the reported literature on infant deaths. However, the other female groomed the male far more than was typical in any previous night, and the male, who had displayed only three times on all previous evenings combined, displayed three times that night, each time ending by attacking Pansy's corpse. The authors report that the surviving chimpanzees were "profoundly subdued" (p. R350) for the subsequent 2 days. Once the night area was opened up, the male refused to enter it, the chimpanzees slept in their day area the first night, and for five nights subsequent to the death, no chimpanzee nested on the platform on which the female had died, despite someone nesting there each of the previous 29 nights of the study. Pansy's daughter was the first to resume sleeping there. Although only anecdotal due to the small sample, the fact that there is quantitative before and after data demonstrates that the surviving chimpanzees changed their behavior both the night of the death and for at least several days subsequent to it.

Other reports also indicate a high degree of curiosity or agitation following the death of a non-infant. A study of the death of a 9-year-old male in a sanctuary group showed that, subsequent to his death, others were extremely interested in the corpse, gathering around and grooming, with some display behavior (van Leeuwen, Mulenga, Bodamer, & Cronin, 2016). Similar to the case with infants, the authors suggest that the degree of social bonding influenced responses, as the most attention was given by a male with whom the deceased male had formed a close bond after his mother's death. This is supported by evidence from Sichuan snub-nosed monkeys (*Rhinopithecus roxellana*), who form one-male units. Yang, Anderson, and Li (2016) report on the death of an older female in which the members of the one-male unit and, in particular, the male, paid close attention to the female in the last hours of her life, including grooming her and keeping others away. The male stayed with her briefly after she died, and appeared to hesitate in following the rest of his unit away from her corpse. They report far more interest from the members of the unit than from other units, which they interpret as a result of their closer social bond.

Indeed, if the social bonding hypothesis is true, one would expect that offspring would be particularly affected by the death of a parent, which appears to be the case. Goodall (1990) reports an instance in which a fully weaned chimpanzee offspring, Flint, quit eating and died subsequent to his mother's (Flo's) death. There also appears to be recognition that individuals who lose a mother may require extra care and assistance. There are several documented cases of adults, usually siblings, assuming additional care of a younger—but weaned—chimpanzee orphan, allowing it to share a night nest, sharing food, and otherwise providing additional grooming and support (Hobaiter, Schel, Langergraber, & Zuberbühler, 2014; Thierry & Anderson, 1986). Reports of adoption appear in monkeys as well as apes (e.g., rhesus monkey; Berman, 1982; chacma baboons, Hamilton, Busse, & Smith, 1982).

Whereas most reports of infants' response to the death of their mothers come from the wild, Whilde and Marples (2011) report on the case of a captive 3-year-old female orangutan that lost her mother. In this case as well, the orangutan appeared to be adopted by another adult female, without human intervention. Fortuitously, these authors also had observed the infant's behavior before and after her mother's death. Consistent with other reports, the infant decreased time spent resting and increased time spent in other activities like climbing and object manipulation. These authors point to a literature involving the behavior of infants that are separated from their mothers, which would make an interesting comparison if enough data could be amassed. Another captive report documents a 3-year-old orphaned bonobo that apparently survived in the absence of an adoption bond (de de Lathouwers & van Elsacker, 2007). She showed an increase in initiating grooming toward other group members following her mother's death, but also received more aggression from the group. The authors acknowledge the obvious developmental confound in comparing pre- and post-observations, but document that these behaviors differed from those of typical bonobos of the same age. With further examples, it might be possible to determine which behavioral changes are a direct response to the death of a mother, rather than other factors.

In what appear to be even more atypical cases, care will be provided even in the absence of the mother's death. In one case, unrelated females provided care to a young male separated from his mother for 6 days until they were reunited (Uehara & Nyundo, 1983), and in another a grandmother adopted an infant for unknown reasons (Wroblewski, 2008). These are important observations as they suggest that postmortem care is a continuation of behavior that exists even in the absence of a death.

Killing in Primates

One area that is typically neglected in discussions of animals' responses to death, which focus on natural deaths, is that individuals do sometimes kill conspecifics. A fuller representation of primates' concept of death requires understanding both why individuals sometimes kill conspecifics and whether responses to a violent death differ from those to a natural death. For instance, in infanticide, a non-maternal adult kills a newborn infant. This is widespread across the animal kingdom (Hiraiwa-Hasegawa, 1988; Janson & van Schaik, 2000). The predominant situation involves a newly high-ranking or immigrant adult male killing a newborn (e.g., Teichroeb, Wikberg, Bădescu, Macdonald, & Sicotte, 2012). Because the mother will come back into estrous sooner without a baby nursing, the hypothesized function of this is to promote the male's reproductive output by giving him additional opportunities to mate before he, too, is overthrown (e.g., Beehner & Bergman, 2008; Yao et al., 2016; although see Alvarez et al., 2015; Bartlett, Sussman, & Cheverud, 1993). Much research focuses on the mothers' reactions, which are to try to avoid the event. For example, across animal species, females have evolved several strategies (e.g., pseudoestrous, early weaning; Beehner & Bergman, 2008) to protect either very early pregnancies or babies that are nearly old enough to survive on their own, and may also spontaneously abort if the pregnancy is further along, as well as strategies such as promiscuous mating to avoid infanticidal males and copulation calls to solicit male mate guarding (Pradhan, Engelhardt, van Schaik, & Maestripieri, 2006). At least one study has shown that cooperation between putative fathers and mothers might reduce the threat of infanticide in sooty mangabeys (Fruteau, Range, & Noë, 2010). Although they behaviorally attempt to avoid infanticide, females typically will not invest too much, presumably due to the high cost of an altercation with a potentially much larger male and the fact that they can try again with another offspring soon. Do females tend to carry these infants? If not, why not? Is it that they fail to bond to an infant that they anticipated would be attacked, or that carrying the baby would exacerbate the male's aggression? In some cases following infanticide, infants are cannibalized (e.g., Culot et al., 2011), so does this account for any reduced carrying? Understanding maternal responses to infanticide will be useful in providing data on an alternative to natural death, which will be informative in determining the degree to which maternal responses generalize across contexts.

Adults will also kill other adults. One of the best documented examples of within-group adult lethal aggression is a long-running power struggle among three

dominant males in the group at the Arnhem Zoo, the Netherlands, documented in the book *Chimpanzee Politics* (de Waal, 1982). Jeroen, the long-time alpha male, was eventually superseded by two younger males, Luit and Nikki. Individually, Nikki was the strongest of the three, but Luit and Jeroen formed an alliance, lasting years, that allowed Luit to be the alpha and Jeroen to be the "power behind the throne," who was allowed to mate and maintain substantial power in return for supporting Luit as the alpha. Eventually, the alliance crumbled and Nikki became alpha almost instantly. One night, while no humans were there to observe, the males got in a fight that killed Nikki. The keepers found the males in the morning together, with the other two males tending to a dying Nikki. De Waal notes that, despite the antagonistic relationship, and the fact that these males had just dealt a mortal wound to Nikki, the males' actions in tending him appeared to indicate that they cared for him. Although this anecdote does not tell us anything about their understanding of death (e.g., Did they realize that he was going to die? Was that their intention?), it does indicate the strength of even adult male chimpanzees' bonds with one another, and suggests a complexity to their relationships.

Finally, males also engage in aggressive, sometimes lethal, interactions between groups. This is typically in the context of territorial defense, although females separated from their group may also fall victim to lethal attack, sufficiently often that females prefer to remain in the center of their territories and avoid areas with frequent intergroup encounters. In the last few decades, it has also become clear that chimpanzees will systematically annihilate the members of other groups in order to take over their territory and females. The first documentation of this occurred at Gombe following a split of the Kasakela group into two separate groups. Several years later, the Kasakela group began to systematically kill males in the new Kahama group, despite the fact that they were mostly known individuals, including close kin. Within another few years, the Kasakela group had annihilated the Kahama group, and there was once more a single group (Goodall, 1986). In this case, we know of no evidence that the males in the Kasakela group experienced anything like remorse over the deaths of their former group mates and kin, but this and subsequent reports from other field sites reveal the frequency of lethal aggression in these apes (Mitani, Watts, & Amsler, 2006; Nishida, Haraiwa-Hasegawa, & Takahata, 1985; Watts, Muller, Amsler, Mbabazi, & Mitani, 2006; Wilson et al., 2014). Any understanding of primates' responses to death will be incomplete without understanding not just their responses to individuals that die of natural causes, but also death in the context of individual or group conflicts.

How Do We Think Primates Respond to Death?

The above results focus on what we see from observing primates, but there are two issues. First, for various reasons (e.g., poor observation conditions, lack of controlled observation protocol), in most situations in which primates die, the reactions of their group mates are not recorded. Second, as we have mentioned, much of what we have access to is implicitly biased by what we expect, and in most cases what we

expect is a sadness that mirrors our own. In the case of long-lived, intelligent animals, including primates, researchers form a bond with the animals, whether they are observing them in the field or working with them daily in a captive setting. As a result, the *researchers* mourn when individuals die, and it is frankly hard to separate our feelings from those of the animals we are assessing.[2] As a result of these two issues, we thought it would be informative to present an informal summary of how those people who work with nonhuman primates think primates are reacting as an initial attempt to gather more information for hypothesis testing.

To do this, in the fall of 2018 we contacted colleagues who work with nonhuman primates to ask for their recollections of primates reacting to the death of conspecifics. We asked a series of questions that respondents could answer anonymously via the Internet.[3] We asked about their history working with primates and for descriptions regarding any death event they had experienced. We asked whether the animals in question were housed socially and whether the group showed any changes from typical behavior in the period immediately preceding and following the individual's death. We asked whether the group members had access to the body of the individual after death. We avoided asking leading questions such as whether the respondents would describe the primates as exhibiting grief; rather, we asked whether respondents noticed any effects of the death on other members of the group, and how they responded to the body (if applicable). Note that this is an informal query of our colleagues, without random sampling methods. The purpose is simply to provide some insight into primatologists' experiences.

Thirty-eight of our colleagues replied. Of these, 47% currently work with primates. The most highly represented context was the zoological setting (82%), whereas 40% of the sample had worked with primates in a laboratory setting and 37% had worked with primates in a sanctuary (as is evident, many worked in more than one context). Most of our respondents worked as primary caretakers for the primates (82%), but 50% had worked as researchers as well. All respondents had worked with primates for at least 1 year, with 53% having worked with primates for over a decade. The majority of the sample (84%) had experienced at least one death of a primate in their care. Our small sample was also biased toward observations of captive primates, especially chimpanzees, and the most detailed description of responses to death came from respondents reporting on chimpanzee behavior.

Nonetheless, some interesting patterns were apparent in the responses. The clearest expressions of grief appeared in cases of strong social bonds, as is present in the literature when females lost offspring or pair-bonded species lost their mates.

[2] The mourning by researchers is such that many primate centers, including those where we have worked, have traditions that mark the passing of any individual, ranging from making footprints of the deceased individual for each staff member to keep to planting of apple trees or leaving a permanent marker in a memorial area. One of us heard a researcher we work with tell a science writer that losing an ape you had a relationship with was somewhere between losing a beloved family dog and your child.

[3] We thank all of our colleagues who shared their thoughts with us.

Considering the former, our respondents observed carrying of an infant's corpse in a group of hamadryas baboons, a species for which this has not been reported in the literature. One respondent also indicated that the mother continued to "mope" even after she stopped carrying the corpse. Considering the latter, a male tamarin was described as being distressed and frequently crying in the weeks following the death of his mate, and another was described as experiencing malaise after the death of a sibling. Little is known about lesser apes (i.e., gibbons, siamangs), but as with the callitrichids and owl monkeys they show long-term pair bonding and a monogamous mating structure. One respondent reported that a male gibbon engaged in copious singing, both alarm and mating calls, following the death of his partner, but another reported the case of a murder of a female gibbon by a male partner, reminding us of the variability in primate social behavior. It is of course unclear whether these events really inspired the most intense reactions, or whether respondents projected their own feelings onto situations in which they themselves would experience the greatest degree of loss. However, it is interesting to note that these contexts mirror the literature (although, again, it is not clear whether this is because these are the most common contexts for grief-like behavior, or because these are the contexts in which researchers expect to see grief).

Considering adults, the loss of alpha individuals led to changes in behavior and group structure, which were described more often than expressions of grief. In many cases, there were changes in behavior, but it was not clear that they were due to grief. Changes in dominance hierarchy, appetite, and activity levels were reported in capuchins. In Old World monkeys, such as macaques, responses were described as ranging from indifferent to chaotic. However, respondents also indicated that the loss of a drill, who collapsed while on exhibit in a mixed-species display with another drill and several silverback gorillas, sparked copious vocalizing from the gorillas, which was described as angry and fearful. The caretakers also reported changes in food consumption and greater willingness to shift between habitats following the death. Members of both species appeared agitated for weeks following the death, and the gorillas continued to appear anxious and were less compliant for weeks following the removal of the remaining drill from the zoo (he was sent to live with other drills at another zoo). Thus, the remaining primates may not have known whether the transferred male had been relocated or also had died. Reports of antipathy following the death of a group member were most likely to come from prosimians (lemurs) and macaques. There were very few observations with these species, but given the dearth of reports from lemurs in the wild captive reports may be important for understanding this taxon.

There were also contexts in which behaviors potentially related to grief were reported. Observers noted that a young spider monkey appeared to struggle with understanding that an older monkey was no longer present in an adjacent enclosure where he would travel after meals to socialize. That is, his behavior did not immediately change to reflect the absence of his social partner and may have reflected either an inability to process that the older monkey was gone or the kind of grief-based behavior one sees in humans when they visit places where they spent time with deceased loved ones. In olive baboons, the impressions of the

response to the death of an adult female were mixed; a male was reported to miss the female for a period of about 2 weeks, whereas no changes were observed in a multi-female group.

Finally, we received the most detailed descriptions in the great apes (including orangutan, gorilla, and chimpanzee groups). Respondents reported that orangutans exhibited some distress and grieved for several days following the deaths of group members. Grief was described as lethargy, loss of appetite, and despondence. The deaths of dominant females were also described as leading to increased fighting between the remaining female group members. The only gorilla observation we received is restricted to the mention of "some gorillas seeming upset" after a young female died accidentally. Only with chimpanzees did we receive descriptions of individuals investigating the body after death. Chimpanzees were described as being quite aggressive with bodies—poking them with sticks and, in one case, mutilating the face. Others described chimpanzees as being fearful of bodies—making rapid touches and quickly withdrawing, while also screaming. Chimpanzees were also described as whimpering following the death of infants and close associates. They were also described as undergoing a period of quiet that could last anywhere from days to more than 1 month. A chimpanzee mother that lost an infant carried the dead infant. She exchanged the body for a highly valued reinforcer after a few days. Deaths of alpha males resulted in significant shifts in the social structure of groups, sometimes leading to dissolution of the group. Groups were reported to be "subdued" following the death of a group member and less engaged with typical activities such as feeding and keeper enrichment. Again, it is unclear whether chimpanzees show the most grief-related behavioral changes, or whether humans are more likely to expect them in chimpanzees and so overreport compared to other species.

Challenges in Interpretation

It is hardly surprising that deaths of important group members would result in changes in behavior within social groups or pairings. At a minimum, there is a change in group membership, and it may involve a stressful event (fight, fall) or an atypical stimulus (dead body). What is challenging is whether to attribute changes to emotional responses to the loss or whether these behaviors are normal responses to openings in social hierarchies, opportunities to mate, or just change in normal activity. These changes in behavior may be due to any number of factors that do not require inferences about mental distress and grief. Thus, like much of the cognitive work reviewed above, observing only behavior is informative about what animals do, but can tell researchers relatively little about the mental experiences of the surviving members of a group. Below we outline some of the challenges facing anyone who wishes to undertake systematic study of this topic.

Bias in Reporting

Perhaps the most pervasive problem (with anthropomorphic interpretations, discussed below, as a close second) is the bias in the research effort on this question. In many cases, we simply do not have the data that we need to determine how primates respond to death. We routinely miss the moment of death, because animals die when no researcher is around, including at night, or, in captive settings, because the animal is removed prior to the moment of death. This leads to a very small sample. There is also an existing bias in the distribution of studies overall, with the most research effort invested in apes, followed by Old World monkeys (often limited to just a few species, such as macaques), followed by New World monkeys. Finally, as discussed above, most cases involve individuals in very close relationships, such as mother and offspring or mated partners. Is this a bias because close relationships elicit the strongest responses, or a bias because that is the context in which we tend to look for such responses? We cannot answer this question.

Another bias is that we do not know what to look for, so we end up looking for analogues to human emotion and behavior (e.g., lack of appetite, disturbed sleep, lethargy) and may be missing other expressions of grief in nonhumans. Looking for the sorts of responses we expect in humans is a reasonable place to start, thanks to our close phylogenetic relationships; indeed, most humans can identify an angry chimpanzee, because their responses look like ours, including screaming, running, banging, and throwing things (if you do not have children yourself, then spend a little time on a playground for a great display of this sort of anger response). However, naïve humans are not very good at identifying a happy chimpanzee, because they assume that a smile indicates contentment, whereas in chimpanzees a smile (silent bared teeth display) indicates fear, particularly in a social context (Preuschoft & van Hooff, 1995; indeed, humans are poor at correctly interpreting the cues of animal emotional responses, in general; Maréchal, Levy, Meints, & Majolo, 2017). Whereas this may be the precursor to the human smile, it is a similar expression used in a *very* different context. So the big question with primate responses to death is what are they more like? Chimpanzee anger or chimpanzee "smiles"? If primates' responses are not similar to ours, we have another problem in that we must determine what we should be looking for.

Lack of Controlled Studies

A second difficulty is that the gold standard of evidence, carefully controlled studies, is all but impossible in this context. Even if it were ethically possible to conduct such studies (which, to be clear, it is not), it would be difficult to mirror a natural context of death in such an unnatural situation. As a result, all of the observations of primate death vary on numerous factors and an enormous sample size will be needed

to reveal consistent reactions and to determine whether and how specific contexts influence primates' reactions.

Related to this, one definite gap in our knowledge is how primates' responses to death vary from their responses to other situations in which individuals are removed from the group. Again, the gold standard to assess whether they perceive these two situations as meaningfully distinct is a careful comparison of reactions in contexts of removal versus death, but this is not ethically possible. As a result, we are left with the few instances in which primates disappear outside of the context of death. It is unlikely that two equivalent cases will occur within the same social group during the same period of time, thus introducing a plethora of confounds into any comparison that one would make. In cases such as infant death, in which there is no natural situation in which disappearance does not also mean death,[4] we could potentially assess responses in cases of natural death versus infanticide to see if differences occur.

Finally, there may be differences in behavior in captive versus wild settings, but it is not obvious in what direction these differences will go. Would you expect to see more responses in captive settings because, freed from the constraints of finding food and shelter and avoiding predators, the primates have more time and energy available to mourn? How is mourning influenced by the less natural social bonds? Do the smaller groups and reduced social flexibility make the death more stressful, or does it lead to less strong bonds and, therefore, less response to death? In a wild context, are responses to death more or less extreme (when compared to captive settings)? Deaths are likely more frequent (it is a much more challenging environment and there is no access to veterinary care) and it is a more natural context where primates have many other pressing concerns and threats to survival that they do not encounter in captivity, but again it is not clear how that would influence mourning.

Anthropomorphism

Anthropomorphism looms large over the study of primates' emotional responses in any context, and their response to death is particularly salient. When we observe animals behaving as humans do, it is tempting to attribute to them the same inner states, including thoughts, intentions, and feelings. For example, the media and the public were captivated in fall 2018 by the story of an orca, J-35, that carried her dead calf for more than 2 weeks. Her actions were attributed to grief, and even scientists proclaimed the observation to be evidence that mother orcas felt the same kind of emotional bond to their infants that humans experience, despite the fact that there was no clear evidence of this (see above alternate explanations).

This problem is not specific to the study of emotional responses. It is dubbed the "Argument by Analogy" (Povinelli, Bering, & Giambrone, 2000), and is, not

[4] In captivity, infants may be removed to a nursery in contexts in which maternal care or adoption is impossible, but these occur primarily in contexts in which death was likely, making this a poor control condition.

surprisingly, most common in species that are closely related to us, those that occupy an important role in our lives, such as pets, or those that are considered particularly charismatic species, such as cetaceans and elephants. We are less likely to attribute grief to the insect that is observed removing the corpse of a conspecific from the colony. One of the reasons it is so insidious is that it is based on a sound scientific principle; when two closely related species share a trait, a reasonable *starting hypothesis*, in the absence of information to the contrary, is that they do so due to homology, or common descent. The problem is when this is the *only* hypothesis, and/or this hypothesis cannot be properly tested. Indeed, it leads to two (opposing) problems; it can lead to the over-attribution of human characteristics to other species (that is, anthropomorphism) or to our missing something interesting about the other species because we never look for it, assuming that it is impossible that the species in question are capable of something so complex (de de Waal, 2016). Indeed, researchers' long-standing focus on primates led us to miss sophisticated abilities in other species (e.g., corvids' impressive abilities at planning, problem-solving, causal reasoning, and relational learning; Emery & Clayton, 2004; but see also Vonk, 2015), and the degree of neglect of less social species, such as felines and ursids, makes it difficult to evaluate the extent to which a homology with humans and a socially complex lifestyle are critical to the emergence of complex behaviors such as abstraction, empathy, and social bonding (Eaton et al., 2018).

A related problem is that we tend to gravitate toward the most sensationalistic accounts, which in this case means the ones that make other species look smartest, or most like us. An example of this is the story noted above, of J-35 carrying her deceased calf for more than 2 weeks. Not only was it at the top of the news cycle for nearly 2 weeks, but it was accompanied by stunning photos and videos of her struggle to keep her calf from sinking (in addition, there was a lead-up of the scientists' desperate struggle to locate and treat the sick calf). If J-35 had been seen swimming away from a newly deceased calf, it would not have made the news. Of course, why J-35 did this is a fascinating and important question, but the humanlike aspect of holding on to one's offspring at all costs kept the dialogue around it anything but objective. Although it may have been a good story to get people interested in orcas and, more broadly, conservation, it was not useful for advancing scientific understanding (Bruck, 2018). One challenge is how to balance these aims, keeping the public interested and engaged without reporting the science in a dry and uninspiring way.

This is also a problem in the scientific literature. There is the so-called file drawer problem in which negative (often boring or commonplace) results languish unpublished, leading to the perception of a greater frequency of "interesting" or "positive" results than is true in reality. For example, J-35 could, like many of the primate studies we have discussed, be written up as a case study and published as a note. It would almost certainly be accepted. But no journal would publish a "case study" of a female walking (swimming) away from her infant when it died. How many times has this occurred without documentation? Conversely, how many times has a researcher witnessed a much less charismatic species interacting with a dead conspecific, without it crossing their mind that this could be an example of grief? This may be particularly true in cases in which we are more familiar with the

mechanisms surrounding how living individuals interact with the dead (e.g., the case of pheromones controlling ants' removal of the bodies of dead colony members; Choe, Millar, & Rust, 2009; Howard & Tschinkel, 1976). We have no way of knowing the answers to these questions, so we do not even know the size of the bias problem in the literature.

Conclusions and Future Directions

The recent surge of interest in how nonhuman primates respond to death has begun to yield intriguing results. Early evidence indicates that primates do change their behavior surrounding the death event, and that responses are stronger in the case of a mother losing an infant or any individual losing a conspecific with whom they have a close bond (e.g., mated pairs, members of a one-male unit, presumably friends). There are numerous emerging theories on why these individuals show these responses, ranging from hypotheses about the underlying emotion (e.g., grief, empathy) to the physiological mechanisms that may underpin them (e.g., hormonal changes; note that these explanations are often not mutually incompatible, but address different levels of explanation). There are many unanswered questions, however, with the largest being what exactly it is to which these primates are reacting. Is it the loss? Is it the changes inherent in a group when one member dies? Is it the oddity of an inanimate being? Or the sudden absence of a key individual? Without knowing this, it is difficult to speculate on what these reactions tell us about primates' conceptions of death.

In this chapter, we have attempted to outline some important open questions related to this issue. We have focused on whether nonhuman primates have some of the cognitive abilities related to grief. Indeed, not only does this help us better understand primates' responses to death, but also better understanding primates' responses to death will conversely shed light on the degree to which primates exhibit some of these cognitive mechanisms. Although we highlight numerous areas in which biases in the literature and our own perception may be hindering our ability to address this question, we found this search through the literature both informative and interesting, and see great potential for the field.

We close with a few recommendations for next directions. First, whereas the case studies are important for helping us better understand the behaviors surrounding a death, we suspect that they are biased in the direction of situations in which something interesting (from a human perspective) happened. We encourage researchers to keep records of *any* death, no matter what occurs afterwards, and either publish summaries or make the results available in a database accessible by researchers interested in the question. It will be hard to advance the field until we know whether these spectacular examples are commonplace or represent a divergence from the normal response.

Specifically, we think that this is an excellent candidate topic for a broad-scale collaborative effort. Deaths are relatively rare, especially those for which experimenters are able to record data. Moreover, it will be important to understand

this across species to understand both the distribution of any responses and how ecology and context influence responses. Finally, experimental manipulations are essentially impossible, meaning that opportunistically gathered data will need to suffice. Ideally, there will be a central repository where researchers, caregivers, and veterinarians can record observations of other individuals' reactions to a primate's death. In this way, we can gain a broad perspective on primates' reactions to death with, hopefully, less uncertainty than is present in the current literature.

We also encourage researchers to more explicitly consider how responses to death differ—or not—from other situations. For example, do responses in the first 24–48 h after a death look similar to or different from responses after an individual disappears for other reasons (i.e., emigrates)? Although it is difficult to compare a mother's response to her infant dying to her response to a subadult male emigrating, due to the differences in behavior between an infant and subadult and the mother's different relationship with older offspring, if we had a database we would eventually be able to compare the mothers' responses to subadult sons emigrating versus subadult sons being killed. As mentioned earlier, it would also be useful to look at responses to infants who die of natural causes versus infants who are victims of infanticide, to see if reaction differs in different contexts. Finally, how do changes in the social group compare when an alpha male is unexpectedly killed or dies versus when he is deposed? For instance, is there a more rapid ascent from another male in one case as compared to the other?

We hope that it is clear that, despite the numerous difficulties and constraints we have highlighted, there is much potential to investigate this understudied but fascinating topic, and we can do so in a manner that parallels our scientific approach to other challenging topics. Decades ago, researchers scoffed at the idea of exploring consciousness in nonhumans, and today there is a growing body of work indicating the foundations of metacognition and self-awareness in other species. A systematic undertaking will entail a large-scale collaborative effort among field and lab researchers working with a variety of different species and who are willing to document behaviors in an inclusive fashion without becoming beholden to anthropomorphic expectations. What sparse data do exist provide promise that there is enough continuity in behavior and emotional response to eventually tease apart important differences in how various primates conceptualize death (through exploring contexts and relationships) and use this information to better understand both primates' responses to death and what this tells us about their underlying cognitive ability.

References

Alvarez, S., Di Fiore, A., Champion, J., Pavelka, M. S., Páez, J., & Link, A. (2015). Male-directed infanticide in spider monkeys (*Ateles* spp.). *Primates, 56*, 173–181.

Anderson, J. R., & Gallup Jr., G. G. (2011). Which primates recognize themselves in mirrors? *PLoS Biology, 9*(3), 1–3.

Anderson, J. R., & Gallup Jr., G. G. (2015). Mirror self-recognition: A review and critique of attempts to promote and engineer self-recognition in primates. *Primates, 56*, 317–326.

Anderson, J. R., Gillies, A., & Lock, L. C. (2010). Pan thanatology. *Current Biology, 20*(8), R349–R351.

Andrews, K. (2018). Apes track false beliefs but might not understand them. *Learning & Behavior, 46*, 3–4.

Apperly, I. A. (2008). Beyond simulation-theory and theory-theory: Why social cognitive neuroscience should use its own concepts to study "theory of mind.". *Cognition, 107*, 266–283.

Atsumi, T., & Nagasaka, Y. (2015). Perception of chasing in squirrel monkeys (*saimiri sciureus*). *Animal Cognition, 18*, 1243–1253.

Bartal, I., Decety, J., & Mason, P. (2011). Empathy and pro-social behavior in rats. *Science, 334*, 1427–1430.

Bartlett, T. Q., Sussman, R. W., & Cheverud, J. M. (1993). Infant killing in primates: A review of observed cases with specific reference to the sexual selection hypothesis. *American Anthropologist, 95*, 958–990.

Beehner, J. C., & Bergman, T. J. (2008). Infant mortality following male takeovers in wild geladas. *American Journal of Primatology, 70*, 1152–1159.

Benatar, D. (2017). *The human predicament: A candid guide to life's biggest questions*. New York, NY: Oxford University Press.

Beran, M. J. (2016). "Zeroing" in on mathematics in the monkey brain. *Learning & Behavior, 44*, 4–6.

Berman, C. M. (1982). The social development of an orphaned rhesus infant on Cayo Santiago: Male care, foster mother-orphan interaction and peer interaction. *American Journal of Primatology, 3*, 131–141.

Biro, D., Humle, T., Koops, K., Sousa, C., Hayashi, M., & Matsuzawa, T. (2010). Chimpanzee mothers at Bossou, Guinea, carry the mummified remains of their dead infants. *Current Biology, 20*(8), R351–R352.

Bliss-Moreau, E., & Brosnan, S. F. (in review). The emotional lives of non-human animals. In A. Scarantino (Ed.), *The Routledge handbook of emotion theory*. New York, NY: Taylor & Francis/Routledge.

Bonnie, K., Horner, V., Whiten, A., & de Waal, F. B. M. (2006). Spread of arbitrary customs among chimpanzees: A controlled experiment. *Proceedings of the Royal Society B: Biological Sciences, 274*, 367–372.

Botero, M., MacDonald, S. E., & Miller, R. S. (2012). Anxiety-related behavior of orphan chimpanzees (*Pan troglodytes schweinfurthii*) at Gombe National Park, Tanzania. *Primates, 54*, 21–26.

Bourjade, M., Call, J., Pele, M., Maumy, M., & Dufour, V. (2014). Bonobos and orangutans, but not chimpanzees, flexibly plan for the future in a token-exchange task. *Animal Cognition, 17*, 1329–1340.

Brosnan, S. F., Houser, D., Leimgruber, K., Xiao, E., Chen, T., & de Waal, F. B. M. (2010). Competing demands of prosociality and equity in monkeys. *Evolution and Human Behavior, 31*(4), 279–288.

Bruck, J. (2018). Grief in animals: does an orca have to be a human with fins for us to care? Retrieved August 17, 2018, from http://awesomeocean.com/top-stories/grief-animals-orca-human-fins-us-care/

Burge, T. (2018). Do infants and nonhuman animals attribute mental states? *Psychological Review, 125*, 409–434.

Buttelmann, D., Buttelmann, F., Carpenter, M., Call, J., & Tomasello, M. (2017). Great apes distinguish true from false beliefs in an interactive helping task. *PLoS One, 12*, 13.

Byrne, R. W. (2007). Culture in great apes: using intricate complexity in feeding skills to trace the evolutionary origin of human technical prowess. *Philosophical Transactions of the Royal Society B: Biological Sciences, 362*, 577–585.

Call, J., & Carpenter, M. (2001). Do apes and children know what they have seen? *Animal Cognition, 3*, 207–220.

Call, J., & Tomasello, M. (1999). A nonverbal false belief task: the performance of children and great apes. *Child development, 70*(2), 381–95.

Campbell, M. W., & de Waal, F. B. M. (2011). In-group-out-group bias in contagious yawning by chimpanzees supports link to empathy. *PLoS One, 6*(4), e18283.
Cäsar, C., & Young, R. J. (2008). A case of adoption in a wild group of black-fronted titi monkeys (*Callicebus nigrifrons*). *Primates, 49*, 146–148.
Chen, Q., Panksepp, J. B., & Lahvis, G. P. (2009). Empathy is moderated by genetic background in mice. *PLoS One, 4*(2), e4387.
Choe, D.-H., Millar, J. G., & Rust, M. K. (2009). Chemical signals associated with life inhibit necrophoresis in Argentine ants. *Proceedings of the National Academy of Sciences of the United States of America, 106*(20), 8251–8255.
Claidière, N., Whiten, A., Mareno, M. C., Messer, E. J. E., Brosnan, S. F., Hopper, L. M., et al. (2015). Selective and contagious prosocial resource donation in capuchin monkeys, chimpanzees and humans. *Scientific Reports, 5*, 7631.
Clayton, N. S. (2017). Episodic-like memory and mental time travel in animals. In J. Call, G. M. Burghardt, I. M. Pepperberg, C. T. Snowdon, & T. Zentall (Eds.), *APA handbook of comparative psychology: Perception, learning, and cognition* (Vol. *2*, pp. 227–243). Washington, DC: American Psychological Association.
Culot, L., Lledo-Ferrer, Y., Hoelscher, O., Lazo, F. J. J. M., Huynen, M., & Heymann, E. W. (2011). Reproductive failure, possible maternal infanticide, and cannibalism in wild moustached tamarins *Saguinus mystax*. *Primates, 52*, 179–186.
Darwin, C. (1998/1899). *The expression of the emotions in man and animals (Third)*. London: HarperCollins.
de Blois, S. T., Novak, M. A., & Bond, M. (1998). Object permanence in orangutans (*Pongo pygmaeus*) and squirrel monkeys (*Saimiri sciureus*). *Journal of Comparative Psychology, 112*, 137–152.
de Lathouwers, M., & van Elsacker, L. (2007). Successful behavioural adaptation of an orphaned juvenile Bonobo *Pan paniscus*: a case study at the Primate Park Apenheul, the Netherlands. *International Zoo Yearbook, 41*, 176–182.
de Veer, M. W., & Van den Bos, R. (1999). A critical review of methodology and interpretation of mirror self-recognition research in nonhuman primates. *Animal Behaviour, 58*, 459–468.
de Waal, F. B. M. (1982). *Chimpanzee politics: Power and sex among apes*. Baltimore, MD: The Johns Hopkins University Press.
de Waal, F. B. M. (2011). What is an animal emotion? *Annals of the New York Academy of Sciences, 1224*, 191–206.
de Waal, F. B. M., & Seres, M. (1997). Propagation of handclasp grooming among captive chimpanzees. *American Journal of Primatology, 43*, 339–346.
Dunham, N. T., & Opere, P. O. (2016). A unique case of extra-group infant adoption in free-ranging Angola black and white colobus monkeys (Colobus angolensis palliatus). *Primates, 57*, 187–194.
Eaton, T., Hutton, R., Leete, J., Lieb, J., Robeson, A., & Vonk, J. (2018). Bottoms-up! Rejecting top-down human-centered approaches in comparative psychology. *International Journal of Comparative Psychology, 31*. Retrieved from https://escholarship.org/uc/item/11t5q9wt.
Eckert, J., Rakoczy, H., & Call, J. (2017). Are great apes able to reason from multi-item samples to populations of food items? *American Journal of Primatology, 79*, 1–14.
Emery, N. J., & Clayton, N. S. (2004). The mentality of crows: Convergent evolution of intelligence in corvids and apes. *Science, 306*, 1903–1907.
Etienne, A. S. (1984). The meaning of object permanence at different zoological levels. *Human Development, 27*, 309–320.
Fashing, P. J., Nguyen, N., Barry, T. S., Goodale, C. B., Burke, R. J., Jones, S. C. Z., et al. (2011). Death among geladas (*Theropithecus gelada*): A broader perspective on mummified infants and primate thanatology. *American Journal of Primatology, 73*, 405–409.
Flavell, J. H. (1999). Cognitive development: Children's knowledge about the mind. *Annual Review of Psychology, 50*, 21–45.
Fruteau, C., Range, F., & Noë, R. (2010). Infanticide risk and infant defence in multi-male free-ranging sooty mangabeys *Cercocebus atys*. *Behavioural Processes, 83*, 113–118.

Goodall, J. (1986). *The chimpanzees of Gombe*. Cambridge, MA: The Belknap Press of Harvard University Press.
Goodall, J. (1990). *Through a window: My thirty years with the chimpanzees of Gombe*. Boston, MA: Houghton Mifflin.
Greenberg, J., Pyszczynski, T., Solomon, S., Simon, L., & Breus, M. (1994). Role of consciousness and accessibility of death-related thoughts in mortality salience effects. *Journal of Personality and Social Psychology, 67*, 627–637.
Hamilton, W. J., Busse, C., & Smith, K. S. (1982). Adoption of infant orphan chacma baboons. *Animal Behaviour, 30*, 29–34.
Hampton, R. (2018). Parallel overinterpretation of behavior of apes and corvids. *Learning & Behavior*. https://doi.org/10.3758/s13420-018-0330-5
Harvell, L. A., & Nisbette, G. S. (Eds.). (2016). *Denying death: An interdisciplinary approach to terror management theory*. New York, NY: Routledge/Taylor & Francis Group.
Hauser, M. D. (1998). A nonhuman primate's expectations about object motion and destination: The importance of self-propelled movement and animacy. *Developmental Science, 1*, 31–37.
Hernandez-Lallement, J., van Wingerden, M., Marx, C., Srejic, M., & Kalenscher, T. (2015). Rats prefer mutual rewards in a prosocial choice task. *Frontiers in Neuroscience, 8*, 443.
Heyes, C. (2017). Apes submentalise. *Trends in Cognitive Sciences, 21*, 1–2.
Hiraiwa-Hasegawa, M. (1988). Adaptive significance of infanticide in primates. *Trends in Ecology and Evolution, 3*(5), 102–105.
Hirata, S., Fuwa, K., & Myowa, M. (2017). Chimpanzees recognize their own delayed self-image. *Royal Society Open Science, 4*, 170370.
Hobaiter, C., Schel, A. M., Langergraber, K., & Zuberbühler, K. (2014). 'Adoption' by maternal siblings in wild chimpanzees. *PLoS One, 9*(8), e103777.
Horn, L., Scheer, C., Bugnyar, T., & Massen, J. J. M. (2016). Proactive prosociality in a cooperatively breeding corvid, the azure-winged magpie (*Cyanopica cyana*). *Biology Letters, 12*, 20160649.
Horner, V., Carter, J. D., Suchak, M., & de Waal, F. B. M. (2011). Spontaneous prosocial choice by chimpanzees. *Proceedings of the National Academy of Sciences of the United States of America, 108*(33), 13847–13851.
House, B. R., Silk, J. B., Lambeth, S. P., & Schapiro, S. J. (2014). Task design influences prosociality in captive chimpanzees (*Pan troglodytes*). *PLoS ONE, 9*(9), e103422.
Howard, D. F., & Tschinkel, W. R. (1976). Aspects of necrophoric behavior in the red imported fire ant, *Solenopsis invicta*. *Behaviour, 56*, 157–180.
Howard, S. R., Avarguès-Weber, A., Garcia, J. E., Greentree, A. D., & Dyer, A. G. (2018). Numerical ordering of zero in honey bees. *Science, 360*, 1124–1126.
Hrdy, S. B. (1999). *Mother nature: A history of mothers, infants, and natural selection*. New York, NY: Pantheon Books.
Jaakkola, K. (2014). Do animals understand invisible displacement? A critical review. *Journal of Comparative Psychology, 128*, 225–239.
Janson, C. H., & van Schaik, C. P. (2000). The behavioural ecology of infanticide by males. In C. P. van Schaik & C. H. Janson (Eds.), *Infanticide by males and it's Implications* (pp. 469–494). Cambridge, MA: Cambridge University Press.
Kabadayi, C., & Osvath, M. (2017). Ravens parallel great apes in flexible planning for tool-use and bartering. *Science, 357*, 202–204.
Kano, F., Krupenye, C., Hirata, S., Call, J., & Tomasello, M. (2017). Submentalizing cannot explain belief-based action anticipation in apes. *Trends in Cognitive Sciences, 21*, 633–634.
Kaplan, J. (1974). Responses of mother squirrel monkeys to dead infants. *Primates, 14*, 89–81.
King, B. J. (2013). *How animals grieve*. Chicago, IL: University of Chicago Press.
Kooriyama, T. (2009, December). The death of a newborn chimpanzee at Mahale: Reactions of its mother and other individuals to the body. *Pan Africa News*, *16*(2)4.
Kornell, N. (2009). Metacognition in humans and animals. *Current Directions in Psychological Science, 18*, 11–15.

Krupenye, C., Kano, F., Hirata, S., Call, J., & Tomasello, M. (2016). Great apes anticipate that other individuals will act according to false beliefs. *Science, 354*, 110–113.

Langford, D. J., Crager, S. E., Shehzad, Z., Smith, S. B., Sotocinal, S. G., Levenstadt, J. S., et al. (2006). Social modulation of pain as evidence for empathy in mice. *Science, 312*, 1967–1970.

Li, T., Ren, B., Li, D., Zhang, Y., & Li, M. (2012). Maternal responses to dead infants in Yunnan snub-nosed monkey (*Rhinopithecus bieti*) in the Baimaxueshan Nature Reserve, Yunnan, China. *Primates, 53*, 127–132.

Lillard, A. S., Zeljo, A., Curenton, S., & Kaugars, A. S. (2000). Children's understanding of the animacy constraint on pretense. *Merrill-Palmer Quarterly, 46*, 21–44.

Maréchal, L., Levy, X., Meints, K., & Majolo, B. (2017). Experience-based human perception of facial expressions in Barbary macaques (*Macaca sylvanus*). *PeerJ, 5*, e3413. https://doi.org/10.7717/peerj.3413

Marticorena, D. C. W., Ruiz, A. M., Mukerji, C., Goddu, A., & Santos, L. R. (2011). Monkeys represent others' knowledge but not their beliefs. *Developmental Science, 14*, 1406–1416.

Matsuzawa, T. (1997). Reviewed Article: The death of an infant chimpanzee at Bossou, Guinea. *Pan Africa News, 4*, 4–6.

Merritt, D. J., Rugani, R., & Brannon, E. M. (2009). Empty sets as part of the numerical continuum: Conceptual precursors to the zero concept in rhesus monkeys. *Journal of Experimental Psychology: General, 138*, 258–269.

Mitani, J. C., Watts, D. P., & Amsler, S. J. (2006). Lethal intergroup aggression leads to territorial expansion in wild chimpanzees. *Current Biology, 20*(12), R507–R508.

Nakamichi, M., Koyama, N., & Jolly, A. (1996). Maternal response to dead and dying infants in wild troops of ring-tailed lemurs at the Berenty Reserve, Madagascar. *International Journal of Primatology, 17*, 505–523.

Nieder, A. (2016). Representing something out of nothing: The dawning of zero. *Trends in Cognitive Sciences, 20*, 830–842.

Nishida, T., Haraiwa-Hasegawa, M., & Takahata, Y. (1985). Group extinction and female transfer in wild chimpanzees in the Mahale National Park, Tanzania. *Zeitschrift Fur Tierpsychologie, 67*, 284–301.

Okuyama, S., Kuki, T., & Mushiake, H. (2015). Representation of the numerosity "zero" in the parietal cortex of the monkey. *Scientific Reports, 5*, 10059.

Osvath, M., & Persson, T. (2013). Great apes can defer exchange: A replication with different results suggesting future oriented behavior. *Frontiers in Psychology, 4*, 8.

Pepperberg, I. M. (2006). Grey parrot (*Psittacus erithacus*) numerical abilities: Addition and further experiments on a zero-like concept. *Journal of Comparative Psychology, 120*, 1–11.

Pepperberg, I. M., & Gordon, J. D. (2005). Number comprehension by a grey parrot (*Psittacus erithacus*), including a zero-like concept. *Journal of Comparative Psychology, 119*, 197–209.

Perry, S., & Manson, J. (2008). *Manipulative monkeys: The capuchins of Lomas Barbudal*. Cambridge, MA: Harvard University Press.

Poulin-Doubois, D., Lepage, A., & Ferland, D. (1996). Infants' concept of animacy. *Cognitive Development, 11*, 19–36.

Povinelli, D. J., & Simon, B. B. (1998). Young children's understanding of briefly versus extremely delayed images of the self: Emergence of the autobiographical stance. *Developmental Psychology, 34*, 188–194.

Povinelli, D. J., Landry, A. M., Theall, L. A., Clark, B. R., & Castille, C. M. (1999). Development of young children's understanding that the recent past is causally bound to the present. *Developmental Psychology, 35*, 1426–1439.

Povinelli, D. J., Bering, J. M., & Giambrone, S. (2000). Toward a science of other minds: Escaping the argument by analogy. *Cognitive Science, 24*, 509–541.

Pradhan, G. R., Engelhardt, A., van Schaik, C. P., & Maestripieri, D. (2006). The evolution of female copulation calls in primates: A review and a new model. *Behavioral Ecology and Sociobiology, 59*, 333–343.

Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *Behavioral and Brain Sciences, 1*, 515–526.

Preuschoft, S., & van Hooff, J. A. R. A. M. (1995). Homologizing primate facial displays: A critical review of methods. *Folia Primatologica, 65*, 121–137.

Pruetz, J. D., Ontl, K. B., Cleaveland, E., Lindshield, S., Marshack, J., & Wessling, E. G. (2017). Intragroup lethal aggression in west African chimpanzees (*Pan troglodytes verus*): Inferred killing of a former alpha male at Fongoli, Senegal. *International Journal of Primatology, 38*, 31–57.

Rosenblatt, A., Greenberg, J., Solomon, S., Pyszczynski, T., & Lyon, D. (1989). Evidence for terror management theory: I. The effects of mortality salience on reactions to those who violate or uphold cultural values. *Journal of Personality and Social Psychology, 57*, 681–690.

Rosenson, L. M. (1977). The response of some prosimian primate mothers to their own anesthetized infants. *Primates, 18*, 579–588.

Santini, L. (2011). Conflictual behavior in a lemur mother toward a dying infant. *Lemur News, 16*, 26–27.

Scarry, C. J., & Tujague, M. P. (2012). Consequences of lethal intragroup aggression and alpha male replacement on intergroup relations and home range use in tufted capuchin monkeys (*Cebus apella nigritus*). *American Journal of Primatology, 74*, 804–810.

Schmelz, M., Grueneisen, S., Kabalak, A., Jost, J., & Tomasello, M. (2017). Chimpanzees return favors at a personal cost. *Proceedings of the National Academy of Sciences of the United States of America, 114*, 7462–7467.

Schwartz, B. L., & Evans, S. (2001). Episodic memory in primates. *American Journal of Primatology, 55*, 71–85.

Shettleworth, S. J. (2012). Darwin, Tinbergen, and the evolution of comparative cognition. In J. Vonk & T. K. Shackelford (Eds.), *The oxford handbook of comparative evolutionary psychology* (pp. 529–546). New York, NY: Oxford University Press.

Small, M. F. (1993). *Female choices: Sexual behavior of female primates*. Ithaca, NY: Cornell University Press.

Smith, J. D., Shields, W. E., & Washburn, D. A. (2003). The comparative psychology of uncertainty monitoring and metacognition. *Behavioral and Brain Sciences, 26*, 317–373.

Sugiyama, Y., Kurita, H., Matsui, T., Kimoto, S., & Shimomura, T. (2009). Carrying of dead infants by Japanese macaque (*Macaca fuscata*) mothers. *Anthropological Science, 117*, 113–119.

Swartz, K. B. (1997). What is mirror self-recognition in nonhuman primates, and what is it not? In J. G. Snodgrass & R. L. Thompson (Eds.), *The self across psychology: Self-recognition, self-awareness, and the self concept; the self across psychology* (pp. 65–71). New York, NY: New York Academy of Sciences.

Tecwyn, E. C., Denison, S., Messer, E. J. E., & Buchsbaum, D. (2017). Intuitive probabilistic inference in capuchin monkeys. *Animal Cognition, 20*, 243–256.

Teichroeb, J. A., Wikberg, E. C., Bădescu, I., Macdonald, L. J., & Sicotte, P. (2012). Infanticide risk and male quality influence optimal group composition for *Colobus vellerosus*. *Behavioral Ecology, 23*, 1348–1359.

Thierry, B., & Anderson, J. R. (1986). Adoption in Anthropoid primates. *International Journal of Primatology, 7*, 191–216.

Tsutsumi, S., Ushitani, T., Tomonaga, M., & Fujita, K. (2012). Infant monkeys' concept of animacy: The role of eyes and fluffiness. *Primates, 53*, 113–119.

Uehara, S., & Nyundo, R. (1983). One observed case of temporary adoption of an infant by unrelated nulliparous females among wild chimpanzees in the Mahale Mountains, Tanzania. *Primates, 24*, 456–466.

van Leeuwen, E. J. C., Mulenga, I. C., Bodamer, M. D., & Cronin, K. A. (2016). Chimpanzees' responses to the dead body of a 9-year-old group member. *American Journal of Primatology, 78*, 914–922.

Vonk, J. (2015). Corvid cognition: Something to crow about? *Current Biology, 25*(2), R69–R71.

Vonk, J. (2016). Apes have eyes to the future. *Learning and Behavior, 44*, 207–208.

Vonk, J. (2018). Are chimpanzees 'stuck' on their 'selves' in video? *Learning and Behavior, 46*, 227–228.

Vonk, J., & MacDonald, S. E. (2002). Natural concept formation in a juvenile gorilla (*Gorilla gorilla gorilla*) at three levels of abstraction. *Journal of the Experimental Analysis of Behaviour, 78*, 315–332.

Vonk, J., & MacDonald, S. E. (2004). Levels of abstraction in orangutan (*Pongo abelii*) categorization. *Journal of Comparative Psychology, 118*, 3–13.

Vonk, J. & Povinelli, D. J. (2006). Similarity and difference in the conceptual systems of primates: The Unobservability hypothesis. In E. Wasserman and T. Zentall (Eds.) Comparative Cognition: Experimental Explorations of Animal Intelligence. pp.363–387 Oxford, UK, Oxford University Press.

Vonk, J., Jett, S. E., Mosteller, K. W., & Galvan, M. (2013). Natural category discrimination in chimpanzees (*Pan troglodytes*) at three levels of abstraction. *Learning and Behavior, 41*, 271–284.

de Waal, F. (2016). *Are we smart enough to know how smart animals are?* New York, NY: W. W. Norton & Company.

Warren, Y., & Williamson, E. A. (2004). Transport of dead infant mountain gorillas by mothers and unrelated females. *Zoo Biology, 23*, 375–378.

Watts, D. P., Muller, M., Amsler, S. J., Mbabazi, G., & Mitani, J. C. (2006). Lethal intergroup aggression by chimpanzees in Kibale National Park, Uganda. *American Journal of Primatology, 68*, 161–180.

Whilde, J., & Marples, N. (2011). The behavior of a zoo-housed orangutan after the death of its mother. *Zoo Biology, 30*, 205–211.

Whiten, A., Goodall, J., McGrew, W. C., Nishida, T., Reynolds, V., Sugiyama, Y., et al. (1999). Cultures in chimpanzees. *Nature, 399*, 682–685.

Whiten, A., Horner, V., & De Waal, F. B. M. (2005). Conformity to cultural norms of tool use in chimpanzees. *Nature, 437*, 737–740.

Wilson, E. O., Durlach, N. I., & Roth, L. M. (1958). Chemical releasers of necrophoric behavior in ants. *Psyche, 65*, 108–114.

Wilson, M. L., Boesch, C., Fruth, B., Furuichi, T., Gilby, I. C., Hashimoto, C., et al. (2014). Lethal aggression in Pan is better explained by adaptive strategies than human impacts. *Nature, 513*, 414–417.

Wroblewski, E. E. (2008). An unusual incident of adoption in a wild chimpanzee (*Pan troglodytes*) population at Gombe National Park. *American Journal of Primatology, 7*, 995–998.

Yamamoto, S., & Takimoto, A. (2012). Empathy and fairness: Psychological mechanisms for eliciting and maintaining prosociality and cooperation in primates. *Social Justice Research, 25*, 233–255.

Yang, B., Anderson, J. R., & Li, B.-G. (2016). Tending a dying adult in a wild multi-level primate society. *Current Biology, 26*(10), R403–R404.

Yao, H., Yu, H., Yang, B., Yang, W., Xu, H., Grueter, C. C., et al. (2016). Male infanticide in the golden snub-nosed monkey (*Rhinopithecus roxellana*), a seasonally breeding primate. *International Journal of Primatology, 37*, 175–184.

Did Human Reality Denial Breach the Evolutionary Psychological Barrier of Mortality Salience? A Theory that Can Explain Unusual Features of the Origin and Fate of Our Species

Ajit Varki

"We now know that the human animal is characterized by two great fears that other animals are protected from: the fear of life and the fear of death."

—Ernest Becker

"A being who knows that he will die arose from ancestors who did not know."

—Theodosius Dobzhansky

"The human race is the only one that knows it must die, and it knows this only through its experience."

—Voltaire

The yaksha asked: "What is the greatest surprise?" Yudhisthira replied: "People die every day, making us aware that men are mortal. Yet we live, work, play, plan, etc., as if assuming we are immortal. What is more surprising than that?"

—The Mahabharata

Abstract Some aspects of human cognition and behavior appear unusual or exaggerated relative to those of other intelligent, warm-blooded, long-lived social species—including certain mammals (cetaceans, elephants, and great apes) and birds (corvids and passerines). One collection of such related features is our remarkable ability for ignoring or denying reality in the face of clear facts, a high capacity for self-deception and false beliefs, overarching optimism bias, and irrational risk-taking behavior (herein collectively called "reality denial"). Such traits should be maladaptive for reproductive success when they first appear as consistent features in

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T. K. Shackelford, V. Zeigler-Hill (eds.), *Evolutionary Perspectives on Death*, Evolutionary Psychology, https://doi.org/10.1007/978-3-030-25466-7_6

individuals of any species. Meanwhile, available data suggest that self-awareness (knowledge of one's own personhood) and basic theory of mind (ToM, also termed mind-reading, intentionality etc.) have evolved independently several times, particularly in the same kinds of species mentioned above. Despite a long-standing opportunity spanning tens of millions of years, only humans appear to have gone on to evolve an extended ToM (multilevel intentionality), a trait required for optimal expression of many other unusual cognitive attributes of our species, such as advanced linguistic communication and cumulative cooperative culture. The conventional view is that extended ToM emerged gradually in human ancestors, via stepwise positive selection of multiple traits that were each beneficial. A counterintuitive alternate possibility is that establishment of extended ToM has been repeatedly obstructed in all other species with the potential to achieve it, due to a "psychological evolutionary barrier," that would arise in isolated individuals of a given species that develop the genetic ability for extended ToM. Such individuals would observe deaths of conspecifics whose minds they fully understood, become aware of mortality, and translate that knowledge into mortality salience (understanding of personal mortality). The resulting conscious realization and exaggeration of an already existing intrinsic fear of death risk would have then reduced the reproductive fitness of such isolated individuals (by favoring personal survival over reproduction). This "psychological evolutionary barrier" would have thus persisted until hominin ancestors broke through, via a rare and unlikely combination of cognitive changes, in which two intrinsically maladaptive traits (reality denial and extended ToM) evolved in the minds of the same individuals, allowing a "mind over reality transition" (MORT) over the proposed barrier. Once some individuals broke through in this manner, conventional natural selection could take over, with further evolution of beneficial aspects of the initial changes. This theory also provides a unifying evolutionary explanation for other unusual features of humans, including our recent emergence as the dominant species on the planet, and replacement of all other closely related evolutionary cousins, with limited interbreeding and no remaining hybrid species. While not directly falsifiable by experiment, the MORT theory fits with numerous facts about humans and human origins, and no known fact appears to strongly militate against it. It is also consistent with most other currently viable theories on related subjects, including terror management theory. Importantly, it has major implications for the human condition, as well as for many serious current issues, ranging all the way from lack of personal health responsibility to ignoring anthropogenic global climate disruption, which now threatens the very existence of our species.

An Unusual Theory from an Unlikely Source. An expert reader might choose to skip this chapter in the volume *Evolutionary Perspectives on Death*, as it is written by a physician-scientist without a track record of publications in evolutionary psychology. However, regarding mortality salience (awareness by an individual that his/her death is inevitable) the author has had much real-world experience. I was once an oncologist giving chemotherapy to patients in the early days when it rarely worked, and thus witnessed first hand the remarkable human ability to suppress the harsh reality of personal mortality as well as the unrealistic optimism of all parties

involved. Many years of studying molecular differences between humans and our closest evolutionary relatives (including human-specific diseases) (Chou, Takematsu, Diaz, et al., 1998; Ghaderi, Springer, Ma, et al., 2011; Hayakawa et al., 2005; Hedlund, Padler-Karavani, Varki, & Varki, 2008; Varki, 2000, 2010; Varki, Strobert, Dick, Benirschke, & Varki, 2011; Wang, Mitra, Secundino, et al., 2012) and transdisciplinary interactions with scholars of many stripes interested in explaining human origins (Enard, Khaitovich, Klose, et al., 2002; Gagneux, Moore, & Varki, 2005; Ghaderi et al., 2011; McConkey & Varki, 2000, 2005; O'Bleness, Searles, Varki, Gagneux, & Sikela, 2012; Olson & Varki, 2003, 2004; Varki, 2007; Varki, Geschwind, & Eichler, 2008) also prepared the author for a contrarian question posed to him in 2005 by the late Danny Brower of the University of Arizona: instead of asking what biological and cultural evolutionary processes generated the human mind, perhaps we should instead ask why we are not currently competing with other species with humanlike cognition. After all, warm-blooded, highly intelligent, socially complex species such as elephants, dolphins, whales, great apes, and corvids have been on this planet for tens of millions of years? So why are we not competing with other lineages with humanlike cognition, and have instead endangered them all by taking over the entire biosphere? Perhaps we should consider the possibility of a difficult cognitive barrier that only the lineage leading to humans was able to breach on a single occasion (Varki, 2009; Varki & Brower, 2013).

Some Unexplained Distinctive Features of Humans and Our Evolutionary Origins. Each living species has unusual or distinctive features that emerge from evolutionary interactions between biology and environment. The symposium addressing *Evolutionary Perspectives on Death* exemplified two unusual features of humans: first, our ability to consider and understand the thoughts of many others at once (as occurred during the lectures and discussions); and second, our ability to dispassionately discuss knowledge of our own mortality without being consumed by fear. I will argue that these two seemingly disparate human peculiarities were involved in a critical interplay in relation to the origin of our species, also then contributing to our subsequent replacement and/or limited genetic assimilation of our closest (now extinct) evolutionary cousins—and eventually to our domination of the entire planet, two additional distinctive features of humans. I will first consider each of these human peculiarities individually, and then attempt to synthesize them into a single overarching theory, which can also explain many other aspects of the human condition and the origin of our species. Note that this is not one of the oft-criticized "umbrella theories" (Langdon, 1997) that seek to explain everything about human origins and cognition. Rather, it is a theory about a *very finite* period of human evolution, and the proposed breaching of a "psychological evolutionary barrier," which allowed our emergence as a cognitively distinct species. It is also a theory that appears to fit with all known relevant information, and is not apparently negated by any other facts, but also cannot be definitively falsified at this time by an experiment.

The Remarkable Human Propensity for "Reality Denial" in the Face of Facts or Realities. The human ability to understand and consider our own mortality without being consumed by fear seems natural to us. In fact, it appears to be just one

manifestation of a peculiar human ability to ignore, rationalize, or outright deny obvious realities, and even to believe in multiple or alternate realities at the same time. For example, advances of in science and medicine have made it clear that health and longevity are improved if we exercise regularly, eat a balanced and healthy diet, avoid tobacco and excessive alcohol, maintain an optimal body weight, detect and treat high blood pressure or sleep apnea, avoid excessive stress, and so on—but very few of us follow these simple and logical recommendations (physicians are often among the worst offenders) (Freeman and Spiegelhalter 2018; Spiegelhalter, 2012). Even when we do acknowledge such realities, we tend to indulge in magical thinking, behaving as if these statistics apply to everyone else, but not to ourselves. Many humans also ignore or even deny scientific and societal realities such as biological evolution, anthropogenic climate change, human "overshoot" with nonrenewable resource depletion, gross degradation of our environment, massive expansion of national debt, ballooning healthcare costs, covert or overt racism, and so on. Instead, many continue to believe in UFOs, literal biblical creationism, magical cures, claims that vaccines do not work (or cause autism), irrational fear of all genetically modified organisms (GMOs), and so on. We also insist on rebuilding our dwellings in the places where the worst natural disasters have repeatedly occurred. On the political front, distortion or denial of obvious realities is prominent in all parties and belief systems, depending on the circumstances. Of course, scientists are also not immune to denying obvious realities, and phenomena like a heliocentric solar system (Copernicus), evolution (Darwin), plate tectonics (Wegener), blood circulation (Harvey), and antisepsis (Semmelweis) were strongly resisted at the time by learned colleagues in the face of facts, and some of these frustrated proponents did not even live long enough to be personally vindicated.

Absent a single entry in the dictionary to denote these and other related phenomena, I have taken the liberty of coining the term "reality denial" defining it as a *subconscious defense mechanism characterized by refusal to acknowledge (or rationalization of) unwanted unpleasant facts, realities, thoughts, and feelings*. There are many other ways to consider about this overall cognitive peculiarity, including "denialism" (Specter, 2009), "corruption of reality" (Schumaker, 1995), "cognitive dissonance" (Harmon-Jones, 2019), "predictable irrationality" (Ariely, 2008), "the believing brain" (Shermer, 2012), various views of "optimism bias" (Gilbert, 2007; Sharot, 2011a, 2011b; Sharot, Korn, & Dolan, 2011; Sharot, Riccardi, Raio, & Phelps, 2007; Weinstein, 1980), and so on. Whichever way we choose to define this broad phenotype, it is a common feature of humans, and (as far as we know) not common in other animals. Thus, it needs to be added to a list of our many unusually exaggerated cognitive characteristics (see Table 1 for a partial list). However, unlike most other features listed in Table 1 that should have had net benefits for positive adaptive selection during evolution when they first appeared, this capacity for persistent and sometimes extreme reality denial *should have been a maladaptation when it first appeared in our lineage*. Indeed, any individual who routinely practiced reality denial and took excessive risks would likely be removed from the gene pool of that species, and there would have been a failure to fix the genotype responsible for this phenotype. The questions then are the following:

Table 1 Some unusual or exaggerated cognitive features of humans

Acting (mime or spoken)	Caring for the sick	Planning ahead
Bargaining	Hospitality	**Reality denial**[a]
Beliefs about death	Inheritance rules	Religiosity
Blushing	Intentional deception	Representational art
Bravery and courage	Language (complex)	Reputation (concern for)
Care of infirm and elderly	Laws and justice	Risk-taking (excessive)
Comedy	Lecturing	Rites of passage
Control of fire	Medicines for others	Romantic infatuation
Cooking	Magical thinking	Social control of paternity
Cooperation	Multi-instrumental music	Suicide (intentional)
Cumulative culture	Nonreciprocal altruism	Teaching (explicit)
Domestication of Animals	Organized sports	**Theory of mind (extended)∗a**
Food preparation for others	Optimism bias	Torture (deliberate)
Funerary practices	Overconfidence	Trade

[a]Deleting extended theory of mind and/or reality denial from the human cognitive repertoire would eliminate or diminish many of the other features in this table

How and why did excessive reality denial and risk-taking evolve in humans, and what benefits outweighed the obvious negative consequences, *at the time when this propensity first emerged*?

Extended Theory of Mind as Another Distinct Feature of Humans. Many warm-blooded species appear to have independently evolved self-awareness as defined by various criteria, including the mirror self-recognition test (Anderson & Gallup, 2015; Candland, 1995; Gallup, 1977; Parker, Mitchell, & Boccia, 1994; Ross et al., 2017; Suddendorf & Butler, 2013), which has been passed by individual members of various species including chimpanzees (Anderson & Gallup, 2015; Eddy, Gallup, & Povinelli, 1996; Gallup, 1977; Kitchen, Denton, & Brent, 1996; Povinelli, Eddy, Hobson, & Tomasello, 1996; Rajala, Reininger, Lancaster, & Populin, 2010), elephants (Dale & Plotnik, 2017; Plotnik, de Waal, & Reiss, 2006), dolphins (Morrison & Reiss, 2018; Reiss, 2011; Reiss & Marino, 2001), corvid birds (Clary & Kelly, 2016; Prior, Schwarz, & Güntürkün, 2008), and possibly even trained monkeys (Huttunen, Adams, & Platt, 2017; Rajala et al., 2010; Toda & Platt, 2015). The question arises whether such individuals with awareness of their own self are also fully aware of the self-awareness of others, a state that is often referred to as "theory of mind" (Apperly, 2010; Baron-Cohen, Leslie, & Frith, 1985; Bedny, Pascual-Leone, & Saxe, 2009; Crockford, Wittig, Mundry, & Zuberbuhler, 2012; Dumontheil, Apperly, & Blakemore, 2010; Emery & Clayton, 2009; Gentner & Goldin-Meadow, 2003; Kappeler & Silk, 2010; Krupenye, Kano, Hirata, Call, & Tomasello, 2016; Meltzoff, 1999; Moll & Meltzoff, 2011; Moll & Tomasello, 2012; Patel, Sestieri, & Corbetta, 2019; Povinelli et al., 1996; Premack & Woodruff, 1978; Schaafsma, Pfaff, Spunt, & Adolphs, 2015; Young, Dodell-Feder, & Saxe, 2010), or "intentionality" (Dennett, 1987, 1996; Tomasello, 2018) (i.e., the ability to not only attribute mental beliefs, desires, and perspectives to oneself, but also to understand that others have beliefs, desires, intentions, or perspectives similar or different from

oneself). Many other terms describe aspects of such mental states, including "inter-subjectivity" (Vogeley, 2017), "mind reading" (Apperly, 2010; Emery & Clayton, 2009; Heyes & Frith, 2014; Samson, 2009), "perspective taking" (Carter, 2002; Hodges, Denning, & Lieber, 2018; Moll & Meltzoff, 2011), and "other-regarding impulses" (Hrdy, 2009).

Of course such cognitive abilities are part of a continuum seen in the postnatal development of humans (Baron-Cohen et al., 1985; Baron-Cohen, O'Riordan, Stone, Jones, & Plaisted, 1999; Bering & Parker, 2006; Corriveau, Kim, Schwalen, & Harris, 2009; Dumontheil et al., 2010; Hofmann, Doan, Sprung, et al., 2016; Luu, Rosnay, & Harris, 2013; Meltzoff, 1999; Moll & Meltzoff, 2011; Moll & Tomasello, 2012; Parker et al., 1994; Piazza, Bering, & Ingram, 2011; Povinelli et al., 1996; Ronfard, Bartz, Cheng, Chen, & Harris, 2018; Ronfard, Chen, & Harris, 2018; Wellman & Brandone, 2009) (Fig. 1), with a 2-year-old recognizing herself in the mirror, the emergence of a rudimentary theory of mind or "collective intentionality" of a 3- or 4-year-old, and what one might call a full theory of mind or "multilevel intentionality" in a 5- or 6-year-old who can tell excellent lies (the ability to understand and deceive other minds). And in adult humans we have an "extended theory of mind," which can now encompass a billion minds across the Internet, simultaneously understanding the beliefs of others (whether or not they are true!).

Why Are We Humans Alone in Dominating the Planet? The continent of Africa was the source of a diverse and complex assemblage of hominin lineages that spread across the Old World beginning about two million years ago (Wood & Boyle E, 2016), and evolved into multiple lineages of behaviorally sophisticated species, only a few which have been defined to date, such as Neanderthals, Denisovans, and "Hobbits" (Culotta, 2016; Hajdinjak, Fu, Hübner, et al., 2018; Meyer, Kircher, Gansauge, et al., 2012; Prufer, de Filippo, Grote, et al., 2017; Prufer, Racimo, Patterson, et al., 2014; Reich, Green, Kircher, et al., 2010). But once our own species emerged in Africa >200,000 years ago (Hublin, Ben-Ncer, Bailey, et al., 2017; Wood, 2017), and later spread across the planet (Clarkson, Jacobs, Marwick, et al., 2017; Galway-Witham & Stringer, 2018), we quickly

Fig. 1 A continuum in the cognitive development of self-awareness, theory of mind (ToM), and intentionality

became (in evolutionary time) the "Lone Survivors" (Stringer, 2012) and "Masters of the Planet" (Tattersall, 2012). To a large extent, our success has been based on a constellation of unusual cognitive features, such as those listed in Table 1. However, if we "delete" our extended theory of mind, many of the other cognitive attributes become less effective (consider a group of individuals with autism spectrum disorder, who may each have special cognitive attributes, but are much less capable of cumulative, rapidly developing culture).

The cognitive benefits of extended theory of mind are many, and may have been necessary for the spread of humans all across the planet, and the development of our varied and complex cultures. Given the obvious benefits to fitness, the counterintuitive question posed to me by the late Danny Brower (Varki, 2009) was why are such abilities are so well developed in adult humans—yet apparently not in otherwise highly intelligent, large-brained, warm-blooded, social, tool-using species ranging from chimpanzees, elephants, dolphins, and other cetaceans, corvids, and the like—lineages that have been on the planet for tens of millions of years of vertebrate evolution? Instead of the conventional assumption that something unusual happened in the course of human brain evolution, what if there was instead a difficult-to-surmount barrier that repeatedly blocked the cognitive progression of all other species? In other words, just as a *physiological evolutionary barrier* held back adaptation of vertebrate species from aquatic to terrestrial life for a very long time, what if there is a "*psychological evolutionary barrier*" (Fig. 2) that has repeatedly thwarted progression of cognitive evolution to the full state of multilevel intentionality?

When and How Did Humans Evolve Tolerance of Knowledge of Personal Mortality? It is reasonable to assume that most or all species with a nervous system have an automated reaction to death risk that has been honed by natural selection,

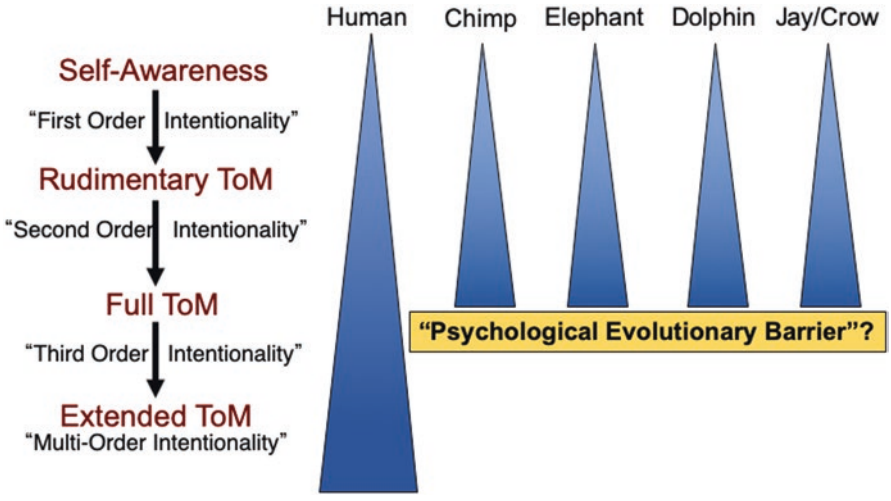

Fig. 2 A psychological evolutionary barrier to acquiring extended theory of mind

and it is likely that all animals have genetically wired reaction responses to death risk. But only a small subset of animals (once again, including elephants, chimpanzees, cetaceans, and corvids) seem to show awareness of the death of a conspecific (Anderson, Gillies, & Lock, 2010; Bearzi et al., 2018; Biro et al., 2010; Goncalves & Biro, 2018; Goncalves & Carvalho, 2019; Marzluff & Angell, 2012; Porter, Eckardt, Vecellio, et al., 2019; Stewart, Piel, & O'Malley, 2012), some descriptions of which can be found in another chapter of this volume (Brosnan & Vonk). Of course, many behaviors and emotions we associate with humans are also present in other species to varying degrees (Safina, 2015, 2019; Waal, 2019).

Regardless, the question remains open as to whether members of such species also experience true mortality salience (i.e., a full understanding of the reality of their own personal mortality) as humans do—as opposed to simply recognizing the death of another individual they were close to and reacting negatively. It is reasonable to suppose that *fully* understanding the death and mortality of other individuals is a prerequisite to *fully* understanding one's own personal mortality. If so, the emergence of a full theory of mind would eventually result in full understanding of the death of another individual, i.e., the permanent extinction of another mind, not unlike oneself. This understanding should translate to stark realization of one's own personal mortality. Severe death anxiety should affect the few individuals who develop this ability at any given time, and this may have sufficiently reduce their fitness to negate the possibility of passing on the genotype to offspring (Fig. 3). Perhaps this is the psychological evolutionary barrier that has held back all other species to date.

Did Two Rare Evolutionary Maladaptations Coincide to Breach the Evolutionary Psychological Barrier of Mortality Salience? As discussed earlier, excessive reality denial and risk-taking should have been maladaptive each time that they first emerged in individuals of a species with advanced cognition. And we have just argued that although an extended theory of mind can have fitness value in the right circumstances (as it does in today's humans), the initial negative impact of the resulting mortality salience should be maladaptive, because of the resulting mortality salience and death anxiety. But if both of these very rare maladaptations *happened*

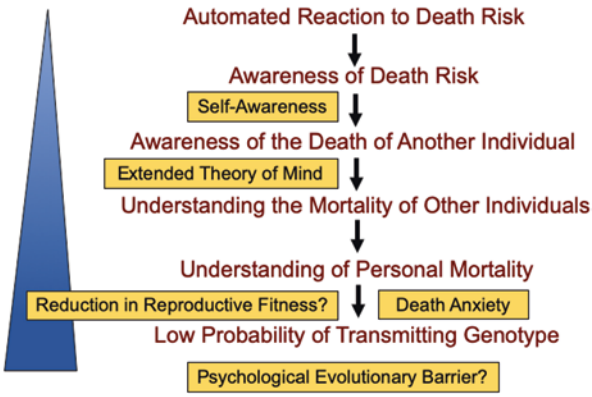

Fig. 3 A continuum in awareness of death risk and understanding of mortality. Potential consequences for evolutionary selection

to evolve in the minds of the same individuals at the same time, they could combine to allow tolerance of death anxiety, and this unlikely combination could be genetically established in the progeny of these individuals (Fig. 4). In the more expanded view of this proposed "mind over reality transition" shown in Fig. 5, a species with a complex social organization, a long life, a preexisting maternal instinct, and helpless young could evolve (Froehle et al., 2019; Hrdy, 2009; Konner, 2010), such as occurs in some of the other mammals mentioned earlier. Such a species might also

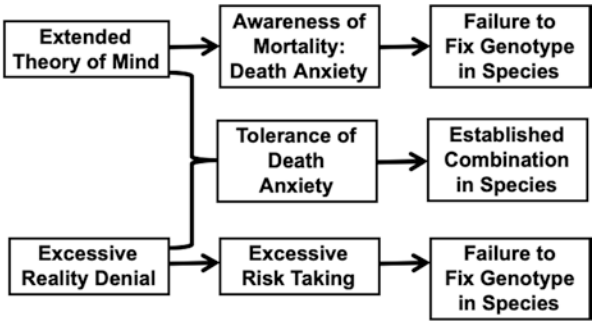

Fig. 4 "Mortality salience" barrier to establishment of an extended theory of mind in a species. A proposed mind over reality transition is based on unlikely coincidental combination of two maladaptive factors during human cognitive evolution

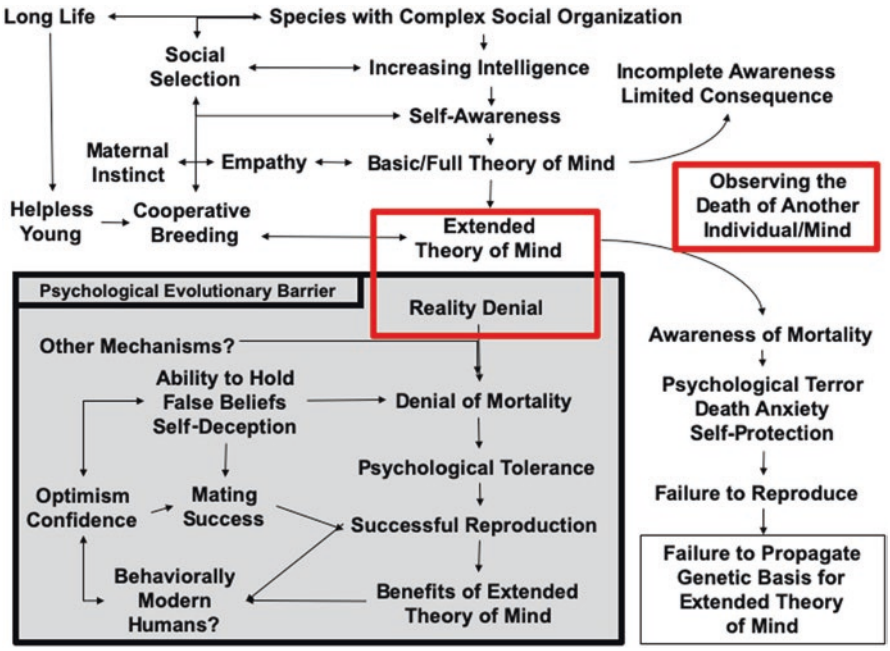

Fig. 5 Extended view of some factors involved in the proposed mind over reality transition

be more likely to develop some level of self-awareness and basic theory of mind, especially in the context of cooperative caring for helpless young (Hrdy, 2009).

In the absence of a full theory of mind, observing the death of another individual of the same species would not trigger full mortality salience and its negative consequences (Fig. 5). On the other hand, individuals who first develop a full theory of mind and observe the death of conspecific would then suffer from awareness of personal mortality, and the resulting psychological terror would result in a failure to establish the genotype in that lineage. If so, a *highly unlikely one-time combination* that includes reality denial of mortality salience would allow psychological tolerance, successful reproduction, and establishment of the benefits of extended theory of mind (Fig. 5). It is also noteworthy that the ability to hold false beliefs, self-deception, optimism, and confidence might support a successful mating strategy, especially for males. This suggestion is congruent with Trivers evolutionary theory of self-deception that includes denial of ongoing deception, self-inflation, ego-biased social theory, false narratives of intention, and a conscious mind that operates via denial and projection to create a self-serving world (Murphy, von Hippel, Dubbs, et al., 2015; Ramachandran, 1996; Trivers, 2000, 2011).

One can thus posit a *hypothetical singular phase in human evolution*, during which mortality salience and maladaptive death anxiety were triggered by acquiring extended theory of mind, but happened to be stabilized by *simultaneous* evolution of reality denial in the same minds. Returning to Table 1, and doing the thought experiment, it is noteworthy that the combined deletion of reality denial and extended theory of mind would blunt or eliminate many of the unusual cognitive features of humans. Thus, once this unusual combination was established in the lineage that gave rise to modern humans, it would have given such individuals a considerable advantage at the cognitive level.

Can This Theory Help Explain the Unusual Origin of Our Species? Although new findings keep changing the numbers, it currently appears that modern humans evolved from a population of 5000–10,000 individuals in Africa >2–300,000 years ago (Nielsen et al., 2017; Scheinfeldt, Soi, Lambert, et al., 2019), and spread across the planet over the last 70,000–100,000 years or so (Clarkson et al., 2017; Galway-Witham & Stringer, 2018), at about the time when the archeological record began to show symbolic art, complex toolmaking, personal ornamentation, and burials with grave goods—the kinds of features one might expect to see if a full theory of mind had emerged. It appears that these "behaviorally modern" humans then replaced all closely related species over a few thousand years, with limited interbreeding (Galway-Witham & Stringer, 2018; Jacobs, Hudjashov, Saag, et al., 2019; Petr, Pääbo, Kelso, & Vernot, 2019), leaving us as the only surviving hominin lineage, eventually gaining dominance over the entire biosphere. The fact that there are no persisting hybrids (Varki, 2016) suggests that a subset of anatomically modern humans may have gone through this "mind over reality transition" (Fig. 6), and then used extended theory of mind, reality denial, self-deception, false beliefs, an overarching optimism bias, and irrational risk-taking, to emerge as the dominant species. Of course, there is much evidence that Neanderthals shared many advanced cognitive features with humans (Finlayson, Brown, Blasco, et al., 2012;

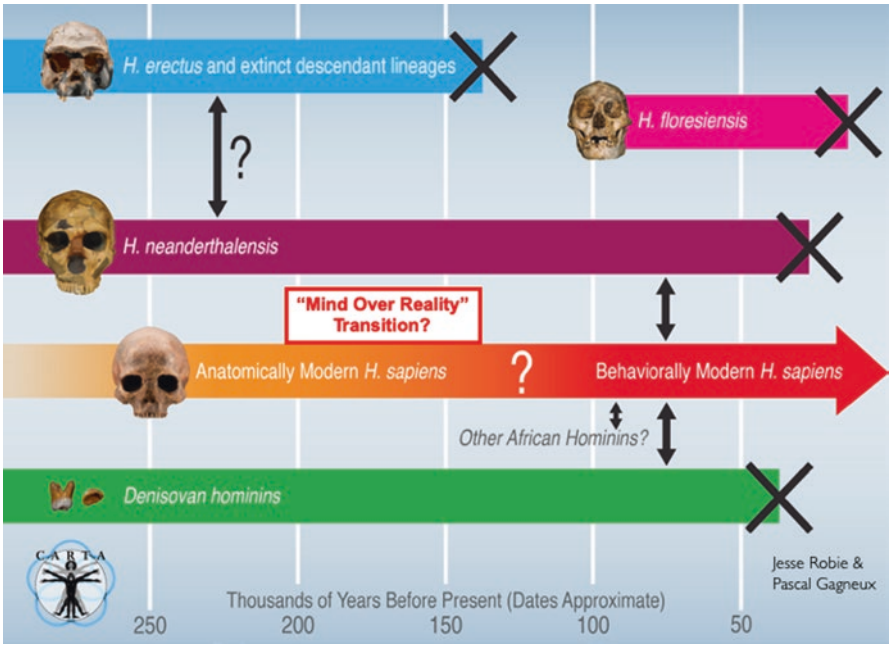

Fig. 6 Possible timing of the proposed mind over reality transition in relation to the origin of modern humans (modified from Varki A.: The Scientist 27:28–29, 2013)

Mithen, 2007; Nakahashi, 2017; Pettitt, 2010). Perhaps there they were also at the brink of the psychological evolutionary barrier, but then failed to attain the optimal combination of genes and culture to cross that Rubicon.

Does Human Psychological Ontogeny Recapitulate the Proposed Original Breaching of the Psychological Evolutionary Barrier? As shown in Fig. 7, this may also be an instance in which ontogeny does indeed recapitulate phylogeny (Clune, Pennock, Ofria, & Lenski, 2012; Gould, 1977), in that human postnatal psychological development seems to recapitulate the proposed evolutionary transition (Moll & Meltzoff, 2011). The proposed breaching of the psychological evolutionary barrier of mortality salience associated with the emergence of our species is perhaps being recapitulated in the death anxiety seen in young children (Barrett & Behne, 2005; Harris, 2018; Roche, Brooten, & Youngblut, 2019; Speece & Brent, 1984; Vázquez-Sánchez et al., 2018), especially in nonreligious families. Parents in such families are often concerned about such anxieties, but the transition to the "invincible" adolescent more prone to take risks usually takes care of the problem over time. Also consistent with the overall theory, children with autism spectrum disorders and limited theory of mind sometimes have difficulties in understanding the concept of God (Akechi, Kikuchi, Tojo, Hakarino, & Hasegawa, 2018; Jack, Friedman, Boyatzis, & Taylor, 2016; Norenzayan, Gervais, & Trzesniewski, 2012) or the deaths of others (Horowitz, Thurm, Farmer, et al., 2018).

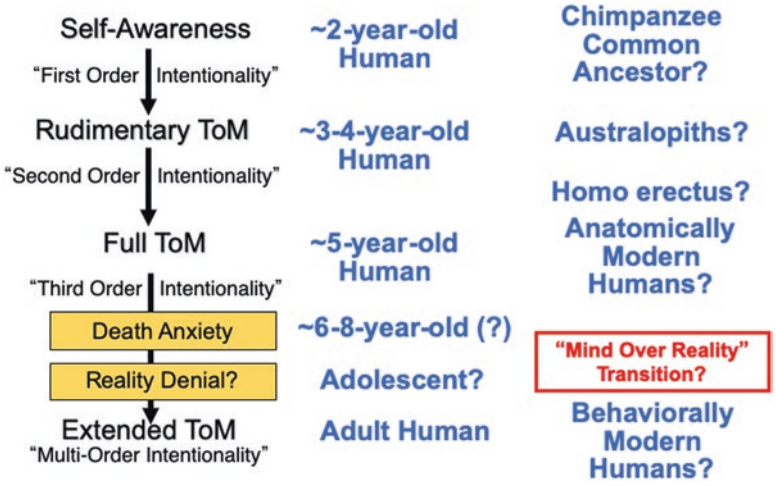

Fig. 7 Does human psychological ontogeny recapitulate our recent phylogeny?

Of course, autism spectrum disorders are not a proxy for our ancestral state, and ethical issues would constrain attempts to explore how well such individuals understand their personal mortality.

Other Examples of Potentially Supportive Evidence. As Dennett has suggested, "any theory that makes progress is bound to be initially counterintuitive" (Dennett, 1987). Any new theory is also more likely to be rejected if it originates from individuals without expertise in the relevant disciplines, and more especially if it cannot be immediately tested or falsified. But as is often done in fields like astronomy (or at the origins of the theory of evolution), one can assemble examples of potentially supportive evidence and also consider all possible "ugly facts" that might destroy the hypothesis.

The current hypothesis is consistent with "terror management theory" (Greenberg, Solomon, & Pyszczynski, 1997; Harmon-Jones et al., 1997; Lewis, 2014; Plusnin, Pepping, & Kashima, 2018; Pyszczynski, Greenberg, & Solomon, 1999; Rosenblatt, Greenberg, Solomon, Pyszczynski, & Lyon, 1989; Solomon, Greenberg, & Pyszczynski, 1991, 2015; Vail et al., 2010) which seeks to explain defensive human thinking and behavior that arises from an awareness and fear of death, driving people to adopt worldviews that help protect their self-esteem, and making them believe that they play an important role in a meaningful world, despite the knowing of certain oblivion in the long run. Space does not allow a proper treatment of the extensive literature on Terror Management Theory (TMT) (see Pyszczynski in this volume). However, assuming that the proposed transition occurred in recent evolutionary time, human suppression of mortality salience is likely incomplete, and this partial suppression could explain the ongoing need for terror management in current-day humans. Perhaps one can suggest that MORT is to terror management theory (TMT) TMT as general relativity is to Newtonian

physics, the former being an improved model of reality, while the latter remaining useful for everyday predictions.[1]

On the other hand, reality denial can be beneficial when it allows for optimism, perhaps explaining the evolutionary origins of the well-documented "optimism bias" in humans (Sharot, 2011a, 2011b; Sharot et al., 2007, 2011) which manifests itself in many human characteristics, such as the "Pollyanna hypothesis" (Iliev, Hoover, Dehghani, & Axelrod, 2016; Schlaghecken, Blagrove, Mantantzis, Maylor, & Watson, 2017) which addresses the apparent universal positivity bias of human language. It can also explain the human propensity for risk-taking and thrill-seeking behavior. Notably, evolutionary modeling shows that reacting in an overconfident manner can actually have fitness benefits, as long as the contested resources are sufficiently large, compared to the cost of competition (Johnson & Fowler, 2011). On the other hand, willfully ignoring negative information can lead to disasters such as unnecessary fatalities in mountain climbers who refuse to turn back against all odds (Krakauer, 1998),[2] major military losses in war (Brighton, 2004), and many other of history's greatest disasters and mistakes (Cooke, 2013).

Reality denial could also contribute to the "end-of-history illusion" (Quoidbach, Gilbert, & Wilson, 2013), in which adults spanning a wide age range acknowledge that they have changed in many ways from how they were in the past, and yet find it hard to imagine that they will change much in the future. As the study authors put it, people seem to "regard the present as a watershed moment at which they have finally become the person they will be for the rest of their lives." This obvious denial of future reality could also help with suppression of mortality salience. Ironically, some of the same individuals are still capable of a major concern for their own posthumous legacy, despite knowing that they will not be there to be personally affected by such a legacy.

Depending on the lens through which it is studied, one aspect of religion can also be considered as strong evidence in support of MORT. Most human behaviors exist in other species on a continuum of development, as one would expect from evolution. But religion appears to be a well-established near universal only in human cultures and there are many obvious fitness advantages that have been discussed by others (Bering, 2011; Boyer, 2001, 2008; Churchland, 2011; Dennett, 2006; Maser & Gallup, 1990; McCauley, 2011; Norenzayan & Shariff, 2008; Schloss & Murray, 2010; Shermer, 2012; Wade, 2009; Wilson, 2002). But most of these advantages should not require a belief in life after death. Nevertheless, almost all religions have at their core some form of such afterlife beliefs, which would serve as another mechanism to blunt the impact of mortality salience. Of course, atheists do not live

[1] Analogy suggested by Rob Mielcarski, whose website Un-denial (https://un-denial.com) addresses many ways in which the MORT theory is consistent with the reality of the current human condition as well as the dismal fate of our species.

[2] "Unfortunately, the sort of individual who is programmed to ignore personal distress and keep pushing for the top is frequently programmed to disregard signs of grave and imminent danger as well. This forms the nub of a dilemma that every Everest climber eventually comes up against: in order to succeed you must be exceedingly driven, but if you're too driven you're likely to die." Jon Krakauer, pg. 177

in constant fear of their mortality (Dawkins, 2008; Harris, 2005; Hitchens, 2009), so the underlying reality denial appears to be the primary mechanism.

Meanwhile, the dark side of mortality salience is the ability to take a decision to commit suicide (Braun, Bschor, Franklin, & Baethge, 2016; Humphrey, 2018; Jamison, 1999; Preti, 2007; Soole, Kõlves, & De Leo, 2015; Stoff & Mann, 1997). This uniquely human phenomenon varies in frequency in time and space in different cultures, but also occurs at a baseline rate in all populations, driven in part by major depressive disorder (Angst, Angst, & Stassen, 1999; Jamison, 1999), a common human psychiatric condition often characterized by "depressive realism" (Haaga & Beck, 1995; Moore & Fresco, 2012; Pacini, Muir, & Epstein, 1998), a concept that suggests that mildly depressed individuals are better at perceiving certain (largely negative) aspects of reality.

If at least some aspects of depression are related to a failure of reality denial, i.e., an inability to sustain the "optimism bias," perhaps the dramatic effects of ketamine in major depressive disorder (Caddy, Amit, McCloud, et al., 2015; DeWilde, Levitch, Murrough, Mathew, & Iosifescu, 2015; Kraus, Rabl, Vanicek, et al., 2017; Machado-Vieira, Salvadore, Diazgranados, & Zarate, 2009; Parsaik, Singh, Khosh-Chashm, & Mascarenhas, 2015) partially constitute a sudden reset into altered reality. In this regard, could the well-known human craving for mind-altering substances also be partly due to the need to escape reality? Could the same be true of the positive value of meditation methods that focus on mindfulness of the present, or the shutting out of irksome reality? Conversely, could episodic panic attacks (Bighelli, Castellazzi, Cipriani, et al., 2018; Imai, Tajika, Chen, Pompoli, & Furukawa, 2016; Meuret, Kroll, & Ritz, 2017) represent a sudden failure of the neural mechanisms of reality denial? The reader may detect a tendency here toward an umbrella theory, but the fact remains that all the speculative suggestions above are consistent with the MORT theory.

Features of Human Sex and Gender Potentially Relevant to the Proposed Transition

Assuming that such an evolutionary transition did occur, what might have been the contributions of sex and gender? As illustrated in the very speculative Fig. 8, human males are at greater risk of autism spectrum disorders, more prone to selective reality denial, systematizing, optimism bias, and risk-taking behavior. Conversely, human females are more prone to empathy, cooperation, theory of mind, depressive realism, and major depressive disorder. Considering these sex and gender differences (which are of course on a continuum, and affected by many cultural and genetic factors), could it be that the original evolutionary transition involved mating of males with a complex genotype manifesting as maladaptive reality denial—with females having an equally complex genotype, suffering from mortality salience due to an enhanced theory of mind? Although we cannot know for certain, could such mating have generated an unusual collection of alleles, as an explanation for the

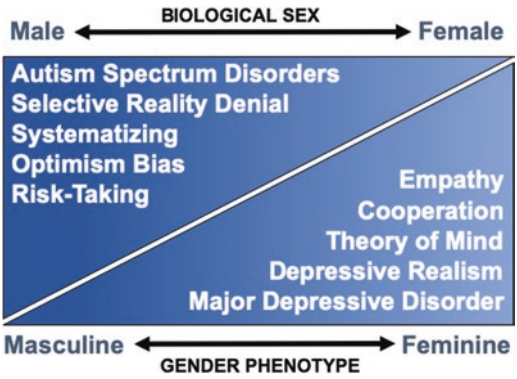

Fig. 8 Speculation regarding features of human sex and gender that are potentially relevant to the theory

origin of humans? Assuming that generating and stabilizing the optimal combination of such alleles were was difficult, perhaps it took a very long time. Perhaps there was a prolonged interim state of recurrent cognitive instability, with ongoing dangers resulting from reality denial and/or existential angst, and possibly even high rates of suicide. Could this difficult transition explain the >100,000-year gap between the genetic origin of modern humans and archeological evidence suggesting our emergence in Africa and then elsewhere?

Issues Arising and Future Directions

Regardless of the sweeping speculations above, we have stated at the outset that the current theory is not falsifiable at this time. Thus, it is vital to search for "ugly facts" that might destroy the hypothesis. Although no such facts have yet emerged, there are many aspects of the earlier discussion that were oversimplified. For example, the mirror self-recognition test is not proof of self-awareness, the evidence for self-awareness in some nonhuman species is not definitive, and self-awareness in various distantly related species may not have necessarily evolved from the same neural processes. It is also true that theory of mind is not a clearly definable concept, that some other mammals and birds may have something approaching a full theory of mind, and that Neanderthals have left some evidence for an extended theory of mind, including burials and injured elderly individuals who must have been cared for (Ekshtain & Tryon, 2019; Morin & Laroulandie, 2012; Nakahashi, 2017; Pettitt, 2010; Staubwasser, Drăguşin, Onac, et al., 2018). Considering the archeological record, stone tool production must have required some degree of teaching, verbal communication, or at minimum active demonstration that was occurring prior to the appearance of modern humans (Asfaw, Gilbert, Beyene, et al., 2002), and the production of ochre pigment (Rosso, Pitarch Martí, & d'Errico, 2016), and long-range transport of obsidian toolmaking materials (Blegen, Jicha, & McBrearty, 2018) also predates evidence for modern humans.

Meanwhile, some would suggest that the biological sex drive should have superseded fear of mortality salience or that extended theory of mind and reality denial could have coevolved gradually. If so the question remains why only in one species? The argument that a rational human can deal with mortality fears with facts and statistics is not relevant to the suggested evolutionary scenario, as the initially maladaptive mortality salience would have emerged in just a few individuals, who would likely be without any facts or statistics to help rationalize the intense fear of death.

Potential Neuroanatomic Correlates of the Theory

If this theory is correct, modern humans should have unique neural pathways that mediated the proposed evolutionary changes. Candidate brain regions include the amygdala (the brain's "danger hub" that activates natural "fight-or-flight" response to danger and death risk) (Barger, Stefanacci, Schumann, et al., 2012; Barger, Stefanacci, & Semendeferi, 2007; Carlo, Stefanacci, Semendeferi, & Stevens, 2010; Feinstein, Adolphs, Damasio, & Tranel, 2011; Johansen, Cain, Ostroff, & LeDoux, 2011; Kim, Dager, & Lyoo, 2012; Kliemann, Dziobek, Hatri, Baudewig, & Heekeren, 2012; Quirin, Loktyushin, Arndt, et al., 2012; Roozendaal, McEwen, & Chattarji, 2009; Weisholtz, Root, Butler, et al., 2015); the prefrontal cortex (involved in judgments, decision-making, problem-solving, and controlling the amygdala during stressful events) (Blakemore & Robbins, 2012; Fuster, 2008; Kuss et al., 2015; Mitchell, 2009; Tamir & Mitchell, 2010); and the anterior cingulate cortex (involved in responding to mistakes, motivation, staying focused on a task, and managing proper emotional reactions) (Ecker, Suckling, Deoni, et al., 2012; Quirin et al., 2012; Rilling et al., 2012; Sharot et al., 2007). These also happen to be some of the regions that have undergone major anatomical changes in humans compared with our closest living evolutionary cousins (Barger et al., 2007, 2012; Rilling et al., 2012; Sakai, Mikami, Tomonaga, et al., 2011), and in which fMRI studies of optimism bias show evidence of activity (Sharot et al., 2007). All these are obviously highly oversimplified views of very complex neural structures and pathways, but they are at least consistent with the theory.

A Potentially Unifying Explanation. Overall, this "mind over reality transition" theory provides a potentially unifying explanation for the *evolutionary* origins of several unusual or exaggerated features of human cognition, including:

- Extended "theory of mind" (required or beneficial for many other aspects of human cognition)
- The ability for reality denial, even when aware of facts
- A strong tendency for self-deception and false beliefs
- Overarching optimism bias
- Irrational risk-taking behavior
- Recent emergence as the dominant species on the planet (perhaps making use of the above attributes)

- Replacement of all other closely related evolutionary cousins, with limited interbreeding

The theory is also consistent with all known facts, compatible with all other related theories, and not negated by any currently known facts. On the other hand, it is not directly testable by experimental reproduction and not directly falsifiable by experimental approaches. Given also the counterintuitive nature and unusual origins of this theory, as well as the lack of expertise of the originators in many relevant disciplines, MORT is very likely to be attacked from many quarters, and resolution is unlikely during the lifetime of this author. Only the passage of time will tell if MORT is as important as plate tectonics or as completely fanciful as "phlogiston" (or something somewhere in between). Fortunately, concern for posthumous legacy is a largely meaningless exercise.[3]

Coda: Relevance to the Current Human Condition and the Future of Our Species. The 2007 draft of Danny Brower's incomplete manuscript that I modified and expanded into a co-authored book (Varki & Brower, 2013) included the following prescient observations: "*We are polluting the earth and changing the climate in ways that we can't predict, and likely at some point, can't easily reverse. If we're so smart, why do we continue to sow the seeds for our eventual destruction? Because we are saddled with a brain that is designed by selection to cope with the ultimate disaster (death) by denying that it will occur, and so we treat other impending disasters by denying that they will ever happen …... Indeed, it is arguable that we are destined ultimately to destroy ourselves as a species*." Although many of our follies arising from reality denial can at least theoretically be eventually reversed, there are two that definitely cannot be turned back once they occur: global nuclear holocaust and anthropogenic climate change. Although not an expert on climate, discussions with such individuals lead me to the conclusion that the human-induced climate disruption is already occurring, and that absent major changes in current human behavior and/or human intervention there is a very high probability of *irreversible* global catastrophic climate disruption before mid-century (Gilding, 2012; Gore, 2007, 2013; Guterl, 2012; Hansen, Sato, & Ruedy, 2012; Mann, 2012; Wallace-Wells, 2019), i.e., a "climate holocaust." In other words, we are putting our children on an airplane with a very high probability of a catastrophic crash (McKibben, 2019; Rich, 2019). If this theory regarding the evolutionary origins of human reality denial is true, the first step to reversing the situation would seem to be a full awareness of our genetic tendency to reality denial by the media, and by our scientific and political leaders. Sadly, it is unlikely that rational discussion or scientific details will be sufficient to sway the average human to do what is right for the future of our species, let alone leaders who are focused on near-term political and economic goals. The only solution then may be "legitimate fear-mongering"! It is notable that it was such fear-mongering that once brought all the nations of the world together during

[3] *"I cannot possibly believe that a false theory would explain so many classes of facts as I think it certainly does explain…..on these grounds I drop my anchor, and believe that the difficulties will slowly disappear."*—Charles Darwin, letter to Asa Gray, shortly after *Origin of Species* was published.

the Cold War, to minimize the risk of a nuclear holocaust (Caldicott, 2017). The only other hope may be to combine fear with shame and guilt, imposed upon adult humans by adolescent school children, who can better imagine the dire future we are leaving them to face (Kjeldahl & Hendricks, 2019). As the 15-year-old Greta Thunberg said to the elites at Davos: "I want you to feel the fear I feel every day. And act as if your house is on fire. Because it is." Of course, even if we manage to avoid catastrophic climate disruption, there are the other existential threats to our species that reality denial makes us prone to, such as widespread and indiscriminate applications of artificial intelligence (Müller, 2016) to the generation of "deep fake videos" (Stover, 2018) and other gross distortions of reality at a population-wide level. If this theory turns out to be the correct explanation for the origin of the species, it might ironically also be now sowing the seeds of our demise.

Acknowledgements The author thanks Sharon Brower, Stuart Firestein, Pascal Gagneux, Stephan Kaufhold, Rob Mielcarski, Todd Shackelford, and Virgil Zeigler-Hill for specific comments and criticisms, many members of the Center for Academic Research and Training in Anthropogeny for inspiring discussions, and the late Danny Brower for the original ideas that lead to this theory.

References[4]

Akechi, H., Kikuchi, Y., Tojo, Y., Hakarino, K., & Hasegawa, T. (2018). Mind perception and moral judgment in autism. *Autism Research, 11*, 1239–1244.

Anderson, J. R., & Gallup, G. G. (2015). Mirror self-recognition: A review and critique of attempts to promote and engineer self-recognition in primates. *Primates, 56*, 317–326.

Anderson, J. R., Gillies, A., & Lock, L. C. (2010). Pan thanatology. [letter]. *Current Biology, 20*(8), R349–R351.

Angst, J., Angst, F., & Stassen, H. H. (1999). Suicide risk in patients with major depressive disorder. *The Journal of Clinical Psychiatry, 60*(Suppl 2), 57–62. discussion 75.

Apperly, I. (2010). *Mindreaders: The cognitive basis of "theory of mind"* (p. 232). New York: Psychology Press.

Ariely, D. (2008). *Predictably irrational: The hidden forces that shape our decisions* (Vol. xxii, p. 280). New York: Harper.

Asfaw, B., Gilbert, W. H., Beyene, Y., et al. (2002). Remains of Homo erectus from Bouri, Middle Awash, Ethiopia. *Nature, 416*, 317–320.

Barger, N., Stefanacci, L., Schumann, C. M., et al. (2012). Neuronal populations in the basolateral nuclei of the amygdala are differentially increased in humans compared with apes: A stereological study. *Journal of Comparative Neurology, 520*, 3035–3054.

Barger, N., Stefanacci, L., & Semendeferi, K. (2007). A comparative volumetric analysis of the amygdaloid complex and basolateral division in the human and ape brain. *American Journal of Physical Anthropology, 134*, 392–403.

Baron-Cohen, S., Leslie, A. M., & Frith, U. (1985). Does the autistic child have a "theory of mind"? *Cognition, 21*, 37–46.

[4]This work draws from a vast range of areas of human knowledge, most of which the author has limited expertise in. Thus, the citations are undoubtedly incomplete and very likely not always the best choices. The author also apologizes for the likely errors of omission and commission in the selection of the citations.

Baron-Cohen, S., O'Riordan, M., Stone, V., Jones, R., & Plaisted, K. (1999). Recognition of faux pas by normally developing children and children with Asperger syndrome or high-functioning autism. *Journal of Autism and Developmental Disorders, 29*, 407–418.

Barrett, H. C., & Behne, T. (2005). Children's understanding of death as the cessation of agency: A test using sleep versus death. *Cognition, 96*, 93–108.

Bearzi, G., Kerem, D., Furey, N. B., Pitman, R. L., Rendell, L., & Reeves, R. R. (2018). Whale and dolphin behavioural responses to dead conspecifics. *Zoology (Jena, Germany), 128*, 1–15.

Bedny, M., Pascual-Leone, A., & Saxe, R. R. (2009). Growing up blind does not change the neural bases of Theory of Mind. *Proceedings of the National Academy of Sciences, 106*, 11312–11317.

Bering, J. (2011). *The belief instinct: The psychology of souls, destiny, and the meaning of life* (p. cm). New York: W.W. Norton & Company.

Bering, J. M., & Parker, B. D. (2006). Children's attributions of intentions to an invisible agent. *Developmental Psychology, 42*, 253–262.

Bighelli, I., Castellazzi, M., Cipriani, A., et al. (2018). Antidepressants versus placebo for panic disorder in adults. *Cochrane Database of Systematic Reviews, 4*, CD010676.

Biro, D., Humle, T., Koops, K., Sousa, C., Hayashi, M., & Matsuzawa, T. (2010). Chimpanzee mothers at Bossou, Guinea carry the mummified remains of their dead infants. *Current Biology, 20*, R351–R352.

Blakemore, S. J., & Robbins, T. W. (2012). Decision-making in the adolescent brain. *Nature Neuroscience, 15*, 1184–1191.

Blegen, N., Jicha, B. R., & McBrearty, S. (2018). A new tephrochronology for early diverse stone tool technologies and long-distance raw material transport in the Middle to Late Pleistocene Kapthurin Formation, East Africa. *Journal of Human Evolution, 121*, 75–103.

Boyer, P. (2001). *Religion explained: The evolutionary origins of religious thought* (Vol. vii, p. 375). New York: Basic Books.

Boyer, P. (2008). Being human: Religion: Bound to believe? *Nature, 455*, 1038–1039.

Braun, C., Bschor, T., Franklin, J., & Baethge, C. (2016). Suicides and suicide attempts during long-term treatment with antidepressants: A Meta-analysis of 29 placebo-controlled studies including 6,934 patients with major depressive disorder. *Psychotherapy and Psychosomatics, 85*, 171–179.

Brighton, T. (2004). *Hell riders: The true story of the charge of the light brigade* (Vol. xxii, p. 370). New York: Henry Holt. [16] p. of plates.

Caddy, C., Amit, B. H., McCloud, T. L., et al. (2015). Ketamine and other glutamate receptor modulators for depression in adults. *Cochrane Database of Systematic Reviews*, CD011612. https://doi.org/10.1002/14651858.CD011611.pub2

Caldicott, H. (2017). *Sleepwalking to armageddon: The threat of nuclear annihilation* (Vol. xviii, p. 232). New York: The New Press.

Candland, D. K. (1995). *Feral children and clever animals: Reflections on human nature* (p. 432). USA: Oxford University Press.

Carlo, C. N., Stefanacci, L., Semendeferi, K., & Stevens, C. F. (2010). Comparative analyses of the neuron numbers and volumes of the amygdaloid complex in old and new world primates. *Journal of Comparative Neurology, 518*, 1176–1198.

Carter, R. (2002). *Exploring consciousness* (Vol. 320). Berkeley: University of California Press.

Chou, H. H., Takematsu, H., Diaz, S., et al. (1998). A mutation in human CMP-sialic acid hydroxylase occurred after the Homo-Pan divergence. *Proceedings of the National Academy of Sciences of the United States of America, 95*, 11751–11756.

Churchland, P. S. (2011). *Braintrust: What neuroscience tells us about morality*. Princeton, NJ: Princeton University Press.

Clarkson, C., Jacobs, Z., Marwick, B., et al. (2017). Human occupation of northern Australia by 65,000 years ago. *Nature, 547*, 306–310.

Clary, D., & Kelly, D. M. (2016). Graded mirror self-recognition by clark's nutcrackers. *Scientific Reports, 6*, 36459.

Clune, J., Pennock, R. T., Ofria, C., & Lenski, R. E. (2012). Ontogeny tends to recapitulate phylogeny in digital organisms. *The American Naturalist, 180*, E54–E63.

Cooke, T. (2013). Atlas of history's greatest disasters & mistakes: The 50 most significant moments explored in words and maps. New York: Metro Books; 1 atlas (223 pages).
Corriveau, K. H., Kim, A. L., Schwalen, C. E., & Harris, P. L. (2009). Abraham Lincoln and Harry Potter: Children's differentiation between historical and fantasy characters. *Cognition, 113*, 213–225.
Crockford, C., Wittig, R. M., Mundry, R., & Zuberbuhler, K. (2012). Wild chimpanzees inform ignorant group members of danger. *Current Biology, 22*, 142–146.
Culotta, E. (2016). HUMAN ORIGINS. Likely hobbit ancestors lived 600,000 years earlier. *Science, 352*, 1260–1261.
Dale, R., & Plotnik, J. M. (2017). Elephants know when their bodies are obstacles to success in a novel transfer task. *Scientific Reports, 7*, 46309.
Dawkins, R. (2008). *The God delusion* (p. 463). Boston: Houghton Mifflin.
Dennett, D. C. (1987). *The intentional stance* (Vol. xi, p. 388). Cambridge, MA: MIT Press.
Dennett, D. C. (1996). *Kinds of minds: Toward an understanding of consciousness* (p. 184). New York: BasicBooks/Weidenfeld and Nicolson.
Dennett, D. C. (2006). *Breaking the spell: Religion as a natural phenomenon* (Vol. xvi, p. 448). New York: Viking.
DeWilde, K. E., Levitch, C. F., Murrough, J. W., Mathew, S. J., & Iosifescu, D. V. (2015). The promise of ketamine for treatment-resistant depression: Current evidence and future directions. *Annals of the New York Academy of Sciences, 1345*, 47–58.
Dumontheil, I., Apperly, I. A., & Blakemore, S. J. (2010). Online usage of theory of mind continues to develop in late adolescence. *Developmental Science, 13*, 331–338.
Ecker, C., Suckling, J., Deoni, S. C., et al. (2012). Brain anatomy and its relationship to behavior in adults with autism spectrum disorder: A multicenter magnetic resonance imaging study. *Archives of General Psychiatry, 69*, 195–209.
Eddy, T. J., Gallup, G. G., & Povinelli, D. J. (1996). Age differences in the ability of chimpanzees to distinguish mirror-images of self from video images of others. *Journal of Comparative Psychology, 110*, 38–44.
Ekshtain, R., & Tryon, C. A. (2019). Lithic raw material acquisition and use by early Homo sapiens at Skhul, Israel. *Journal of Human Evolution, 127*, 149–170.
Emery, N. J., & Clayton, N. S. (2009). Comparative social cognition. *Annual Review of Psychology, 60*, 87–113.
Enard, W., Khaitovich, P., Klose, J., et al. (2002). Intra- and interspecific variation in primate gene expression patterns. *Science, 296*, 340–343.
Waal, F. B. M. D. (2019). *Mama's last hug: Animal emotions and what they tell us about ourselves*. New York: W.W. Norton.
Feinstein, J. S., Adolphs, R., Damasio, A., & Tranel, D. (2011). The human amygdala and the induction and experience of fear. *Current Biology, 21*, 34–38.
Finlayson, C., Brown, K., Blasco, R., et al. (2012). Birds of a feather: Neanderthal exploitation of raptors and corvids. *PLoS One, e45927*, 7.
Freeman, A. L. J., & Spiegelhalter, D. J. (2018). Communicating health risks in science publications: Time for everyone to take responsibility. *BMC Medicine, 16*, 207.
Froehle, A. W., Wells, G. K., Pollom, T. R., Mabulla, A. Z. P., Lew-Levy, S., & Crittenden, A. N. (2019). Physical activity and time budgets of Hadza forager children: Implications for self-provisioning and the ontogeny of the sexual division of labor. *American Journal of Human Biology, 31*, e23209.
Fuster, J. (2008). *The prefrontal cortex* (4th ed.p. 424). New York: Academic Press.
Gagneux, P., Moore, J. J., & Varki, A. (2005). The ethics of research on great apes. *Nature, 437*, 27–29.
Gallup, G. G. J. (1977). Absence of self-recognition in a monkey (Macaca fascicularis) following prolonged exposure to a mirror. *Developmental Psychobiology, 10*, 281–284.
Galway-Witham, J., & Stringer, C. (2018). How did Homo sapiens evolve. *Science, 360*, 1296–1298.
Gentner, D., & Goldin-Meadow, S. (2003). Language in mind: Advances in the study of language and thought. A Bradford Book (p 538). MIT Press Cambridge, MA, USA

Ghaderi, D., Springer, S. A., Ma, F., et al. (2011). Sexual selection by female immunity against paternal antigens can fix loss of function alleles. *Proceedings of the National Academy of Sciences of the United States of America, 108*, 17743–17748.
Gilbert, D. (2007). *Stumbling on happiness* (p. 336). New York: Vintage.
Gilding, P. (2012). *The great disruption: Why the climate crisis will bring on the end of shopping and the birth of a new world* (p. 304). London: Bloomsbury Press.
Goncalves, A., & Biro, D. (2018). Comparative thanatology, an integrative approach: Exploring sensory/cognitive aspects of death recognition in vertebrates and invertebrates. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 373*. https://doi.org/10.1098/rstb.2017.0263
Goncalves, A., & Carvalho, S. (2019). Death among primates: A critical review of non-human primate interactions towards their dead and dying. *Biological Reviews of the Cambridge Philosophical Society, 94*(4), 1502–1529.
Gore, A. (2007). *AN inconvenient truth: The crisis of global warming* (p. 192). New York: Viking Juvenile.
Gore, A. (2013). *The future: Six drivers of global change* (p. 592). New York: Random House.
Gould, S. J. (1977). *Ontogeny and phylogeny* (Vol. ix, p. 501). Cambridge, MA: Belknap Press of Harvard University Press.
Greenberg, J., Solomon, S., & Pyszczynski, T. (1997). Terror management theory of self-esteem and cultural worldviews: Empirical assessments and conceptual refinements. *Advances in Experimental Social Psychology, 29*, 61–139.
Guterl, F. (2012). *The fate of the species: Why the human race may cause its own extinction and how we can stop it* (p. 224). New York: Bloomsbury.
Haaga, D. A., & Beck, A. T. (1995). Perspectives on depressive realism: Implications for cognitive theory of depression. *Behaviour Research and Therapy, 33*, 41–48.
Hajdinjak, M., Fu, Q., Hübner, A., et al. (2018). Reconstructing the genetic history of late Neanderthals. *Nature, 555*, 652–656.
Hansen, J., Sato, M., & Ruedy, R. (2012). Perception of climate change. *Proceedings of the National Academy of Sciences of the United States of America, 109*, E2415–E2423.
Harmon-Jones, E. (2019). *Cognitive dissonance: Reexamining a pivotal theory in psychology* (p. cm). Washington, DC: American Psychological Association.
Harmon-Jones, E., Simon, L., Greenberg, J., Pyszczynski, T., Solomon, S., & McGregor, H. (1997). Terror management theory and self-esteem: Evidence that increased self-esteem reduces mortality salience effects. *Journal of Personality and Social Psychology, 72*, 24–36.
Harris, P. L. (2018). Children's understanding of death: From biology to religion. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 373*. https://doi.org/10.1098/rstb.2017.0266
Harris, S. (2005). *The end of faith: Religion, terror, and the future of reason* (p. 352). New York: W. W. Norton.
Hayakawa, T., Angata, T., Lewis, A. L., Mikkelsen, T. S., Varki, N. M., & Varki, A. (2005). A human-specific gene in microglia. *Science, 309*, 1693.
Hedlund, M., Padler-Karavani, V., Varki, N. M., & Varki, A. (2008). Evidence for a human-specific mechanism for diet and antibody-mediated inflammation in carcinoma progression. *Proceedings of the National Academy of Sciences of the United States of America, 105*, 18936–18941.
Heyes, C. M., & Frith, C. D. (2014). The cultural evolution of mind reading. *Science, 344*, 1243091.
Hitchens, C. (2009). *God is not great: How religion poisons everything* (p. 336). New York: Twelve.
Hodges, S. D., Denning, K. R., & Lieber, S. (2018). Perspective taking: Motivation and impediment to shared reality. *Current Opinion in Psychology, 23*, 104–108.
Hofmann, S. G., Doan, S. N., Sprung, M., et al. (2016). Training children's theory-of-mind: A meta-analysis of controlled studies. *Cognition, 150*, 200–212.
Horowitz, L. M., Thurm, A., Farmer, C., et al. (2018). Talking about death or suicide: Prevalence and clinical correlates in youth with autism spectrum disorder in the psychiatric inpatient setting. *Journal of Autism and Developmental Disorders, 48*, 3702–3710.

Hrdy, S. B. (2009). *Mothers and others: The evolutionary origins of mutual understanding* (p. 422). Cambridge, MA: Belknap Press of Harvard University Press.

Hublin, J. J., Ben-Ncer, A., Bailey, S. E., et al. (2017). New fossils from Jebel Irhoud, Morocco and the pan-African origin of Homo sapiens. *Nature, 546*, 289–292.

Humphrey, N. (2018). The lure of death: Suicide and human evolution. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 373*. https://doi.org/10.1098/rstb.2017.0269

Huttunen, A. W., Adams, G. K., & Platt, M. L. (2017). Can self-awareness be taught? Monkeys pass the mirror test-again. *Proceedings of the National Academy of Sciences of the United States of America, 114*, 3281–3283.

Iliev, R., Hoover, J., Dehghani, M., & Axelrod, R. (2016). Linguistic positivity in historical texts reflects dynamic environmental and psychological factors. *Proceedings of the National Academy of Sciences of the United States of America, 113*, E7871–E7879.

Imai, H., Tajika, A., Chen, P., Pompoli, A., & Furukawa, T. A. (2016). Psychological therapies versus pharmacological interventions for panic disorder with or without agoraphobia in adults. *Cochrane Database of Systematic Reviews, 10*, CD011170.

Jack, A. I., Friedman, J. P., Boyatzis, R. E., & Taylor, S. N. (2016). Why do you believe in god? relationships between religious belief, analytic thinking, mentalizing and moral concern. *PLoS One, 11*, e0149989.

Jacobs, G. S., Hudjashov, G., Saag, L., et al. (2019). Multiple deeply divergent denisovan ancestries in papuans. *Cell, 177*(4), 1010–1021.e32.

Jamison, K. R. (1999). *Night falls fast understanding suicide* (Vol. x, p. 432). New York: Knopf.

Johansen, J. P., Cain, C. K., Ostroff, L. E., & LeDoux, J. E. (2011). Molecular mechanisms of fear learning and memory. *Cell, 147*, 509–524.

Johnson, D. D., & Fowler, J. H. (2011). The evolution of overconfidence. *Nature, 477*, 317–320.

Kappeler, P. M., & Silk, J. B. (2010). *Mind the gap: Tracing the origins of human universals.* (Vol. xix, p. 503). Heidelberg: Springer.

Kim, J. E., Dager, S. R., & Lyoo, I. K. (2012). The role of the amygdala in the pathophysiology of panic disorder: Evidence from neuroimaging studies. *Biology of Mood and Anxiety Disorders, 2*, 20.

Kitchen, A., Denton, D., & Brent, L. (1996). Self-recognition and abstraction abilities in the common chimpanzee studied with distorting mirrors. *Proceedings of the National Academy of Sciences of the United States of America, 93*, 7405–7408.

Kjeldahl, E. M., & Hendricks, V. F. (2019). Response by the authors. *EMBO Reports, 20*, e47764.

Kliemann, D., Dziobek, I., Hatri, A., Baudewig, J., & Heekeren, H. R. (2012). The role of the amygdala in atypical gaze on emotional faces in autism spectrum disorders. *The Journal of Neuroscience, 32*, 9469–9476.

Konner, M. (2010). *The evolution of childhood: Relationships, emotion, mind* (Vol. xv, p. 943). Cambridge, MA: Belknap Press of Harvard University Press.

Krakauer, J. (1998). *Into thin air: A personal account of the Mount Everest disaster* (Vol. xxii, p. 407). New York: Villard.

Kraus, C., Rabl, U., Vanicek, T., et al. (2017). Administration of ketamine for unipolar and bipolar depression. *International Journal of Psychiatry in Clinical Practice, 21*, 2–12.

Krupenye, C., Kano, F., Hirata, S., Call, J., & Tomasello, M. (2016). Great apes anticipate that other individuals will act according to false beliefs. *Science, 354*, 110–114.

Kuss, K., Falk, A., Trautner, P., Montag, C., Weber, B., & Fliessbach, K. (2015). Neuronal correlates of social decision making are influenced by social value orientation-an fMRI study. *Frontiers in Behavioral Neuroscience, 9*, 40.

Langdon, J. H. (1997). Umbrella hypotheses and parsimony in human evolution: A critique of the Aquatic Ape Hypothesis. *Journal of Human Evolution, 33*, 479–494.

Lewis, A. M. (2014). Terror management theory applied clinically: Implications for existential-integrative psychotherapy. *Death Studies, 38*, 412–417.

Luu, B., Rosnay, M., & Harris, P. L. (2013). Five-year-olds are willing, but 4-year-olds refuse, to trust informants who offer new and unfamiliar labels for parts of the body. *Journal of Experimental Child Psychology, 116*, 234–246.

Machado-Vieira, R., Salvadore, G., Diazgranados, N., & Zarate, C. A. J. (2009). Ketamine and the next generation of antidepressants with a rapid onset of action. *Pharmacology & Therapeutics, 123*, 143–150.

Mann, M. E. (2012). *The Hockey stick and the climate wars: Dispatches from the front lines* (Vol. 384). New York: Columbia University Press.

Marzluff, J., & Angell, T. (2012). *Gifts of the crow: How perception, emotion, and thought allow smart birds to behave like humans* (p. 304). New York: Free Press.

Maser, J. D., & Gallup, G. G. (1990). Theism as a by-product of natural selection. *The Journal of Religion., 70*, 515–532.

McCauley, R. N. (2011). *Why religion is natural and science is not* (Vol. xv, p. 335). New York: Oxford University Press.

McConkey, E. H., & Varki, A. (2000). A primate genome project deserves high priority. [letter]. *Science, 289*(5483), 1295–1296.

McConkey, E. H., & Varki, A. (2005). Genomics. Thoughts on the future of great ape research. *Science, 309*, 1499–1501.

McKibben, B. (2019). *Falter: Has the human game begun to play itself out* (p. cm). New York: Henry Holt and Company.

Meltzoff, A. N. (1999). Origins of theory of mind, cognition and communication. *Journal of Communication Disorders, 32*, 251–269.

Meuret, A. E., Kroll, J., & Ritz, T. (2017). Panic disorder comorbidity with medical conditions and treatment implications. *Annual Review of Clinical Psychology, 13*, 209–240.

Meyer, M., Kircher, M., Gansauge, M. T., et al. (2012). A high-coverage genome sequence from an archaic Denisovan individual. *Science, 338*, 222–226.

Mitchell, J. P. (2009). Inferences about mental states. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 364*, 1309–1316.

Mithen, S. (2007). *The singing neanderthals: The origins of music, language, mind, and body* (Vol. 384). Cambridge, MA: Harvard University Press.

Moll, H., & Meltzoff, A. N. (2011). How does it look? Level 2 perspective-taking at 36 months of age. *Child Development, 82*, 661–673.

Moll, H., & Tomasello, M. (2012). Three-year-olds understand appearance and reality – just not about the same object at the same time. *Developmental Psychology, 48*, 1124–1132.

Moore, M. T., & Fresco, D. M. (2012). Depressive realism: A meta-analytic review. *Clinical Psychology Review, 32*, 496–509.

Morin, E., & Laroulandie, V. (2012). Presumed symbolic use of diurnal raptors by Neanderthals. *PLoS One, 7*, e32856.

Morrison, R., & Reiss, D. (2018). Precocious development of self-awareness in dolphins. *PLoS One, 13*, e0189813.

Müller, V. C. (2016). *Risks of artificial intelligence* (Vol. x, p. 291). Boca Raton, FL: CRC Press.

Murphy, S. C., von Hippel, W., Dubbs, S. L., et al. (2015). The role of overconfidence in romantic desirability and competition. *Personality and Social Psychology Bulletin, 41*, 1036–1052.

Nakahashi, W. (2017). The effect of trauma on Neanderthal culture: A mathematical analysis. *Homo, 68*, 83–100.

Nielsen, R., Akey, J. M., Jakobsson, M., Pritchard, J. K., Tishkoff, S., & Willerslev, E. (2017). Tracing the peopling of the world through genomics. *Nature, 541*, 302–310.

Norenzayan, A., Gervais, W. M., & Trzesniewski, K. H. (2012). Mentalizing deficits constrain belief in a personal God. *PLoS One, 7*, e36880.

Norenzayan, A., & Shariff, A. F. (2008). The origin and evolution of religious prosociality. *Science, 322*, 58–62.

O'Bleness, M., Searles, V. B., Varki, A., Gagneux, P., & Sikela, J. M. (2012). Evolution of genetic and genomic features unique to the human lineage. *Nature Reviews Genetics, 13*, 853–866.

Olson, M. V., & Varki, A. (2003). Sequencing the chimpanzee genome: Insights into human evolution and disease. *Nature Reviews Genetics, 4*, 20–28.

Olson, M. V., & Varki, A. (2004). Genomics. The chimpanzee genome – a bittersweet celebration. *Science, 305*, 191–192.

Pacini, R., Muir, F., & Epstein, S. (1998). Depressive realism from the perspective of cognitive-experiential self-theory. *Journal of Personality and Social Psychology, 74*, 1056–1068.
Parker, S. T., Mitchell, R. W., & Boccia, M. (1994). *Self-awareness in animals and humans: Developmental perspectives* (Vol. xviii, p. 442). Cambridge, England: Cambridge University Press.
Parsaik, A. K., Singh, B., Khosh-Chashm, D., & Mascarenhas, S. S. (2015). Efficacy of ketamine in bipolar depression: Systematic review and meta-analysis. *Journal of Psychiatric Practice, 21*, 427–435.
Patel, G. H., Sestieri, C., & Corbetta, M. (2019). The evolution of the temporoparietal junction and posterior superior temporal sulcus. *Cortex*. https://doi.org/10.1016/j.cortex.2019.01.026
Petr, M., Pääbo, S., Kelso, J., & Vernot, B. (2019). Limits of long-term selection against Neanderthal introgression. *Proceedings of the National Academy of Sciences of the United States of America, 116*, 1639–1644.
Pettitt, P. (2010). *The palaeolithic origins of human burial* (p. 320). Abingdon: Routledge.
Piazza, J., Bering, J. M., & Ingram, G. (2011). "Princess Alice is watching you": Children's belief in an invisible person inhibits cheating. *Journal of Experimental Child Psychology, 109*, 311–320.
Plotnik, J. M., de Waal, F. B., & Reiss, D. (2006). Self-recognition in an Asian elephant. *Proceedings of the National Academy of Sciences of the United States of America, 103*, 17053–17057.
Plusnin, N., Pepping, C. A., & Kashima, E. S. (2018). The role of close relationships in terror management: A systematic review and research agenda. *Personality and Social Psychology Review, 22*, 307–346.
Porter, A., Eckardt, W., Vecellio, V., et al. (2019). Behavioral responses around conspecific corpses in adult eastern gorillas (Gorilla beringei spp.). *PeerJ, e6655*, 7.
Povinelli, D. J., Eddy, T. J., Hobson, R. P., & Tomasello, M. (1996). *What young chimpanzees know about seeing* (Vol. vi, p. 191). Chicago, IL: University of Chicago Press.
Premack, D., & Woodruff, G. (1978). Does the chimpanzee have a theory of mind? *The Behavioral and Brain Sciences, 4*, 515–526.
Preti, A. (2007). Suicide among animals: A review of evidence. *Psychological Reports, 101*, 831–848.
Prior, H., Schwarz, A., & Güntürkün, O. (2008). Mirror-induced behavior in the magpie (Pica pica): Evidence of self-recognition. *PLoS Biology, 6*, e202.
Prufer, K., de Filippo, C., Grote, S., et al. (2017). A high-coverage Neandertal genome from Vindija Cave in Croatia. *Science, 358*, 655–658.
Prufer, K., Racimo, F., Patterson, N., et al. (2014). The complete genome sequence of a Neanderthal from the Altai Mountains. *Nature, 505*, 43–49.
Pyszczynski, T., Greenberg, J., & Solomon, S. (1999). A dual-process model of defense against conscious and unconscious death-related thoughts: An extension of terror management theory. *Psychological Review, 106*, 835–845.
Quirin, M., Loktyushin, A., Arndt, J., et al. (2012). Existential neuroscience: A functional magnetic resonance imaging investigation of neural responses to reminders of one's mortality. *Social Cognitive and Affective Neuroscience, 7*, 193–198.
Quoidbach, J., Gilbert, D. T., & Wilson, T. D. (2013). The end of history illusion. *Science, 339*, 96–98.
Rajala, A. Z., Reininger, K. R., Lancaster, K. M., & Populin, L. C. (2010). Rhesus monkeys (Macaca mulatta) do recognize themselves in the mirror: Implications for the evolution of self-recognition. *PLoS One, 5*. https://doi.org/10.1371/journal.pone.0012865
Ramachandran, V. S. (1996). The evolutionary biology of self-deception, laughter, dreaming and depression: Some clues from anosognosia. *Medical Hypotheses, 47*, 347–362.
Reich, D., Green, R. E., Kircher, M., et al. (2010). Genetic history of an archaic hominin group from Denisova Cave in Siberia. *Nature, 468*, 1053–1060.
Reiss, D. (2011). *The dolphin in the mirror: Exploring dolphin minds and saving dolphin lives* (p. 276). Boston: Houghton Mifflin Harcourt. [8] p. of plates.
Reiss, D., & Marino, L. (2001). Mirror self-recognition in the bottlenose dolphin: A case of cognitive convergence. *Proceedings of the National Academy of Sciences of the United States of America, 98*, 5937–5942.

Rich, N. (2019). *Losing Earth: A recent history* (p. cm). New York: MCD/Farrar, Straus and Giroux.

Rilling, J. K., Scholz, J., Preuss, T. M., Glasser, M. F., Errangi, B. K., & Behrens, T. E. (2012). Differences between chimpanzees and bonobos in neural systems supporting social cognition. *Social Cognitive and Affective Neuroscience, 7*, 369–379.

Roche, R. M., Brooten, D., & Youngblut, J. M. (2019). Children's fears 2-13 months after sibling NICU/PICU/emergency department death. *Journal of the American Association of Nurse Practitioners*. https://doi.org/10.1097/JXX.0000000000000193

Ronfard, S., Bartz, D. T., Cheng, L., Chen, X., & Harris, P. L. (2018). Children's developing ideas about knowledge and its acquisition. *Advances in Child Development and Behavior, 54*, 123–151.

Ronfard, S., Chen, E. E., & Harris, P. L. (2018). The emergence of the empirical stance: Children's testing of counterintuitive claims. *Developmental Psychology, 54*, 482–493.

Roozendaal, B., McEwen, B. S., & Chattarji, S. (2009). Stress, memory and the amygdala. *Nature Reviews. Neuroscience, 10*, 423–433.

Rosenblatt, A., Greenberg, J., Solomon, S., Pyszczynski, T., & Lyon, D. (1989). Evidence for terror management theory: I. The effects of mortality salience on reactions to those who violate or uphold cultural values. *Journal of Personality and Social Psychology, 57*, 681–690.

Ross, J., Yilmaz, M., Dale, R., Cassidy, R., Yildirim, I., & Suzanne, Z. M. (2017). Cultural differences in self-recognition: The early development of autonomous and related selves. *Developmental Science, 20*. https://doi.org/10.1111/desc.12387

Rosso, D. E., Pitarch Martí, A., & d'Errico, F. (2016). Middle stone age ochre processing and behavioural complexity in the Horn of Africa: Evidence from Porc-Epic Cave, Dire Dawa, Ethiopia. *PLoS One., 11*, e0164793.

Safina, C. (2015). *Beyond words: What animals think and feel* (Vol. xiii, p. 461). New York: Henry Holt and Company. 16 unnumbered pages of plates.

Safina, C. (2019). *Beyond words: What elephants and whales think and feel* (p. cm). New York, NY: Roaring Brook Press.

Sakai, T., Mikami, A., Tomonaga, M., et al. (2011). Differential prefrontal white matter development in chimpanzees and humans. *Current Biology, 21*, 1397–1402.

Samson, D. (2009). Reading other people's mind: Insights from neuropsychology. *Journal of Neuropsychology, 3*, 3–16.

Schaafsma, S. M., Pfaff, D. W., Spunt, R. P., & Adolphs, R. (2015). Deconstructing and reconstructing theory of mind. *Trends in Cognitive Sciences, 19*, 65–72.

Scheinfeldt, L. B., Soi, S., Lambert, C., et al. (2019). Genomic evidence for shared common ancestry of East African hunting-gathering populations and insights into local adaptation. *Proceedings of the National Academy of Sciences of the United States of America*. https://doi.org/10.1073/pnas.1817678116

Schlaghecken, F., Blagrove, E., Mantantzis, K., Maylor, E. A., & Watson, D. G. (2017). Look on the bright side: Positivity bias modulates interference effects in the Simon task. *Journal of Experimental Psychology. General, 146*, 763–770.

Schloss, J., & Murray, M. J. (2010). *The believing primate: Scientific, philosophical, and theological reflections on the origin of religion* (Vol. xii, p. 365). Oxford, New York: Oxford University Press.

Schumaker, J. F. (1995). *The corruption of reality: A unified theory of religion, hypnosis, and psychopathology* (p. 289). Amherst, NY: Prometheus Books.

Sharot, T. (2011a). The optimism bias. *Current Biology, 21*, R941–R945.

Sharot, T. (2011b). *The optimism bias: A tour of the irrationally positive brain*. New York, NY: Pantheon.

Sharot, T., Korn, C. W., & Dolan, R. J. (2011). How unrealistic optimism is maintained in the face of reality. *Nature Neuroscience, 14*, 1475–1479.

Sharot, T., Riccardi, A. M., Raio, C. M., & Phelps, E. A. (2007). Neural mechanisms mediating optimism bias. *Nature, 450*, 102–105.

Shermer, M. (2012). *The believing brain: From Ghosts and gods to politics and conspiracies – how we construct beliefs and reinforce them as truths* (p. 400). New York: St. Martin's Griffin.
Solomon, S., Greenberg, J., & Pyszczynski, T. (1991). A terror management theory of social behavior: The psychological functions of self-esteem and cultural worldviews. *Advances in Experimental Social Psychology, 24*, 93–159.
Solomon, S., Greenberg, J., & Pyszczynski, T. A. (2015). *The worm at the core: On the role of death in life*. xi, 274 pages. Penguin Books, Random House, New York
Soole, R., Kõlves, K., & De Leo, D. (2015). Suicide in Children: A Systematic Review. *Archives of Suicide Research, 19*, 285–304.
Specter, M. (2009). *Denialism: How irrational thinking hinders scientific progress, harms the planet, and threatens our lives* (p. 304). London: Penguin Press HC.
Speece, M. W., & Brent, S. B. (1984). Children's understanding of death: A review of three components of a death concept. *Child Development, 55*, 1671–1686.
Spiegelhalter, D. (2012). Using speed of ageing and "microlives" to communicate the effects of lifetime habits and environment. *BMJ, 345*, e8223.
Staubwasser, M., Drăguşin, V., Onac, B. P., et al. (2018). Impact of climate change on the transition of Neanderthals to modern humans in Europe. *Proceedings of the National Academy of Sciences of the United States of America, 115*, 9116–9121.
Stewart, F. A., Piel, A. K., & O'Malley, R. C. (2012). Responses of chimpanzees to a recently dead community member at Gombe National Park. *Tanzania. American Journal of Primatol, 74*, 1–7.
Stoff, D. M., & Mann, J. (1997). Suicide research. *Annals of the New York Academy of Sciences, 836*, 1–11.
Stover, D. (2018). Garlin Gilchrist: Fighting fake news and the information apocalypse. *The Bulletin of the Atomic Scientists, 74*, 283–288.
Stringer, C. (2012). *Lone survivors: How we came to be the only humans on earth* (p. cm). New York: Henry Holt and Company.
Suddendorf, T., & Butler, D. L. (2013). The nature of visual self-recognition. *Trends in Cognitive Sciences, 17*, 121–127.
Tamir, D. I., & Mitchell, J. P. (2010). Neural correlates of anchoring-and-adjustment during mentalizing. *Proceedings of the National Academy of Sciences of the United States of America, 107*, 10827–10832.
Tattersall I. Masters of the planet: The search for our human origins (Macsci). Palgrave Macmillan; Basingstoke 2012:288.
Toda, K., & Platt, M. L. (2015). Animal cognition: Monkeys pass the mirror test. *Current Biology, 25*, R64–R66.
Tomasello, M. (2018). How children come to understand false beliefs: A shared intentionality account. *Proceedings of the National Academy of Sciences of the United States of America, 115*, 8491–8498.
Trivers, R. (2000). The elements of a scientific theory of self-deception. *Annals of the New York Academy of Sciences, 907*, 114–131.
Trivers, R. (2011). *The folly of fools: The logic of deceit and self-deception in human life* (p. cm). New York, NY: Basic Books.
Vail, K. E., Rothschild, Z. K., Weise, D. R., Solomon, S., Pyszczynski, T., & Greenberg, J. (2010). A terror management analysis of the psychological functions of religion. *Personality and Social Psychology Review, 14*, 84–94.
Varki, A. (2000). A chimpanzee genome project is a biomedical imperative. *Genome Research, 10*, 1065–1070.
Varki, A. (2007). The uncertain future of research chimpanzees. *Science, 315*, 1493–1494.
Varki, A. (2009). Human uniqueness and the denial of death. *Nature, 460*, 684.
Varki, A. (2010). Colloquium paper: Uniquely human evolution of sialic acid genetics and biology. *Proceedings of the National Academy of Sciences of the United States of America, 107*(Suppl 2), 8939–8946.

Varki, A. (2016). Why are there no persisting hybrids of humans with Denisovans, Neanderthals, or anyone else[letter]. *Proceedings of the National Academy of Sciences of the United States of America, 113*(17), E2354.
Varki, A., & Brower, D. L. (2013). *Denial: Self-deception, false beliefs, and the origins of the human mind* (Vol. 375). New York: Twelve.
Varki, A., Geschwind, D. H., & Eichler, E. E. (2008). Explaining human uniqueness: Genome interactions with environment, behaviour and culture. *Nature Reviews. Genetics, 9*, 749–763.
Varki, N. M., Strobert, E., Dick, E. J. J., Benirschke, K., & Varki, A. (2011). Biomedical differences between human and nonhuman hominids: Potential roles for uniquely human aspects of sialic acid biology. *Annual Review of Pathology, 6*, 365–393.
Vázquez-Sánchez, J. M., Fernández-Alcántara, M., García-Caro, M. P., Cabañero-Martínez, M. J., Martí-García, C., & Montoya-Juárez, R. (2018). The concept of death in children aged from 9 to 11 years: Evidences through inductive and deductive analysis of drawings. *Death Study*, 1–11. https://doi.org/10.1080/07481187.2018.1480545
Vogeley, K. (2017). Two social brains: Neural mechanisms of intersubjectivity. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences, 372*. https://doi.org/10.1098/rstb.2016.0245
Wade, N. (2009). *The faith instinct: How religion evolved and why it endures* (p. 320). The: Penguin Press HC.
Wallace-Wells, D. (2019). *The uninhabitable earth: Life after warming* (p. 310). New York: Tim Duggan Books.
Wang, X., Mitra, N., Secundino, I., et al. (2012). Specific inactivation of two immunomodulatory SIGLEC genes during human evolution. *Proceedings of the National Academy of Sciences of the United States of America, 109*, 9935–9940.
Weinstein, N. D. (1980). Unrealistic optimism about future life events. *Journal of Personality and Social Psychology, 39*, 806.
Weisholtz, D. S., Root, J. C., Butler, T., et al. (2015). Beyond the amygdala: Linguistic threat modulates peri-sylvian semantic access cortices. *Brain and Language, 151*, 12–22.
Wellman, H. M., & Brandone, A. C. (2009). Early intention understandings that are common to primates predict children's later theory of mind. *Current Opinion in Neurobiology, 19*, 57–62.
Wilson, D. S. (2002). *Darwin's cathedral: Evolution, religion, and the nature of society* (Vol. v, p. 268). Chicago: University of Chicago Press.
Wood, B., & Boyle E, K. (2016). Hominin taxic diversity: Fact or fantasy. *American Journal of Physical Anthropology, 159*, S37–S78.
Wood, B. (2017). Evolution: Origin(s) of modern humans. *Current Biology, 27*, R767–R769.
Young, L., Dodell-Feder, D., & Saxe, R. (2010). What gets the attention of the temporo-parietal junction? An fMRI investigation of attention and theory of mind. *Neuropsychologia, 48*, 2658–2664.

Death in Literature

Joseph Carroll

Introduction

People worry a lot about death—about how to avoid it, of course, but also how to think about it. As they develop cognitively from the onset of conscious awareness in early childhood, they gradually come to recognize that death is universal, unavoidable, and irreversible, and that it involves the complete cessation of all motion, feeling, sensation, and thought—a cluster of characteristics that is designated the "biological" concept of death (Harris, 2018; Panagiotaki, Hopkins, Nobes, Ward, & Griffiths, 2018; Watson-Jones, Busch, Harris, & Legare, 2017). That biological concept of death would by itself be sufficient to ensure that death excites the human imagination, goading people into attempting to imagine the end of all imagination, and compelling them to wonder about the meaning and value of a life that seems a mere flicker of conscious experience isolated within an unimaginable infinity of nothingness. But the human mind is complicated, messy, and often inconsistent. In many minds, by the age of 10 years, the biological concept of death coexists with supernatural ideas that the mind, or both the mind and the body, persists beyond death, goes somewhere else, and becomes transformed, sometimes diminished and sometimes purified and exalted. Such beliefs predate historical cultures and assume multitudinous forms in cultures all across the world and in all historical periods (Lane, Zhu, Evans, & Wellman, 2016; Paulson, Kellehear, Kripal, & Leary, 2014b; Pettitt, 2018). The equivocal coexistence of biological and supernatural ways of envisioning death often generates uncertainty and insecurity. The anxiety produced by uncertainty is yet another goad to imaginative activity (Martin & van den Bos, 2014; van den Bos, 2009; Wong, Reker, & Gesser, 1994).

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T. K. Shackelford, V. Zeigler-Hill (eds.), *Evolutionary Perspectives on Death*,
Evolutionary Psychology, https://doi.org/10.1007/978-3-030-25466-7_7

Because people worry a lot about death, they also speak and write a lot about death. Literature articulates and elaborates the thoughts and feelings that enter into the awareness of death. All forms of imagination transmitted in the arts are evocative and expressive; they appeal to the senses and emotions, externalizing subjective experience and giving it aesthetic shape. Language enables heightened levels of conceptual complexity and flexibility in humans. In verbal forms of imaginative activity, people relate subjective experience to abstract concepts, delineate relationships among ideas, connect the present with the past and future, introject group identity into individual identity, construct autobiographical narratives, and envision multiple perspectives on the same events. Verbal forms of imaginative activity are human universals (Brown, 1991, 2004; Carroll, 2018a, 2018b; Hogan, 2003). Literature is a written extension of an originally oral form of verbal imagination.

For most of the twentieth century, scholars wishing to formulate general ideas about literary responses to death could expect little help from the social sciences (Wong et al., 1994). They had to rely instead on ideas extrapolated from speculative philosophy and from literature itself. Even now, no single school of research in the social sciences provides a framework that includes a comprehensive account of evolved human motives, the human imagination, and the forms of "meaning" relevant to literary responses to death. This chapter aims at constructing that sort of framework by integrating ideas from multiple fields. Terror management theory (e.g., Solomon, Greenberg, & Pyszczynski, 1997) focuses attention on human responses to death but erroneously identifies survival as the ultimate human motive and the fear of death as the evolutionary origin of multiple psychological processes (Buss, 1997). Terror management theory has no biologically grounded account of human life history. Evolutionary psychology and human life history theory usefully identify a set of evolved human motives but give little attention to meaning, imagination, and awareness of death. Research on "meaning in life" illuminates the uniquely human adaptive role of meaning in human behavior but does not clearly ground itself in an evolutionary conception of human life. Like terror management theory, psychological research on meaning in life lacks a structured account of human motives.

Contributions to understanding the nature of meaning in literature have been made by evolutionary aesthetics, evolutionary literary theory, the psychology of fiction, the psychology of self-narratives, and the psychology of emotions. Information useful to understanding death in literature can also be gleaned from clinical research on coping with death and dying, and from research on death in biology, medicine, archeology, cognitive developmental psychology, comparative psychology, and paleolithic and cross-cultural anthropology (see for instance a recent multidisciplinary special issue on "evolutionary thanatology," Anderson, Biro, & Pettitt, 2018).

This chapter explains why humans create literary depictions of death, describes how imaginative meaning works in literature, characterizes the emotions evoked in literary depictions of death, and characterizes the attitudes toward death adopted by authors and characters. After constructing this theoretical framework, the chapter gives examples of literature that describe the whole span of an individual human life

and other examples in which literature deals with death in relation to three specific themes in human life history: imminent threats to survival, childhood, and pair bonding. Critical commentary on three short stories further illustrates these three life history themes. Jack London's "To Build a Fire" illustrates survival as a motive. Hans Christian Andersen's "The Little Match Girl" illustrates death in childhood. D. H. Lawrence's "Odour of Chrysanthemums" illustrates death in an intimate pair bond. A final section of the chapter describes the state of research in the main fields that have contributed to the theoretical framework and suggests directions for further development.

Why Imagine Death?

Human beings construct fictional narratives and create symbolic images within which to imagine the world and their own place in the world. They create legends and myths that explain the world. They fashion their own life stories and situate those stories within the legends and myths of their social groups (McAdams, 2015, 2019). They conduct their lives in large part through imagining their own behavior in relation to the beliefs, values, images, and narrative structures provided by their cultures and by their own inventive powers (Baumeister, 1991b; Carroll, 2012a, 2018b; Martela & Steger, 2016; Wilson, 1998). Fictional narratives expand the scope of possible experiences by simulating imagined lives and generating imagined scenarios. They also provide readers with story-line templates and mental images that help them organize their own self-narratives in meaningful ways (Carney & Robertson, 2018; Carroll, Gottschall, Johnson, & Kruger, 2012; Gottschall, 2012; Mar & Oatley, 2008; Oatley, 2011, 2012, 2016; Oatley, Dunbar, & Budelmann, 2018; Tamir, Bricker, Dodell-Feder, & Mitchell, 2015).

Coping with the death of loved ones or the prospect of one's own death is not an all-consuming motive in most people's lives, but it is a prominent feature of personal experience, and it is illustrated abundantly in literature. We have an adaptively functional need to make imaginative sense of our lives (Carroll, 2012a), and death is a decisively important event in every life.

We know in advance that death will bring an end to all our striving, all our obligations and commitments, and all our mortal pleasures and pains. It will definitively close out the account of our good and evil deeds. Once we die, whatever we might have done, or should have done, or should not have done, can never again be altered—either realized or rectified. Work left undone will remain always incomplete. Needs and desires unfulfilled will be frozen into a permanent emptiness. Our fulfillments will be sealed off as a finite measure and vanish into an irrecoverable past.

Every human relationship we have will be changed by our deaths. If we are lucky, loving relatives and friends will be with us as we die, but some of those will perhaps be left desolate, unprotected, or impoverished. Others might be enriched or relieved of an awful burden. Any resources we have accumulated will be redistrib-

uted, and will quite possibly become sources of conflict among our heirs. Our absence will affect, in some degree, the habits and plans of every person with whom we work or socialize. If we are still engaged in activities that involve other people, those activities will have to be reorganized or canceled. The world will go on, but without us. We won't be there.

Of the many things that will be permanently altered by our deaths, one of the things that matters most to us is ourselves, our own individual bodies and minds. Whatever supernatural beliefs people might hold, virtually everyone also registers the reality of biological death. Our bodies are the nerve centers through which we are consciously oriented to the physical world (Damasio, 2010). We know that in death our bodies will decompose and that those nerve centers will become inert, blank, void (Dreier et al., 2018; Schofield, Urch, Stebbing, & Giamas, 2015). Everything that makes us distinct individual persons—the ongoing streams of sensation, perception, feeling, self-awareness, memory, and foresight—will dissolve into oblivion (Baumeister, 1991a; James, 1890; Landau, Solomon, Pyszczynski, & Greenberg, 2007).

As we accumulate experience, the abstract general truths we know about biological death—that it is universal, unavoidable, and irreversible, and that it involves the cessation of motion, feeling, and thought—are illustrated for us by the deaths of people we know, or know about. It is most vividly illustrated by the deaths of people whom we love, hate, or fear, and whose absence makes some large difference in our lives, causing grief, satisfaction, or relief. The deaths of other people convince us in a multitude of particular ways that death is real and that it has immense consequences, not just for the person who dies but for everyone concerned in that person's life.

For all these reasons, the evolved human need to make imaginative sense of life necessarily includes a need to make sense of death. All the known and unknown future consequences of death work backwards in our minds, shedding influence over our memories, channeling our aims and expectations, and thus affecting the way we behave. As Baumeister (1991a) observes, "the fact of being mortal—of having to die eventually—colors all one's experience of time" (p. 273). The interdependence of views on life and death is neatly summed up by Wong et al. (1994). After reflecting that "how individuals view life affects their attitudes toward death," they rightly note that "the converse is also true: How people view death affects how they conduct their lives" (p. 128).

Meaning in Literature

In both life and literature, meaning consists of experiences in individual minds: sensations, emotions, perceptions, and thoughts. The writing and reading of literature always involve at least two minds—those of an author and a reader—and it frequently also involves the minds of fictional characters. Characters depicted in plays, in fictional narratives, and in some lyric poetry are imaginary persons. Like

authors and readers, they are invested with self-awareness and awareness of others. They possess distinct beliefs and values, have desires, set goals, solve problems, experience emotions, observe people and events, make judgments, and build worldviews. Because characters are produced by an author's mind, their attributes and actions reveal characteristics of their author's worldview. Readers' responses to characters parallel their responses to actual people (Alderson-Day, Bernini, & Fernyhough, 2017; Carroll, 2012c; Oatley, 2011). Those responses reveal characteristics of their own worldviews.

In drama and fictional narrative, meaning in the minds of fictional characters emerges as experience in relation to motivated actions, for instance: struggling to survive, winning a lover or spouse, protecting children, defeating an enemy, or finding a place in society. In the minds of authors and readers, meaning often emerges as an experience in relation to the experience of fictional characters involved in motivated actions. Authors of lyric poems engage the same kinds of topics that motivate fictional characters—all the general concerns of human life.

In real life, individuals are motivated not only by concrete goals like surviving or winning a spouse but also by a need to sustain structures of meaning (Baumeister, 1991b; Baumeister & Landau, 2018; Heine, Proulx, & Vohs, 2006; Martela & Steger, 2016; Wong, 2012). Authors, characters, and readers are also strongly motivated to sustain and affirm their structures of meaning. In responding to lyric poems and fictional stories, readers are responding not only to depicted actions but also to the meaning structures generated by authors and fictional characters.

Authors of plays and fictional narratives usually engage the emotional interest of readers by creating characters for whom readers are expected to care, either liking or disliking them, wishing them to succeed or fail (Mar & Oatley, 2008; Oatley, 2012). "Agonistic structure"—the organization of characters into protagonists, antagonists, and minor characters—implies a structure of values. It reveals the emotional and moral bias that authors expect readers to share. Protagonists are major characters whom readers wish to succeed. Antagonists are major characters who are enemies of protagonists. Antagonists often harbor values and beliefs inimical to those of the protagonist (Carroll et al., 2012; Johnson, Carroll, Gottschall, & Kruger, 2011; Kjeldgaard-Christiansen, 2016, 2017).

To understand the total structure of meaning in any given poem, play, or fictional narrative, researchers must evaluate how readers respond to the behavior of characters, but they must also evaluate how characters view themselves and other characters; how the author views himself or herself; how the author views each character; how the author implicitly views his or her prospective readers; how an implied author views any internal narrators; and how readers view themselves and respond to the views of both the author and the characters (Booth, 1983; Carroll, 2018b; Hogan, 2013b; Iser, 1974).

To understand the attitudes of authors, readers, and characters, one must make inferences about their worldviews—their beliefs, values, and tastes. One must also take account of their temperamental dispositions and all the various facets of experience that go to make up individual identity—for instance, age, sex and gender,

social group affiliation, class identity, family background, religious and ideological affiliations, and characteristics of mind and imagination.

The constituents of meaning in literature include subjects and themes, emotions, metaphors, symbolic images, narratival or scenic structures, and aesthetic modulations of language like word choice, rhyme, and rhythm. All these constituents are ultimately subsumed within the imaginative mental experiences of authors, readers, and characters. Meaning in literature thus ultimately consists of an imaginative interplay among the minds of authors, readers, and characters (Booth, 1983, 1996; Carroll, 2012c, 2018a, 2018b; Hogan, 2013b).

Emotions in Literary Works Depicting Death

Literature evokes the subjective quality of experience. Consequently, emotions—anger, resentment, sadness, liking, disgust, admiration, embarrassment, envy, and all the rest—are integral to its form of meaning. Responses evoked to depictions of death can include virtually any conceivable emotion. Death can be made a matter of comedy (black comedy, the macabre). And it can evoke joy—as when Dante in the *Paradiso* and Bunyan in *Pilgrim's Progress* envision their protagonists ascending to heaven. In Tolstoy's "The Death of Ivan Ilyich," as Ivan is dying, he has an experience like that reported by many people who have had near-death experiences—a vision of light and a feeling of universal benevolence. "'So that's what it is,' he suddenly exclaimed aloud. 'What joy!'" (Literary quotations in this chapter are taken from works available in many editions by different publishers. These quotations are not identified by reference to specific editions. On near-death experiences, see Parnia (2014) and Paulson, Fenwick, Neal, Nelson, and Parnia (2014a).)

There are no rules restricting emotional responses to depictions of death in literature. Nonetheless, depictions of death act naturally as attractors for some emotions more readily than for others. Fear, sadness, and pleasure in cruelty form the emotional core for major literary genres.

Horror literature is a genre dedicated to the task of evoking extreme fear, sometimes modulated by disgust (Clasen, 2017). Ghosts, vampires, werewolves, zombies, demons, knife-wielding psychopaths, and malignant forces lurking in the hearts of humans—these are the standard *dramatis personae* of horror. Folk tales and fairy tales all over the world testify to the spontaneous emergence of horror independently of specific cultural traditions. Some authors, such as Edgar Alan Poe or Stephen King, seem to have nervous systems hardwired for the production of horror, but horror is sometimes interwoven into literary works that are not clearly examples of genre fiction (for instance, Shakespeare's *Titus Andronicus*, Conrad's *Heart of Darkness*, Golding's *Lord of the Flies*, and Heller's *Catch-22*).

Elegy and tragedy both depend on sadness for their emotional weight. Elegy is a form of poetry memorializing the dead. Tennyson's *In Memoriam* offers a signal example. Elegiac sentiment also weaves itself into many novels and plays. Like elegy, tragedy evokes grief, but whereas elegy tends to be gentle and meditative,

tragedy typically involves violent passions such as rage, jealousy, outraged pride, implacable resentment, and hatred. Tragedies conclude in exhausted sorrow among the survivors. Examples of tragedy include the plays of Aeschylus, Sophocles, and Euripides; Shakespeare's *Othello, Macbeth, Hamlet,* and *King Lear*; Tolstoy's *Anna Karenina*; Thomas Hardy's *Tess of the d'Urbervilles*; and Theodore Dreiser's *An American Tragedy*.

The literature of cruelty can involve rage, vindictive spite, moralistic retribution, victorious exultation, and sadism. The literature of the ancient Western world begins with epics of cruelty—the *Iliad* and *Aeneid*; China has its equivalent in *Three Kingdoms*. Shakespeare's nationalist epic *Henry V* celebrates leadership, companionship, perseverance, and courage, but all those noble virtues culminate in mass slaughter. Sadism animates the ingenious cruelties devised by Dante to torment the wicked in the *Inferno*, and the same lust for cruelty, without Dante's coloring of moralistic retribution, flourishes in novels such as the Marquis de Sade's *One Hundred and Twenty Days of Sodom*, Gustave Flaubert's *Salammbô*, Bret Easton Ellis's *American Psycho*, and Iain Banks's *The Wasp Factory*.

Attitudes Toward Death in Literature

Psychologists identify fear, uncertainty, and avoidance as responses to death, but they also identify a desire to escape from pain, an anticipation of encountering some sublime mystery or renewing ties with lost loved ones, a willingness to sacrifice oneself for some greater good, an increased appreciation for life in all its brevity, cold detachment bordering on indifference, or simple acceptance because death is part of the natural process of life. For many people, especially among the elderly, acceptance of death is more prominent than anxiety about it (Clements & Rooda, 2000; Tomer, 2012; Wong et al., 1994).

The range of attitudes toward death recorded by psychologists corresponds to the range one can readily identify in many major works of literature. In *King Lear*, the old king is in agony over the body of his dead daughter, who has been hanged. He loses consciousness. When someone tries to revive him, his faithful follower Kent exclaims "O, let him pass! he hates him much/That would upon the rack of this tough world/Stretch him out longer" (5.3). Death for Lear is an escape from pain. Longfellow's Evangeline, visiting a hospital during a plague, observes how "death the consoler,/Laying a hand upon many a heart, had healed it forever." Ivan Ilyich, as we have seen, encounters a sublime mystery. Dante and Bunyan confidently anticipate such encounters. Sidney Carton in Dickens's *A Tale of Two Cities* willingly goes to his death to save the husband of a woman he loves. "It is a far, far better thing that I do than ever I have done." Horace, the ancient Roman poet, opines that "it is sweet and fitting to die for one's country." In his sonnet "That Time of Year Thou Mayst in Me Behold," Shakespeare declares that his coming death should make his interlocutor "love that well which thou must leave ere long." Yeats also affirms that the prospect of death enhances the value of life. He exhorts himself to

perform only acts that are "suited for such men as come/Proud, open-eyed and laughing to the Tomb" ("Vacillation"). Anticipating his own early death, in "When I Have Fears That I May Cease to Be," Keats responds not with affirmation of life but with cold withdrawal. "On the shore/Of the wide world I stand alone, and think/ Till love and fame to nothingness do sink." Confronting death, Macbeth also expresses a contempt for life. Being told that his wife is dead, he declares that life "is a tale/Told by an idiot, full of sound and fury, / signifying nothing" (5.5). "Neutral acceptance" is neither affirmation of life nor denial of its value (Clements & Rooda, 2000; Wong et al., 1994). In *Julius Caesar*, the title character is warned not to go out into the public on a certain ill-omened day. He scoffs at this timidity. "It seems to me most strange that men should fear; / Seeing that death, a necessary end,/Will come when it will come" (2.2). That is simple acceptance of a natural process. So too, Hamlet: "If it be now,/'tis not to come; if it be not to come, it will be/now; if it be not now, yet it will come: the/readiness is all" (4.2). And in *King Lear*, Edgar admonishing his blinded father to bear his suffering with patience: "'Men must endure/Their going hence, even as their coming hither: / Ripeness is all'" (5.2).

Terror management theory proposes that fear of death is an all-encompassing human motive (Landau et al., 2007; Pyszczynski, Solomon, & Greenberg, 2015; Solomon et al., 1997). Three forms of counterevidence undermine this claim. First, the attitudes toward death recorded in empirical psychological research and displayed in literature are not restricted to the fear stipulated by terror management theory (Clements & Rooda, 2000; Wong et al., 1994). Second, a concept of human motives dominated by an overmastering desire for survival cannot explain suicide or the death-defying forms of risky behavior in which humans habitually engage—behaviors that include having sex, competing for mates, risking life to protect offspring or other group members, seeking thrills through dangerous sports, engaging in violent intragroup conflict, conducting warfare, and using stimulants, narcotics, and inebriating toxins (Muraven & Baumeister, 1997). Third, identifying the fear of death as the ultimate human motive is inconsistent with the way people often respond to actual close encounters with death. Such encounters include "near-death experiences" in which the heart stops and is then restarted. Many people respond to such experiences with feelings of spiritual illumination, a transformative moral vision, a renewed love of life, an increased benevolence, or a persistent feeling of calm well-being (Martin & van den Bos, 2014; Nelson, 2014; Parnia, 2014; Paulson, Fenwick, et al., 2014a; Rosen, 1975; Wong, 2007).

Stories About Whole Lives

Death is the natural conclusion to any story of a whole life. Many meditative passages in literature reflect on the course of all human life. Jaques in Shakespeare's *As You Like It* offers a celebrated example. He divides life into seven stages, beginning with "the infant,/Mewling and puking in the nurse's arms," running through childhood, erotic romance in young manhood, and stages of mature adulthood, and

ending in extreme old age, "second childishness and mere oblivion,/Sans [= without] teeth, sans eyes, sans taste, sans everything" (2.7.150–51, 172–73).

Some plays, short stories, and novels lead readers through the whole course of a fictional person's life, so that the shape of that life, rather than any particular part of it, is what matters most. Instances include Sophocles's life of Oedipus in the two plays *Oedipus the King* and *Oedipus at Colonus*, Daniel Defoe's *Moll Flanders* (1722), and William Boyd's *The New Confessions* (1987). The full title of *Moll Flanders* describes the scope of her story: *The Fortunes and Misfortunes of the Famous Moll Flanders Who was born in Newgate [prison], and during a life of continu'd Variety for Threescore Years, besides her Childhood, was Twelve Years a Whore, five times a Wife (whereof once to her brother), Twelve Years a Thief, Eight Years a Transported Felon in Virginia, at last grew Rich, liv'd Honest, and died a Penitent.*

In "The Curious Case of Benjamin Button," F. Scott Fitzgerald whimsically highlights the specificity of the human life cycle by turning it on its head. Benjamin is (to the consternation of his parents) born as a little old man; he gradually regresses in age to mature adulthood, then to childhood, and finally dies as an infant, mewling and puking in the nurse's arms.

Depictions of Death in Parts of Life

Most plays and stories depict only parts of a life. They focus on some particular motive, phase, or relationship—for instance, survival, growing up, a struggle for social status or inclusion in a social group, conflict within families, marriage, clashes with enemies, or a spiritual, intellectual, or artistic quest. Any of these stories can of course end in death. Avoiding death or failing to avoid death is the natural conclusion of any story focused on mortal threat to a protagonist. If the central concern of an action is something other than survival, the meaning of the story—the significance attributed to the death—reflects that central concern. Death in stories of childhood, of marriage, or of social life all reflect themes specific to that part of human life history on which the story concentrates.

In the following three subsections, this chapter presents examples of death in literature from three categories of human life history theory: survival, childhood, and the intimate pair bond. Each subsection begins with comments on the theme in general and then offers an example of interpretive literary criticism about one short story devoted to that particular theme. (The three stories can all be found online.) The interpretive comments on these examples are designed to exemplify aspects of literary meaning that have already been described: the interplay of worldviews among authors, characters, and readers; emotions expressed by authors, depicted in characters, and evoked in readers; and the idea that the meaning of death in any particular work (poem, play, or story) reflects the specific life history themes on which that work focuses attention.

Survival

Death, or avoiding death, is the natural end of a survival story. When people are threatened by natural forces, enemies, predators, hunger, or illness, survival becomes an urgent motive. A protagonist's mind often becomes concentrated with painful intensity on the details of his physical environment and his efforts to control that environment. Most readers identify closely with a protagonist's effort to cope with the threat of death. In Stephen Crane's "The Open Boat," four men in a lifeboat escape a shipwreck and spend 30 h in stormy weather along a coast, trying to attract attention, avoid capsizing, and avoid being smashed against the shore. The men are reduced to a single, shared set of basic emotions—fear and resolution. They have to maintain strict discipline and resist the despair that leads to surrender and death. Robinson Crusoe, in Daniel Defoe's novel, is shipwrecked near shore, and vividly recreates the strategy by which he makes it to shore, mostly underwater, walking forward along the sand between each wave, and rising to let each wave push him forward a little closer to the shore. Once on shore, he sets about single-mindedly providing himself with the means of life. For 300 years, readers have participated vicariously in that victorious struggle for survival. For closer to 3,000 years, readers have vicariously rejoiced in the cunning strategy of Homer's Odysseus, trapped in a cave by a one-eyed giant who is devouring his men two at a time. Odysseus and his men get the giant drunk and as he sleeps stab him in the eye with a sharpened pole. The same basic emotions that animate Odysseus and his men are at work in James Dickey's modern novel *Deliverance*, a story in which men in a canoe in the wilderness struggle against both the river and the monstrous local inhabitants who assault them. The protagonists in Cormac McCarthy's *The Road* are a father and son traveling through a dead, post-apocalyptic world. Like Odysseus and his men, they must find food and avoid being eaten by cannibals.

Survival stories form a distinct genre—a genre in which the struggle to survive is the central plot situation. But avoiding death is an active motive in most stories of adventure, in virtually all war stories, in crime dramas, mysteries, and tales of espionage, horror stories, tragedies, and often even in dramas that are centrally focused on romantic, familial, or social themes. Thomas Hardy's *Tess of the d'Urbervilles* focuses on romantic themes. Tess is raped, has a baby who dies, and then later marries while keeping her past hidden from her husband. On her wedding night, she reveals her secret and is abandoned by her husband. Her rapist takes her as his mistress. When her husband returns, she murders the rapist in order to free herself of his taint and make herself worthy, in her own mind, of her husband. She and her husband make a desperate, futile flight to save her from hanging. *King Lear* is a story about disrupted family ties. Lear repudiates one daughter, turns over all his power and wealth to the other two, and is abused by them. Lear's follower, the Earl of Gloucester, is tricked by his bastard son Edmund into seeking the life of his legitimate son Edgar. Edgar must flee and disguise himself as a mad beggar in order to survive. Lear kills Edmund's henchman, who has been sent to kill Lear and his youngest daughter, Cordelia, but Cordelia is already dead from hanging. Edgar fights

Edmund in a duel and kills him. In all these relationships, the anguish of family conflict intertwines with fear of death and the need to fight for survival. William Golding's *Lord of the Flies* is a parable about civilization and savagery. The boy protagonist Ralph struggles to uphold civilized order in a group of boys marooned on an island during a nuclear war, but his struggle to maintain civilized order ends with him running for his life from the savage band led by his chief rival. They chase him with spears and set the jungle on fire to smoke him out. Throughout the story, Ralph has struggled to understand and communicate the idea of a social group organized by principles of due process, but when he is running for his life, Ralph's mind is reduced to just that—running for his life.

Jack London specializes in tales of survival in brutal conditions. In novels such as *The Call of the Wild* and *White Fang*, and in stories such as "Love of Life" and "To Build a Fire," London places his protagonists in situations in which they must fight for their lives against mortal enemies or a deadly natural world. The unnamed protagonist of "To Build a Fire" (1908) sets out alone on an ill-advised trek in the Yukon when the cold is so intense that spittle freezes and shatters before striking the ground. He steps into a snow-covered, fast-running stream and has to build a fire before his feet freeze. One mishap after another follows. Readers feel the intensity of his rising panic, and then finally the despairing peace of his surrender to death.

The plain fact of dying or not dying does not contain the whole meaning of a story. Even in a relatively simple survival story like "To Build a Fire," the meaning is not wholly contained within the emotions activated by the struggle to survive. The meaning also includes London's subtly mocking reflections on his protagonist's limitations and vulnerabilities. The protagonist has foolishly failed to follow the advice of an experienced old-timer. He lacks the "instinct" that warns his dog against traveling in such unusually severe cold, but he also lacks the "imagination" to foresee his danger until it is too late. London thus implies a normative vision of humanity in which imagination should compensate for a loss of instinct. This normative vision is also part of the meaning of the story.

The protagonist's terror, so local, personal, and intense, is framed within a cool, detached, and reflective authorial vision. The effect of this tension between London's point of view and that of the protagonist is arguably the largest scale of meaning in the story. At this level, "meaning" is not an idea but rather an imaginative effect localized in a relationship between two perspectives, two contrasting states of emotional and imaginative experience. Every reader who responds to the story reads it within his or her own perspective, identifying more with the protagonist or with London, liking or disliking them, and bringing his or her own personal experience, temperament, and normative conceptions into play. Each individual reader's response creates yet a third dimension in the total structure of meaning for the story.

Reading an emotionally gripping story about a man who dies from making careless mistakes would in all likelihood serve an admonitory function for most readers, reminding them that life is fragile and that recklessness can be fatal. The adaptive utility of such reminders might seem obvious, but the adaptive functions of stories are not limited to simple lessons geared toward survival or reproductive success. All people create imaginative virtual worlds within which to make sense of their

experience. Those structures contain memories of the past, projections of the future, cosmological and ideological systems, myths, values, and beliefs. Such structures have an emotional coloring that powerfully influences motives and behavior. Maintaining such structures is in itself a specifically human need (Baumeister, 1991b; Heine et al., 2006; Martela & Steger, 2016). The shape and content of imaginative structures vary from mind to mind, but the need to fashion such structures, maintaining coherence while assimilating new information, is a universal human need. Many or most readers might be made a little more cautious by reading "To Build a Fire," but the total imaginative impact of that story would necessarily vary in some degree for each individual person. That matters because the total structure of any individual's imaginative virtual world is a functional part of that individual's behavioral repertory.

Childhood

When a child dies in real life, what is lost is the whole potential future life of the child (Baumeister, 1991a). The magnitude of the loss evokes a special pathos. For most people, the death of the elderly can scarcely matter so much. Old people have had their lives, as much as could be expected. For most adults, sorrow at a child's death combines with a painful bruise to the protective feelings adults typically have toward children. Dickens understands that kind of sentiment and dwells on it voluptuously in the deaths of Little Nell in *The Old Curiosity Shop*, Paul Dombey in *Dombey and Son*, and Jo, the crossing sweeper in *Bleak House.*

Children are of course particularly important to their kin, and especially to their parents. Hence the shock felt when Euripides's Medea murders her own children to strike back at her unfaithful husband. Her anguish at murdering her own children gives a measure of her hatred for her husband. The protagonist of Toni Morrison's *Beloved* chooses to murder her children rather than have them returned to slavery—an act that gives a measure of her loathing of the slave condition. In William Styron's *Sophie's Choice*, Sophie has to choose which of her two children to sacrifice to the gas chambers at Auschwitz. Years later, her inner torment drives her to suicide. Even a child murdered by strangers, like the son of Macduff in *Macbeth*, or the two young princes murdered by Richard III, can evoke feelings of pity and outrage different from the feelings evoked by the murder of an adult, however innocent that adult might be.

Hans Christian Andersen's "Little Match Girl" (1845) is abused and neglected. She has wandered the streets barefoot all day in deep winter, on New Year's Eve. As evening comes, she is afraid to go home, where she would be beaten for failing to sell any matches. Huddling in a corner, she lights four matches, one at a time, for warmth, and in the light of each match sees a vision of comfort and pleasure. In the first, she sees a large iron stove; in the second a roast goose; in the third a beautifully decorated Christmas tree; and in the fourth her dead grandmother, the only person who has loved her. Unwilling to let this last vision vanish, she lights a

whole bundle of matches. The grandmother takes the girl into her arms and ascends with her to heaven. In the morning, people in the neighborhood find the little girl's frozen body. Andersen remarks that no one suspected what beautiful visions she had seen, nor "the splendor in which, with her grandmother she had entered on the joys of a new year."

This story commingles the pathos of a child's death with the idea of a spiritual rebirth. For Christian readers (and Andersen could have anticipated that virtually all his readers would be Christians), the story would presumably give pleasure by making the ascent to heaven imaginatively vivid. But the ascent to heaven is not simply stated as fact. The "beautiful visions" the girl sees include not only heaven but also the illusions of the stove, the goose, the tree, and the grandmother. The story thus builds a cognitive continuum between pleasurable fantasy and the image of heaven. The striking of a whole bundle of matches seems to suggest that pleasurable fantasy, if it is intense enough, might actually create a supernatural event.

The subtle ambiguity about the reality or unreality of the girl's ascent to heaven is part of the imaginative meaning of the story. Readers no doubt vary in the degree to which they are sensitive to this ambiguity, but for all readers the story contains a contrast between a picture of cruelty and suffering, on the one side, and pleasurable illusions on the other side. Andersen is inviting readers to share in his own perspective, standing apart from the people who find the girl's frozen body. Those spectators observe simply that she must have wanted to warm herself. That is a brute animal reality to which Andersen contrasts the glamor of imaginative experience. That glamor in this case is colored by moral sentiments that include pity, sorrow, moral indignation, kindness, and piety.

Christian readers would not escape the sensations of pain and suffering evoked by the story. Some readers, Christian or not, might feel queasy at the celebration of pleasurable fantasy. And Christians might feel some subliminal qualms about the dubious ontological status of heaven. But regardless of their response to the theme of fantasy, most readers would enter empathetically into the feelings of a helpless child seeking an escape from pain. The sensation of exercising compassionate empathy would itself be a main effect of the story. It would be a mental experience stimulated by the story, and thus part of its meaning.

The Intimate Pair Bond

Pair bonding and dual parenting are core features of the human adaptive complex (Chapais, 2013, 2017; Fisher, 2016; Low, 2015). Erotic romance or romantic love is a motivator for pair bonding. Though not officially approved in all cultures, it appears to be a human universal (Gottschall & Nordlund, 2006; Nordlund, 2007). Romantic comedies—whether in Shakespeare, Jane Austen, or a contemporary novel—typically end in a marriage. Weddings are public ceremonies giving evidence that a particular sexual pair bond is being formally approved by society. In romantic comedies, resolving conflicts between the lovers also tacitly affirms the

health of the larger social order. In tragic love stories, the lovers are typically enmeshed in wider social dysfunctions, causing them or being affected by them. Helen and Paris, in ancient Greek literature, bring about the devastation of Troy and the ruin of royal families. Antony and Cleopatra are enmeshed in a tangle of personal emotions, international politics, and civil war. Romeo and Juliet die because of a feud between two families. Emily Brontë's Catherine and Heathcliff, in *Wuthering Heights*, wreck the lives of all their close associates, including their own kin, before they themselves die.

Marriage in some form—the socially acknowledged right of exclusive sexual access combined with mutual obligations—is a human universal (Brown, 1991). Romantic love might or might not be part of any given marriage, which functions as a social and economic unit, forms a node in kinship networks, and has its primary adaptive rationale in producing and rearing children. Marriages are of course vulnerable to many strains: conflicts over the acquisition and allocation of material resources; struggles over alignments with bilateral kinship networks; the distribution of work in maintaining a household; irritations from incompatible temperaments, goals, and value systems; and the universal tension between self-interested motives and motives oriented to shared concerns. Little wonder that traits such as a dependable character, emotional stability, maturity, and a pleasing disposition rank so high, cross-culturally, on traits desired in marital partners, for both men and women (Buss, 2016; Buss et al., 1990). Marriage is difficult enough even when pair bonding with a relatively responsible and well-disposed partner. When pair bonding with a partner who is undependable, unstable, immature, or ill tempered, it would become a torment.

D. H. Lawrence's story "Odour of Chrysanthemums" (1911) centers on the mind of a married woman in a mining town in northern England. Mrs. Bates has two children and is pregnant. Her husband is a coal miner and a drunkard. The story follows her across the course of a late afternoon and into the evening. She suffers from a constant state of resentment, anger, and frustration about the time and money her husband spends in the local pub. The main action of the story consists of her waiting for him to arrive home from work. As hours pass—the whole story transpires in a period of 7 or 8 h—her anger and disgust become intertwined with anxiety about some harm having possibly come to him in the mine. She asks after him from a neighboring miner, who checks a local pub and finds he isn't there. The husband's old mother comes to the house and says that people from the mine have told her that her son has been in an accident. Mrs. Bates immediately asks if he is dead and calculates the financial consequences of his possible death. "'Would she be able to manage on the little pension and what she could earn?'—she counted up rapidly." But thinking he might be only hurt, not killed, she also thinks of the difficulty of nursing him at home, and then indulges a "sentimental" fantasy of getting him off drink. Finally, late in the evening, after the children have been put to bed, the body of the husband is brought home and laid out on the floor. He had been trapped in a small space by a fall of rock and had suffocated. While his wife and mother wash his body and dress him in a clean shirt, Mrs. Bates experiences a flow of intense emotions about her dead husband and about death as an ultimate reality: horror, awe, respect, denial, dread, fear, shame, gratitude, grief, pity, anguish, and humility.

Threading through these emotions, one constant imaginative realization dominates Mrs. Bates's thinking—the complete mental separateness of the lives she and her husband have led, their mutual failure to "see" one another from within the other's own perspective. This revelation about the emotional and imaginative failure of her marriage begins with the sight of her husband's dead body, heavy and inert. The body makes the gap between life and death seem absolute. The husband, as a dead thing, seems utterly disconnected from her. The dead body is "inviolable" and "impregnable," impervious to any touch of intimacy or gesture of communication. This sensation leads to Mrs. Bates's climactic realization. She "felt the utter isolation of the human soul." That realization has an implication for her identity as a mother, also. "The child within her was a weight apart from her." This feeling about her unborn child is different from the practical anxiety about raising children without the help of her husband's income. It is an existential feeling, about isolation, separateness. The wife and husband have been strangers to one another. "Each time he had taken her, they had been two isolated beings."

In Mrs. Bates's flow of emotions, four recur with special frequency: horror, fear, dread, and shame. Her sensations of horror include something almost as simple as a startle response, but she also feels empathetic pity for the horror her husband must have felt in the minutes before he suffocated, and she has a "horror of the distance between them." That third kind of horror is closely associated with the "fear" and "dread" that interlace her thoughts: emotions activated not by the practical consequences of her husband's death but by fear of her own self-consciousness—the recognition of her own emotional inadequacy. She feels shame at the memory of having had sex with her husband, not because she is ashamed of sex itself, but because looking at his body, realizing that he was something different from anything she had ever understood, she feels that she had known his body "falsely." Remembering sex with him is like remembering sex with a stranger, sex that has no savor of love or romance. Apart from being an object of animal sexual contact, her husband has, in her mind, been only a necessary feature of her domestic economy. Neither of them has ever experienced any real intimacy. "They had met in the dark and had fought in the dark, not knowing whom they met nor whom they fought."

Shame at false feeling generates a curiously positive nuance in the rapid flow of Mrs. Bates's emotions. "She was grateful to death, which restored the truth." Truth in this context means authenticity, an existential feeling. Despite her gratitude for this moment of existential authenticity, the final lines of the story return to the emotional keynotes. "She knew she submitted to life, which was her immediate master. But from death, her ultimate master, she winced with fear and shame."

In failing to have achieved an intimate bond with her husband, Mrs. Bates is facing an existential crisis—a crisis about meaning in her life. She remains committed to her children. "She was absolutely necessary for them. They were her business." But the source of meaning in her meditation is limited to the kind of relationship she has had, and has not had, with her husband. The trajectory of that relationship is summarized in her own mind by the image of chrysanthemums. At the beginning of the story, she picks chrysanthemums and places them in her apron. At home, her daughter exclaims with delight over this unusual touch of gaiety. She asks to smell the flowers, but Mrs. Bates irritably removes them from her apron. Asked if they

don't smell beautiful, she responds, "'Not to me. It was chrysanthemums when I married him, and chrysanthemums when you were born, and the first time they ever brought him home drunk he'd got brown chrysanthemums in his button-hole.'" The odor of chrysanthemums, for Mrs. Bates, is the odor of disappointment, rancor, and bitterness—fresh smells turning sour. The first two points in the symbolic trajectory traced by the flowers have some charm—the early hopes of marriage, the fulfillment of childbirth—but then, the downward spiral in which pleasure turns to indulgence, and indulgence becomes degradation, generating strife and the endless frustration of trying to control another person's addictive behavior.

Lawrence makes no explicit declarations about his attitude toward Mrs. Bates. He begins with describing her objectively—"She was a tall woman of imperious mien, handsome, with definite black eyebrows"—but then slips into paraphrasing her thoughts and feelings, speaking as if articulating her sensations for her. She becomes the dominating consciousness in the story. Readers have no cause to think that Lawrence stands apart from her, looking at her thoughts and feelings ironically. His prose rhythm, declaring her sensations, is that of emphatic assertion, without hesitation or equivocation. We are to understand that what she feels and thinks is a true revelation about the character of her marriage.

Behind that true revelation stands the whole body of Lawrence's work, the main themes and the personal ideology. Lawrence's emotional life is riven by a tension between self-affirmation and the intimacy of true pair bonding. Emotional triumph, as in *Women in Love*, consists in a successful pair bonding that preserves the integrity of both egos. As he sees it, all other values and considerations degrade intimate pair bonding. He frequently depicts irreconcilable tensions between intimate pair bonding and the expenses and commitments of domestic life in the middle classes. He expresses sincere contempt for money-hunger and status-hunger, and he has little sympathy for the various forms of identification with a wider community: patriotism, religion, ethnicity, or humanity in general. Even the love of children and other kin figures in his imagination mostly as competition for the emotional and mental resources that one might devote to the intimate pair bond.

The dead miner's mother is a minor character. Her experience is almost parenthetical to the story. She speaks of her son, but we are invited to see deep inside her mind only once, briefly. Like Mrs. Bates, she feels "dread" at the implications of the miner's death. But the source of her dread is different from that of the dead miner's wife. "The mother felt the lie was given to her womb, she was denied." Her life had extended itself imaginatively into the life of her son, and that extension of life has now been amputated, retroactively canceling out the emotions and motives that had given meaning to her life.

There is of course no reason, objectively, that extending one's life emotionally through devotion to progeny would be less meaningful than extending one's life emotionally through sympathetic interaction with a mate, and indeed from an evolutionary perspective, progeny would seem to have the stronger claim. For Lawrence, though, the sympathetic interaction with a mate has an absolute, transcendental character. It is an ultimate value.

From an evolutionary perspective, Lawrence's idolization of the pair bond is something very close to a cognitive error. The pair bond is just one aspect of the whole human adaptive complex. Regarding the pair bond as the central source of meaning in life reflects an idiosyncratic foreshortening of the systemic relationships that govern human life history. It is a deformation, a distortion. Still, the pair bond itself is a real and important part of human emotional life. The distortions in Lawrence's worldview enable him to bring out that reality with exceptional evocative power.

Directions for Future Research

Literature is just one aspect of imaginative culture. Since death is such a prominent feature of conscious experience, it also bulks large in literature. Our understanding of death in literature will presumably continue to develop, taking advantage of advances in the many disciplines that feed into an understanding of imaginative culture.

Understanding meaning in literature intertwines with understanding meaning in life. Research on meaning in life has not yet settled into a coherent paradigm, or even a well-attested factor model. Recent efforts have been made to establish a three-factor system, with understanding, purpose, and significance or "mattering" as the three factors (George & Park, 2016, 2017; Martela & Steger, 2016), but other models are still in play, and the relationships between the three factors and other aspects of meaning remain open (Baumeister & Landau, 2018; George & Park, 2016; Martela, Ryan, & Steger, 2018; Steger, 2017). To my knowledge, no one working in this field has yet made a serious effort to integrate ideas about meaning with human life history theory and evolutionary psychology.

Evolutionary literary study is inherently "biocultural" (Carroll et al., 2017a). Literary works are embedded in cultures. Authors and readers share in collective, cultural forms of meaning. Our understanding of specific literary works, genres, and periods would be strengthened by the development of more detailed biocultural critiques of specific historical periods. The evolutionary social sciences have done extensive and fruitful work on the behavioral ecology of hunter-gatherer populations and on the psychology of contemporary populations. If hunter-gatherer populations be taken as a proxy for ancestral human populations, we may say that evolutionary social scientists have bracketed the history of behaviorally modern human experience at its beginning and what is currently its end, leaving out most of its historical middle. Filling in that middle will require the collective efforts of biologically informed historians, economists, and scholars of religion, philosophy, ideology, and the arts.

Evolutionary cultural theory has been extensively developed in the past two or three decades, making advances in the cognitive underpinnings of social learning, but it still focuses primarily on technology and on forms of social organization, giving little attention to the imaginative aspect of culture (Henrich, 2016; P. Richerson

et al., 2016; Richerson & Boyd, 2005; Tomasello, Carpenter, Call, Behne, & Moll, 2005). Religion has been extensively studied from an evolutionary perspective, but much of this research has either emphasized its social functions or taken it as a by-product of adaptive cognitive mechanisms that evolved for other reasons (Boyer, 2001; Wilson, 2002). Much less attention has been given to it as part of an adaptively functional process for making imaginative sense of life and death (Dissanayake, 2011).

A handful of evolutionary humanists—mostly literary scholars accompanied by a few film scholars and aesthetic philosophers—have given attention to literature and the other arts, but many areas in this domain, especially in music and the plastic arts, remain unexplored. Evolutionary literary critics have produced a slowly growing body of work sensitive both to cultural context and to the interplay of perspective among authors, readers, and characters (Boyd, 2009; Boyd, Carroll, & Gottschall, 2010; Carroll, 2011, 2012b; Clasen, 2017; Gottschall, 2008b; Jonsson, 2013; Saunders, 2018).

Cognitive literary theorists have sometimes fought shy of association with evolutionary literary theory, which continues to receive a chilly reception from an academic literary establishment committed to the idea of cultural autonomy (Carroll et al., 2017b). But enough work has been done to give reasonable hope for continued progress in integrating research on evolved human motives with research on the cognitive mechanisms that correlate with features of literary form (Burke & Troscianko, 2017; Carney & Robertson, 2018; Hogan, 2013a, 2013b; Jacobs & Willems, 2018; Oatley, 2011).

Evolutionary literary scholars have sometimes made use of the experimental and statistical methods characteristic of the social sciences (Carroll et al., 2012; Clasen, Kjeldgaard-Christiansen, & Johnson, 2018; Gottschall, 2008a; Johnson et al., 2011). With increasing frequency, social scientists and neuroscientists have been taking literature as their subject matter (Altmann, Bohrn, Lubrich, Menninghaus, & Jacobs, 2012; Altmann, Bohrn, Lubrich, Menninghaus, & Jacobs, 2014; Jacobs & Willems, 2017; Mar, Oatley, Djikic, & Mullin, 2011; McCrae, Gaines, & Wellington, 2012; Salmon, 2003; Salmon & Symons, 2004; Tamir et al., 2015; Vessel, Starr, & Rubin, 2012). As research develops, one can anticipate that literary scholars will increasingly feel the pressure to devise empirical means of testing opinions, impressions, and speculations. One can also anticipate that some social scientists studying literature will look to evolutionary literary study to gain insights into the constituents of literary meaning.

Imaginative culture—religion, ideology, and the arts—is the single most important component needed to complete a comprehensive and basically adequate model of human nature (Carroll, 2017). If this proposition is correct, one can be confident that the kinds of research described in this section will advance steadily, each in its own field, and with recurrent episodes of cross-disciplinary synthesis. The history of science offers many instances of convergence by researchers working independently of one another. Darwin and Wallace independently came to the idea of natural selection. Separate teams raced to discover the structure of DNA and to sequence the Neanderthal genome. Established knowledge contains a structure of

implications pointing in definite directions. Multiple researchers see those implications and move in those directions. The time seems ripe for an evolutionary understanding of imaginative culture.

"Evolutionary thanatology" includes an array of disciplines that explore what death means for all animals, but meaning means most for humans. It prompts their behavior in ways unique in the animal kingdom (Martela & Steger, 2016). Future research in the development of evolutionary thanatology should be closely intertwined with evolutionary ideas on imaginative culture.

References

Alderson-Day, B., Bernini, M., & Fernyhough, C. (2017). Uncharted features and dynamics of reading: Voices, characters, and crossing of experiences. *Consciousness and Cognition, 49*, 98–109. https://doi.org/10.1016/j.concog.2017.01.003

Altmann, U., Bohrn, I. C., Lubrich, O., Menninghaus, W., & Jacobs, A. M. (2012). The power of emotional valence—From cognitive to affective processes in reading. *Frontiers in Human Neuroscience, 6*. https://doi.org/10.3389/fnhum.2012.00192

Altmann, U., Bohrn, I. C., Lubrich, O., Menninghaus, W., & Jacobs, A. M. (2014). Fact vs. fiction—How paratextual information shapes our reading processes. *Social cognitive and affective neuroscience, 9*(1), 22–29. https://doi.org/10.1093/scan/nss098

Anderson, J. R., Biro, D., & Pettitt, P. (2018). Evolutionary thanatology. *Philosophical Transactions of the Royal Society B: Biological Sciences, 373*(1754), 1–5 (Introduction to a special journal issue on evolutionary thanatology).

Baumeister, R. F. (1991a). Meanings of death. In *Meanings of life* (pp. 269–292). New York: Guilford.

Baumeister, R. F. (1991b). *Meanings of life*. New York: Guilford Press.

Baumeister, R. F., & Landau, M. J. (2018). Finding the meaning of meaning: Emerging insights on four grand questions. *Review of General Psychology, 22*(1), 1–10 (Introduction to a special journal issue on meaning). https://doi.org/10.1037/gpr0000145

Booth, W. C. (1983). *The rhetoric of fiction* (2nd ed.). Chicago: University of Chicago Press.

Booth, W. C. (1996). Distance and point of view: An essay in classification. In M. J. Hoffman & P. D. Murphy (Eds.), *Essentials of the theory of fiction* (2nd ed., pp. 116–133). Durham, NC: Duke University Press.

van den Bos, K. (2009). Making sense of life: The existential self trying to deal with personal uncertainty. *Psychological Inquiry, 20*(4), 197–217. https://doi.org/10.1080/10478400903333411

Boyd, B. (2009). *On the origin of stories: Evolution, cognition, and fiction*. Cambridge, MA: Harvard University Press.

Boyd, B., Carroll, J., & Gottschall, J. (Eds.). (2010). *Evolution, literature, and film: A reader*. New York: Columbia University Press.

Boyer, P. (2001). *Religion explained: The evolutionary origins of religious thought*. New York: Basic Books.

Brown, D. E. (1991). *Human universals*. Philadelphia: Temple University Press.

Brown, D. E. (2004). Human universals, human nature & human culture. *Daedalus, 133*(4), 47–54. https://doi.org/10.1162/0011526042365645

Burke, M., & Troscianko, E. (2017). *Cognitive literary science: Dialogues between literature and cognition*. Oxford: Oxford University Press.

Buss, D. M. (1997). Human social motivation in evolutionary perspective: Grounding terror management theory. *Psychological Inquiry, 8*(1), 22–26. https://doi.org/10.1207/s15327965pli0801_3

Buss, D. M. (2016). *The evolution of desire: Strategies of human mating* (revised ed.). New York: Basic Books.

Buss, D. M., Abbott, M., Angleitner, A., Asherian, A., Biaggio, A., Blanco-Villasenor, A., et al. (1990). International preferences in selecting mates: A study of 37 cultures. *Journal of Cross-Cultural Psychology, 21*(1), 5–47. https://doi.org/10.1177/0022022190211001

Carney, J., & Robertson, C. (2018). People searching for meaning in their lives find literature more engaging. *Review of General Psychology, 22*(2), 199–209. https://doi.org/10.1037/gpr0000134

Carroll, J. (2011). *Reading human nature: Literary Darwinism in theory and practice*. Albany: State University of New York Press.

Carroll, J. (2012a). The adaptive function of the arts: Alternative evolutionary hypotheses. In C. Gansel & D. Vanderbeke (Eds.), *Telling stories/Geschichten erzählen: Literature and evolution/Literatur und Evolution* (pp. 50–63). Berlin: de Gruyter.

Carroll, J. (2012b). An evolutionary approach to Shakespeare's *King Lear*. In J. Knapp (Ed.), *Critical insights: The family* (pp. 83–103). Ipswitch, MA: EBSCO.

Carroll, J. (2012c). Meaning and effect in fiction: An evolutionary model of interpretation illustrated with a reading of 'Occurrence at Owl Creek Bridge'. *Style, 26*(3), 297–316.

Carroll, J. (2017). Introduction to the first issue: Why we need a journal with the title Evolutionary Studies in Imaginative Culture. *Evolutionary Studies in Imaginative Culture, 1(1)*, vii–vxi.

Carroll, J. (2018a). Literary meaning: An evolutionary perspective. *Literary Universals Project.* Retrieved from https://literary-universals.uconn.edu/2017/02/09/literary-meaning-and-universals/

Carroll, J. (2018b). Minds and meaning in fictional narratives: An evolutionary perspective. *Review of General Psychology, 22*(2), 135–146. https://doi.org/10.1037/gpr0000104

Carroll, J., Gottschall, J., Johnson, J. A., & Kruger, D. (2012). *Graphing Jane Austen: The evolutionary basis of literary meaning*. New York: Palgrave Macmillan.

Carroll, J., Clasen, M., Jonsson, E., Kratschmer, A. R., McKerracher, L., Riede, F., et al. (2017a). Biocultural theory: The current state of knowledge. *Evolutionary Behavioral Sciences, 11*(1), 1–15. https://doi.org/10.1037/ebs0000058

Carroll, J., Johnson, J. A., Salmon, C., Kjeldgaard-Christiansen, J., Clasen, M., & Jonsson, E. (2017b). A cross-disciplinary survey of beliefs about human nature, culture, and science. *Evolutionary Studies in Imaginative Culture, 1*(1), 1–32. https://doi.org/10.26613/esic.1.1.2

Chapais, B. (2013). Monogamy, strongly bonded groups, and the evolution of human social structure. *Evolutionary Anthropology: Issues, News, and Reviews, 22*(2), 52–65. https://doi.org/10.1002/evan.21345

Chapais, B. (2017). Psychological adaptations and the production of culturally polymorphic social universals. *Evolutionary Behavioral Sciences, 11*(1), 63–82. https://doi.org/10.1037/ebs0000079

Clasen, M. (2017). *Why horror seduces*. New York: Oxford University Press.

Clasen, M., Kjeldgaard-Christiansen, J., & Johnson, J. A. (2018). Horror, personality, and threat simulation: A survey on the psychology of scary media. *Evolutionary Behavioral Sciences*. https://doi.org/10.1037/ebs0000152

Clements, R., & Rooda, L. A. (2000). Factor structure, reliability, and validity of the death attitude profile-revised. *SAGE Journals, 40*(3), 453–463. https://doi.org/10.2190/xff0-c6ua-58pc-phpb

Damasio, A. R. (2010). *Self comes to mind: Constructing the conscious brain*. New York: Pantheon Books.

Dissanayake, E. (2011). In the beginning, evolution created religion and the arts. *The Evolutionary Review: Art, Science, Culture, 2*, 64–81.

Dreier, J. P., Major, S., Foreman, B., Winkler, M. K. L., Kang, E.-J., Milakara, D., et al. (2018). Terminal spreading depolarization and electrical silence in death of human cerebral cortex. *Annals of Neurology, 83*(2), 295–310. https://doi.org/10.1002/ana.25147

Fisher, H. E. (2016). *Anatomy of love: A natural history of mating, marriage, and why we stray* (2nd ed.). New York: Norton.

George, L. S., & Park, C. L. (2016). Meaning in life as comprehension, purpose, and mattering: Toward integration and new research questions. *Review of General Psychology, 20*(3), 205–220.

George, L. S., & Park, C. L. (2017). The multidimensional existential meaning scale: A tripartite approach to measuring meaning in life. *The Journal of Positive Psychology, 12*(6), 613–627. https://doi.org/10.1080/17439760.2016.1209546

Gottschall, J. (2008a). *Literature, science, and a new humanities*. New York: Palgrave Macmillan.

Gottschall, J. (2008b). *The rape of troy: Evolution, violence, and the world of Homer*. Cambridge: Cambridge University Press.

Gottschall, J. (2012). *The storytelling animal: How stories make us human*. Boston: Houghton Mifflin Harcourt.

Gottschall, J., & Nordlund, M. (2006). Romantic love: A literary universal? *Philosophy and Literature, 30*(2), 450–470.

Harris, P. L. (2018). Children's understanding of death: From biology to religion. *Philosophical Transactions of the Royal Society B: Biological Sciences, 373*(1754). https://doi.org/10.1098/rstb.2017.0266

Heine, S. J., Proulx, T., & Vohs, K. D. (2006). The meaning maintenance model: On the coherence of social motivations. *Personality and Social Psychology Review, 10*(2), 88–110. https://doi.org/10.1207/s15327957pspr1002_1

Henrich, J. (2016). *The secret of our success: How culture is driving human evolution, domesticating our species, and making us smarter*. Princeton, NJ: Princeton University Press.

Hogan, P. C. (2003). *The mind and its stories: Narrative universals and human emotion*. Cambridge: Cambridge University Press.

Hogan, P. C. (2013a). *How authors' minds make stories*. Cambridge: Cambridge University Press.

Hogan, P. C. (2013b). *Narrative discourse: Authors and narrators in literature, film, and art*. Columbus: Ohio State University Press.

Iser, W. (1974). *The implied reader: Patterns of communication in prose fiction from Bunyan to Beckett*. Baltimore: Johns Hopkins University Press.

Jacobs, A. M., & Willems, R. M. (2018). The fictive brain: Neurocognitive correlates of engagement in literature. *Review of General Psychology, 22*(2), 147–160. https://doi.org/10.1037/gpr0000106

James, W. (1890). *The principles of psychology*. New York: Henry Holt.

Johnson, J. A., Carroll, J., Gottschall, J., & Kruger, D. (2011). Portrayal of personality in Victorian novels reflects modern research findings but amplifies the significance of agreeableness. *Journal of Research in Personality, 45*(1), 9. https://doi.org/10.1016/j.jrp.2010.11.011

Jonsson, E. (2013). The human species and the good gripping dreams of H. G. Wells. *Style, 47*(3), 296–315.

Kjeldgaard-Christiansen, J. (2016). Evil origins: A Darwinian genealogy of the popcultural villain. *Evolutionary Behavioral Sciences, 10*, 109–122. https://doi.org/10.1037/ebs0000057

Kjeldgaard-Christiansen, J. (2017). The bad breaks of Walter White: An evolutionary approach to the fictional antihero. *Evolutionary Studies in Imaginative Culture, 1*(1), 103–120. https://doi.org/10.26613/esic.1.1.19

Landau, M. J., Solomon, S., Pyszczynski, T., & Greenberg, J. (2007). On the compatibility of Terror Management Theory and perspectives on human evolution. *Evolutionary Psychology, 5*(3), 476–519. https://doi.org/10.1177/147470490700500303

Lane, J. D., Zhu, L., Evans, E. M., & Wellman, H. M. (2016). Developing concepts of the mind, body, and afterlife: Exploring the roles of narrative context and culture. *Journal of Cognition and Culture, 16*(1–2), 50–82.

Low, B. S. (2015). *Why sex matters: A Darwinian look at human behavior* (Revised ed.). Princeton, NJ: Princeton University Press.

Mar, R. A., & Oatley, K. (2008). The function of fiction is the abstraction and simulation of social experience. *Perspectives on Psychological Science, 3*(3), 173–192. https://doi.org/10.1111/j.1745-6924.2008.00073.x

Mar, R. A., Oatley, K., Djikic, M., & Mullin, J. (2011). Emotion and narrative fiction: Interactive influences before, during, and after reading. *Cognition & Emotion, 25*(5), 818–833. https://doi.org/10.1080/02699931.2010.515151

Martela, F., & Steger, M. F. (2016). The three meanings of meaning in life: Distinguishing coherence, purpose, and significance. *The Journal of Positive Psychology, 11*(5), 531–545. https://doi.org/10.1080/17439760.2015.1137623

Martela, F., Ryan, R. M., & Steger, M. F. (2018). Meaningfulness as satisfaction of autonomy, competence, relatedness, and beneficence: Comparing the four satisfactions and positive affect as predictors of meaning in life. *Journal of Happiness Studies, 19*(5), 1261–1282. https://doi.org/10.1007/s10902-017-9869-7

Martin, L. L., & van den Bos, K. (2014). Beyond terror: Towards a paradigm shift in the study of threat and culture. *European Review of Social Psychology, 25*(1), 32–70. https://doi.org/10.1080/10463283.2014.923144

McAdams, D. P. (2015). *The art and science of personality development*. New York: Guilford Press.

McAdams, D. P. (2019). "First we invented stories, then they changed us": The evolution of narrative identity. *Evolutionary Studies in Imaginative Culture, 3*(1), 1-18 (a target article followed by responses and a rejoinder). https://doi.org/10.26613/esic.3.1.110

McCrae, R. R., Gaines, J. F., & Wellington, M. A. (2012). In I. B. Weiner (Ed.), *The five-factor model in fact and fiction, Handbook of psychology: Personality and social psychology* (Vol. 5, 2nd ed., pp. 65–91). Hoboken, NJ.

Muraven, M., & Baumeister, R. F. (1997). Suicide, sex terror, paralysis, and other pitfalls of reductionist self-preservation theory. *Psychological Inquiry, 8*(1), 36–40.

Nelson, K. R. (2014). Near-death experience. *Arising from the borderlands of consciousness in crisis., 1330*(1), 111–119. https://doi.org/10.1111/nyas.12576

Nordlund, M. (2007). *Shakespeare and the nature of love: Literature, culture, evolution*. Evanston, IL: Northwestern University Press.

Oatley, K. (2011). *Such stuff as dreams: The psychology of fiction*. Chichester, UK: Wiley-Blackwell.

Oatley, K. (2012). *The passionate muse: Exploring emotion in stories*. New York: Oxford University Press.

Oatley, K. (2016). Fiction: Simulation of social worlds. *Trends in cognitive sciences, 20*(8), 618–628. https://doi.org/10.1016/j.tics.2016.06.002

Oatley, K., Dunbar, R., & Budelmann, F. (2018). Imagining possible worlds. *Review of General Psychology, 22*(2), 121–124. https://doi.org/10.1037/gpr0000149

Panagiotaki, G., Hopkins, M., Nobes, G., Ward, E., & Griffiths, D. (2018). Children's and adults' understanding of death: Cognitive, parental, and experiential influences. *Journal of Experimental Child Psychology, 166*, 96–115. https://doi.org/10.1016/j.jecp.2017.07.014

Parnia, S. (2014). Death and consciousness—an overview of the mental and cognitive experience of death. *Annals of the New York Academy of Sciences, 1330*(1), 75–93. https://doi.org/10.1111/nyas.12582

Paulson, S., Fenwick, P., Neal, M., Nelson, K., & Parnia, S. (2014a). Experiencing death: An insider's perspective. *Annals of the New York Academy of Sciences, 1330*(1), 40–57. https://doi.org/10.1111/nyas.12473

Paulson, S., Kellehear, A., Kripal, J. J., & Leary, L. (2014b). Confronting mortality: Faith and meaning across cultures. *Annals of the New York Academy of Sciences, 1330*(1), 58–74. https://doi.org/10.1111/nyas.12474

Pettitt, P. (2018). Hominin evolutionary thanatology from the mortuary to funerary realm: The palaeoanthropological bridge between chemistry and culture. *Philosophical Transactions of the Royal Society B: Biological Sciences, 373*(1754). https://doi.org/10.1098/rstb.2018.0212

Pyszczynski, T., Solomon, S., & Greenberg, J. (2015). Thirty years of terror management theory: From genesis to revelation. In J. M. Olson & M. P. Zanna (Eds.), *Advances in experimental social psychology* (Vol. 52, pp. 1–70). New York: Academic Press.

Richerson, P. J., & Boyd, R. (2005). *Not by genes alone: How culture transformed human evolution*. Chicago: University of Chicago Press.

Richerson, P., Baldini, R., Bell, A. V., Demps, K., Frost, K., Hillis, V., Mathew S, Newton EK, Naar N, Newson L, Ross C, Smaldino PE, Waring TM. Zefferman, M. (2016). Cultural group

selection plays an essential role in explaining human cooperation: A sketch of the evidence. *Behavioral and Brain Sciences, 39*, 1–68 (a target article followed by responses and a rejoinder). e30, https://doi.org/10.1017/S0140525X1400106X

Rosen, D. H. (1975). Suicide survivors: A follow-up study of persons who survived jumping from the Golden Gate and San Francisco-Oakland Bay Bridges. *Western Journal of Medicine, 122*(4), 289–294.

Salmon, C. (2003). *Warrior lovers: Erotic fiction, evolution and female sexuality*. New Haven, CT: Yale University Press.

Salmon, C., & Symons, D. (2004). Slash fiction and human mating psychology. *Journal of Sex Research, 41*(1), 94–100. https://doi.org/10.1080/00224490409552217

Saunders, J. P. (2018). *American classics: Evolutionary perspectives*. Brighton, MA: Academic Studies Press.

Schofield, G. M., Urch, C. E., Stebbing, J., & Giamas, G. (2015). When does a human being die? *QJM: An International Journal of Medicine, 108*(8), 605–609. https://doi.org/10.1093/qjmed/hcu239

Solomon, S., Greenberg, J., & Pyszczynski, T. (1997). Return of the living dead. *Psychological Inquiry, 8*(1), 59–71 (Rejoinder to responses to a target article).

Steger, M. F. (2017). Meaning in life and wellbeing. In M. Slade, L. Oades, & A. Jarden (Eds.), *Wellbeing, recovery and mental health* (pp. 75–85). Cambridge, NY: Cambridge University Press.

Tamir, D. I., Bricker, A. B., Dodell-Feder, D., & Mitchell, J. P. (2015). Reading fiction and reading minds: The role of simulation in the default network. *Social Cognitive and Affective Neuroscience*, 215–224. https://doi.org/10.1093/scan/nsv114

Tomasello, M., Carpenter, M., Call, J., Behne, T., & Moll, H. (2005). Understanding and sharing intentions: The origins of cultural cognition. *Behavioral and Brain Sciences, 28*(5), 675–691 (a target article followed by responses and a rejoinder). https://doi.org/10.1017/s0140525x05000129

Tomer, A. (2012). Meaning and death attitudes. In P. T. P. Wong (Ed.), *The human quest for meaning: Theories, research, and applications* (pp. 209–231). New York: Routledge.

Vessel, E., Starr, G. G., & Rubin, N. (2012). The brain on art: Intense aesthetic experience activates the default mode network. *Frontiers in Human Neuroscience, 6*(66). https://doi.org/10.3389/fnhum.2012.00066

Watson-Jones, R. E., Busch, J. T. A., Harris, P. L., & Legare, C. H. (2017). Does the body survive death? Cultural variation in beliefs about life everlasting. *Cognitive Science, 41*(S3), 455–476. https://doi.org/10.1111/cogs.12430

Wilson, E. O. (1998). The arts and their interpretation. In *Consilience: The unity of knowledge* (pp. 210–237). New York: Knopf.

Wilson, D. S. (2002). *Darwin's cathedral: Evolution, religion, and the nature of society*. Chicago: University of Chicago Press.

Wong, P. T. P. (2007). Meaning management theory and death acceptance. In A. Tomer, E. Grafton, & P. T. P. Wong (Eds.), *Existential and spiritual issues in death attitudes* (pp. 65–87). New York: Erlbaum.

Wong, P. T. P. (2012). *The human quest for meaning: Theories, research, and applications* (2nd ed.). New York: Routledge.

Wong, P. T. P., Reker, G. T., & Gesser, G. (1994). Death attitude profile-revised: A multidimensional measure of attitudes toward death. In R. A. Neimeyer (Ed.), *Death anxiety handbook: Research, instrumentation, and application* (pp. 121–148). Washington, DC: Taylor & Francis.

Last Moments: Witnessing and Representing the Death of Pets

Jessica Pierce and Ross Taylor

This chapter explores the phenomenon of in-home pet euthanasia, through the intersection of two disciplinary perspectives: bioethics and photojournalism. The world of pet euthanasia, as an academic point of interest, is largely unexplored. Only a handful of academic articles, scattered through literature of the past four decades, have focused on the death of companion animals, and nearly always from the angle of the psychology of pet loss and bereavement. Yet as a cultural phenomenon, in-home euthanasia of pets is surprisingly common and becoming more so each year. The experience of ushering a companion animal through the final moments of life—of orchestrating and managing the death of a best friend—is profoundly moving and often deeply traumatizing for pet owners yet remains largely unseen by the public or by scholars. Capturing these moments on film has the potential to tell us a great deal about people, animals, and death.

This chapter describes the first visual media project to document the in-home pet euthanasia experience: a series of still photographs called *Last Moments* by photojournalist Ross Taylor and a feature-length documentary film called *The Hardest Day* by Ross Taylor and fellow filmmaker Luke Rafferty. The images in these works give viewers a window into the intimate and sacred world of pet euthanasia, a widespread, yet largely invisible, death experience for companion animals and their people. We will explore the role of the documentarian in witnessing trauma, and the potential for visual imagery to reduce the social isolation and psychological distress experienced after an animal's death. We also examine some of the ethical ramifications of documenting animal death, with particular attention to the potential for

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T. K. Shackelford, V. Zeigler-Hill (eds.), *Evolutionary Perspectives on Death*, Evolutionary Psychology, https://doi.org/10.1007/978-3-030-25466-7_8

visual imagery to increase understanding of the human-animal bond and foster a sense of empathy toward animals and the people who love them.

In-home euthanasia of companion animals is, at this point, an almost completely unexplored area, a *terra incognita* for scholars from a wide range of disciplines. This chapter provides an initial foray into this territory.

In-Home Pet Euthanasia: A Vast and Unexplored Terrain

Pet euthanasia is an area of growing interest and concern, and in-home euthanasia appears to be an increasingly popular choice among people who are facing end-of-life decisions for animal companions. The number of companion animals dying each year is likely on the rise, based simply on the rapidly increasing numbers of dogs and cats being kept as companion animals in people's homes. In the USA alone, approximately 90 million dogs and 94 million cats—not to mention the many other species of animal now considered an appealing choice for "pet"—are currently living in people's homes, and the numbers continue to grow. Indeed, the population of pet animals in the USA is now larger than the population of humans (Pierce, 2016). The number of animals being euthanized by owners, usually with the help of veterinarians, is also likely increasing, in pace with the overall increase in number of pets. More to our point, the number of pet owners choosing in-home euthanasia for ill, aged, and dying animals appears to be trending upwards.[1]

Unlike human deaths, animal deaths, including companion animal deaths, are not reliably tracked or recorded. No requirement exists for veterinarians or pet owners to report the death of an animal by accident, illness, or implementation of euthanasia. Without reliable tracking of how many pets die per day or even per year across the USA and the circumstances of these deaths, there is no way to know how many animals are euthanized and what percentage of euthanasias are occurring in the home versus the veterinary clinic. Guesswork based on indirect measures such as a rise in the number of mobile veterinarians and veterinary technicians offering in-home euthanasia services suggests, however, that hundreds of thousands of people may be going through this experience with their animal.[2] Lap of Love, the largest company in

[1] We are not including in this discussion the issue of shelter killings—often inaccurately described as "euthanasia"—which are performed not for the sake of relieving suffering at the end of life, but to reduce numbers of unwanted, unhomed, and behaviorally "unacceptable" dogs and cats. This is a completely different cultural phenomenon and raises a unique set of concerns. Even though the two phenomena may seem unrelated, companion animal euthanasia of owned dogs and cats and performed in the home or clinic is linked in complex ways with the killing of unwanted/unhomed dogs and cats in shelters. Shifts in the demographics of killing among one population (homed animals) are connected to shifts in the demographics of shelter killings. These dynamics are worth further exploration but are beyond the reach of this chapter.

[2] For example, Home to Heaven's directory of mobile providers now has over 300 active members, and probably over 450 if you include inactive members who have not renewed. The Association for Pet Loss and Bereavement has its own directory of euthanasia providers, and the International Association for Animal Hospice and Palliative Care now has more than 550 active members—up more than 120% from last year (sources: Kathy Cooney, personal email correspondence, December 13, 2018; IAAHPC membership directory).

the pet euthanasia business, estimates that they "help" nearly 50,000 families a year in the USA, which co-founder Mary Gardner believes is about 1% of the euthanasia business in the country. About 85 million families have pets, and perhaps 6% of these will be euthanized in a given year, according to Gardner's calculations. This means that about five million companion animals are being euthanized, and at least five million people each year going through one of the most emotionally challenging experiences of their life. Nobody knows how many of these managed animal deaths are occurring in the home, with the help of a mobile euthanasia veterinarian, but Gardner's guess is about 20% or a little under (so, around a million). This number is likely to grow, as more pet owners become aware of the option of in-home euthanasia and if the number of providers continues its current growth trajectory.[3]

Euthanasia is an area of human/animal interaction that has remained behind a seawall of privacy because it is an intimate act of compassion and violence in combination. It is also, from what we can gather from the sparse psychology literature, a point of significant trauma for pet owners and perhaps also for veterinary staff. Pet euthanasia can evoke feelings not only of anguish and grief, but also of deep ambivalence, guilt, and personal responsibility. These intense experiences are often socially isolating, because grieving for animals is not widely understood, nor is it culturally accepted as appropriate. The home as a site of loss is of special interest, both because of the increased comfort and intimacy of the environment (as opposed to the veterinary clinic) and because of the potential for isolation and social withdrawal.

What would we see if we could gain access into this intimate, private experience of humans ushering their companion animals through the final moments of life?

Filming Animal Death

For over a year now, photojournalist Ross Taylor has been working on one of the most intense documentary projects of his career. The project focuses on the human-animal bond, specifically on the moments just before, and after, the death of a pet at home with their owner. It is an unprecedented journey into the lives of people and their beloved pets, in their final minutes together before and after a scheduled euthanasia.

In some ways, the project was not an obvious one for Ross. He is not a pet owner and before this project had no particular interest in pet-keeping or in the pet loss experience. His idea for documenting the end-of-life experience originated a couple of years ago, when a close friend decided to have her dog euthanized at home. She agonized over the decline and impending death of her dog, and ultimately decided that she did not want her dog to spend his last moments distressed by a visit to the clinic and that it would be better for her dog to remain in the home. It was an intense and emotional experience for her.

Driven by what he had witnessed, Ross researched in-home euthanasia and found little documentation in media beyond the superficial. Ross' specialty is the intersection of documentary and trauma-related events and the role that documentary can

[3] We are focusing mainly on practices in the USA because in-home euthanasia appears to be less common and less available in other countries.

plan in healing those who have been traumatized. This includes documentation of what was at the time the largest trauma hospital in Afghanistan,[4] a burn unit in Syracuse, New York,[5] and the end-of-life process with a family within hospice care.[6] He immediately recognized in-home euthanasia as a trauma-related event.

As his interest in pet euthanasia grew, he began working collaboratively with Lap of Love (mentioned above), the largest at-home pet euthanasia organization in the nation. Each month, thousands of people across the country use this service to help ease the painful transition at a pet's end of life. Lap of Love agreed to let Ross ride along on several appointments and film the euthanasia procedure, if the clients gave permission. Every family Ross approached agreed to let him film.

Ross's project has two components: a feature-length film called *The Hardest Day* and a photographic essay entitled *Last Moments*. The photographic component has been published in *Visual Communication Quarterly Journal* (with an image on the cover), and the photographs have been presented at the Visual Communication Conference. Two of the images received a juror award at a nationally recognized gallery show, and another image was published in the *American Photography 34* annual book. A representation of the photo series was published in *The Washington Post* on January 2, 2019.[7]

The photographs and film cover a period of perhaps 30–60 min, from the time the veterinarian arrives at the home until the veterinarian leaves, often with the deceased animal's body which is being taken for cremation. We are shown intimate moments: the time before the injection, when the veterinarian is explaining what will happen and pet owners are preparing themselves and saying goodbye. We see the animals, who by contrast to their human family members, look serene. Some of the animals are bed-bound, whereas others are seen coming to the door to greet the veterinarian and are standing with their families as people talk. The euthanasia proceeds: the animal is given an initial injection with a sedative to induce sleep and a few minutes' elapse, during which time the family is seen stroking the animal, offering reassurances in quiet voices, and crying. The veterinarian locates an appropriate vein and shaves off a small area of fur. The shaved fur is gently placed in a small container and will be offered to the family as a memento. Within the images, people remain in close physical proximity to their pet, touching or stroking the pet's head or side. The euthanasias take place on the floor, a couch, or somewhere within the home environment, with family and veterinarian on the same plane as the animal.

The feature length film explores five different families, with a different vet on each case. The viewer is taken on a journey, beginning with the moment the veterinarian knocks on the door to the moment the veterinarian leaves. In addition to providing a new type of documentary look into the human-animal bond, the film seeks to tap into

[4] https://pilotonline.com/news/local/projects/collection_97bef9c4-9c85-11e5-9380-1b26fd7e04b6.html

[5] http://rosstaylor.net/films-and-motion-graphics/worthy/

[6] http://rosstaylor.net/photo-stories/glorias-goodbye/

[7] https://www.washingtonpost.com/news/in-sight/wp/2019/01/02/a-photographer-documents-the-heart-wrenching-final-moments-of-pet-owners-with-their-dying-pets/?fbclid=IwAR2eHQF5Z7QO4XBDSY5hT1l_q-zvyANzmb3oOG-UsiklQZqE-uPH5twRlZk&utm_term=.8dfec78b2324

the motivation behind why the vets perform this work and its importance. In addition to the "in the trenches" footage of veterinarians interacting with families and families interacting with animals, the film also explores broader thematic elements through interviews with a range of experts within the realm of animal end-of-life care and pet loss. The filmmakers interview Dani McVety, a co-founder of Lap of Love; Kathryn Jennings, the Executive Director of the International Association for Animal Hospice and Palliative Care; and Jessica Pierce (co-author of this chapter), a bioethicist who has specialized in the ethics of end-of-life care for animals.

The film is raw and intimate, and sheds light on both the visual and auditory experience of the moment in a way that expands on the photographic component. The auditory component not only adds to the poignancy of the images but may also provide interesting and unique material for scholars to explore. For instance, there seem to be characteristic vocal patterns in the way humans talk to dying animals: the use of soft tones and the repetition of certain phrases ("you're a good boy; you're such a good boy"), which may be meant to reassure the animal or may serve as a form of self-soothing. This "death speech" occurred in almost every case witnessed by Ross. The veterinarians also use characteristic speech, talking in a slow, soft voice and using soft metaphors and reassuring speech to describe what is happening: "you're making the right decision"; "they're not suffering anymore"; and (referring to the animal) "she's at peace"; "he has his wings now."

Why Document These Moments?

Why should people see these intimate moments? What purpose does it serve to break into this extraordinarily private experience and open it to view? To expose viewers to what will be, for many, a visceral response to watching others in pain, must serve a purpose beyond mere documentation. In our minds, there are four key areas of insight: documentary work can serve as a mitigating factor in trauma; it can build empathy among viewers, particularly among those with no personal experience of the documented events; it can reduce social isolation for those experiencing loss and grief, by showing people that others have been through a similar experience; and it can raise awareness about the issue being documented.

Documentary as a Mitigating Factor in Trauma

The images caught on film in *Last Moments* and *The Hardest Day* clearly show how the experience of loss can be a source of anguish for some pet owners. The existing literature on pet loss and bereavement confirms that the death of a pet can be a significant source of suffering. Research suggests that people form attachments to companion animals that are like attachments to people, and which can be as close or even closer than human-human bonds. In turn, grief responses to the loss of a closely attached animal are like those of a lost human companion and can be felt with similar intensity (though typically the time frame for bereavement is shorter in relation to

animals). People often experience initial feelings of shock and disbelief, followed by a preoccupation with the object of loss, anxiety over the loss, and depression (for a review of the literature, see Kemp, Jacobs, & Stewart, 2016). As Kemp et al. (2016) note, however, the heavy reliance on attachment theory to define the experience of pet loss may have led researchers to ask only a certain range of questions about pet loss and to see things through an overly narrow lens. We may thus lose sight of the idiosyncrasies of the human-animal relationship and the experience of witnessing the death of a beloved companion animal. Documentary may help highlight the individuality of the death experience—for animals and humans alike—by focusing on individual narratives and showing context.

Some evidence suggests that the event of losing a pet—and, especially, the decision to euthanize a pet—has profound and lasting psychological repercussions for a subset of people who are highly bonded to an animal who has died. It is unclear exactly what makes the death of a pet traumatic, and what variables might lead some people to find the experience traumatic or to experience prolonged distress or complicated grieving. But one possible factor is the mechanism of death. Davis, Irwin, Richardson, and O'Brien-Malone (2003) explored which factors might affect how well individuals cope with the loss of a pet and found that the strongest predictor of distress was whether an animal had been euthanized (as opposed to dying a natural death). Rachel MacNair, in her book *Perpetration-Induced Traumatic Stress* (2002), builds a case that certain people experience profound trauma, even PTSD-like symptoms, after deciding to euthanize a pet. Pet euthanasia is unique in that the caretaker/family member is the key decision-maker in whether and when to have an animal killed. The pet owner must initiate the request and confirm the request in writing (all pet owners are required to sign a consent form for euthanasia). As one pet owner articulated his experience: "I killed my dog … I killed my best friend." This phenomenon has also been described as "responsibility grief," in which a caretaker feels that he or she has somehow betrayed a contract of care toward an animal by deciding to hasten the animal's death (Dawson, 2010).

Many pet owners express feelings of guilt and uncertainty about the decision to euthanize, some of which may stem from a lack of consensus-building; pet owners often have minimal to no guidance from veterinarians or others who might be viewed as experts about whether a decision to euthanize an animal is in the animal's best interests. The timing of a planned passing is often also a source of distress, with pet owners frequently reporting either fear they jumped to euthanasia prematurely or, conversely, that they allowed their animal to suffer for longer than they should have. Although little is known about ambivalence and guilt surrounding pet euthanasia, one study found that about half of respondents felt guilty about euthanizing an animal (Dickinson, 2014) but this is a general figure that is not specific to pet owners choosing in-home euthanasia. No research has investigated whether trauma or distress is more likely to be experienced by those who have an animal euthanized in the home, as opposed to the veterinary clinic.

Documentary work seems to serve as a mitigating factor for those experiencing trauma. One avenue is as a therapeutic mechanism for those whose trauma is being documented; the act of telling one's story and being heard can serve as a release of aspects of the pain endured by people. It is common in the documentary form for

people to want to share their experience, which seems to resonate with a similar notion of talk therapy. There does seem to be a lessening of the pain through talking about a painful experience with another.

Documentary may also help audiences who view the film or photographs. It could, for example, play a role in helping bereaved pet owners process grief. This is speculative, but we believe that the experience of watching the film *The Hardest Day* or seeing images of families experiencing the death of an animal could aid someone grieving a loss, by building a sense that they are not alone in their suffering. The grief associated with the death of a pet is often experienced in isolation, because social acceptance of and support for such grief are lacking. Indeed, pet loss is often described as a form of "disenfranchised grief" (see Cordaro, 2012). Pet bereavement has been pathologized within the psychology literature, and "overly" strong bonds with an animal have been labeled as unhealthy and abnormal (e.g., Kemp et al., 2016). Not surprisingly, people often grieve alone, reluctant to share their feelings because of fear of being considered sentimental or weird. Nevertheless, social support and external validation are known to be important factors in aiding healing. And as Kemp et al. (2016) note, "a strong need for acknowledgement" is also evidenced by the millions of dollars spent annually on pet burials and cremation, memorial urns, and objects of remembrance such as clay paw prints, customized paintings, and jewelry made from crystalized remains (p. 554).

It is also possible, of course, that some people could find viewing these images deeply upsetting, triggering memories of their own loss and rekindling feelings of anguish that had been put to rest. The images in the film and in the photographs may also release feelings of disappointment and guilt about past experiences with animal death. The documented deaths are, without exception, planned passings which have been stewarded by highly skilled veterinarians, where everything has gone "right." The animals have been cherished and respected in their final moments. Unfortunately, some pet owners may feel that in the death of their own animals, things went very wrong.

"Listening Is an Act of Love": Building Empathy

One of the important functions of documentary lies in the experience of "being heard." The documentarian listens and empathizes and invites audiences to do the same. Documenting through film, then, can be an act of compassion, when done correctly.

We can see the theme of empathy-building expressed throughout interviews with photojournalists in the interview archive "The Image, Deconstructed," one of the largest archives of its kind. The idea of documenting as an act of compassion is not confined to visual documentary. For instance, the mission statement of the nationally renowned Story Corps' program (familiar to US listeners of National Public Radio) is "to preserve and share humanity's stories in order to build connections between people and create a more just and compassionate world." One of Story Corps' taglines summarizes this ethic succinctly: "Listening is an act of love."[8]

[8] https://storycorps.org/

Whether it is audio, visual, or their combination in film and motion, the underpinning motivation is the same.

Media psychologist Martin Smith-Rodden, an assistant professor at Ball State University, has researched best practices in photojournalism, and much of his work has focused on empathy. He describes how empathy functions in the work of the documentarian:

> Empathy is fundamental to the benevolent motivations that drive trust. Being able to understand another human from their frame of reference rather than one's own, not only facilitates cooperation and trust with those whom journalists document, but also is a path to proper comprehension of human events. It drives meaningful storytelling. Therefore, it may not be entirely coincidental that empathy is a frequently-mentioned core skill for journalists, especially those working in sensitive situations. Being able to leverage and manage the emotional labor as part of the journalistic approach is understood to be crucial to producing powerful work (Smith-Rodden, 2019).

Rob Finch, a two-time newspaper photographer of the year for the Pictures of the Year International Contest, echoes much the same sentiments in an interview on The Image, Deconstructed website. The interview explored his documentation of a human end-of-life case:

> The reality of any intimate story is that you must give of yourself if you expect people to open up to you. It's simple advice but difficult to do. You are there because of your job. They are living their real life. If you are not empathic to them, you will never gain access to their lives. Those feelings must be real and genuine. You cannot fake it. Never think about your subjects as compositional elements. Respect them. Give of yourself. Treat them how you want to be treated. It's basic life stuff and they teach it in preschool.[9]

In Ross's experience, Finch is right. People can often sense right away if your motives are pure, respectful, and empathetic. Subjects who are documented tend to respond, time and again, by allowing documentarians' access into their lives when respect and empathy are demonstrated via language (both verbal and body).

We can see this same theme in comments from other accomplished photographers such as Scott Strazzante. Strazzante is a photographer for *The San Francisco Chronicle* and was also awarded the National Newspaper Photographer of the Year, as well as an 11-time Illinois Photographer of the Year. He was also part of a *Chicago Tribune* team that won a Pulitzer Prize in 2007 for investigative journalism. A veteran who has documented the span of the human condition, he's particularly known for his in-depth documentation of a family who lost their farm. He was present on the day that Harlow Cagwin's home of 74 years was torn down. Strazzante documented the moment, just a few feet away from Harlow. Strazzante explains in an interview how he gained access to such an intense moment:

> Put in the time. Respect your subjects. Share your life. Ask specific questions about future activities. Visit often but for short periods of time. Listen, listen and then listen some more. Be respectful but be bold. Don't be afraid to photograph uncomfortable situations. You can always not use an image that your photo subject hates but you can't go back and shoot something that you were uncomfortable shooting but unbeknownst to you, your subject didn't have a problem with.[10]

[9] http://www.imagedeconstructed.com/post/spotlight-on-rob-finch

[10] http://imagedeconstructed.com/post/spotlight-on-scott-strazzante

The capacity to empathize relies on understanding how another person or animal feels. Documentary increases our understanding of the world around us and reveals shared behavioral experiences. People who may not have experienced pet loss, or more broadly those who have never developed a deep emotional attachment to an animal and who do not initially empathize with those suffering a loss, may gain insight, through these documentary images, into the anguish and beauty of the human-animal bond. As Smith-Rodden suggests, it is through empathy that documentarians can create more effective works that provide a robust understanding of one's individual condition and perhaps also the "human condition"—those shared universals, such as suffering over the loss of an important social attachment.

Although framed within the narrative of in-home euthanasia, the subject matter of *Last Moments* and *The Hardest Day* is, at its core, empathy. The visual imagery captures the empathy of humans toward an animal, attuned to the suffering of their animal and tenderly easing this suffering through hastening death—despite the heavy emotional cost. The images also display the empathy of veterinary professionals toward animals and pet owners. The photos and film repeatedly show instances of veterinarians being kind to animals and humans, for instance in the gentle handling of the animals. The presence of the veterinarian in the animal's home, and their willingness to treat these final moments of an animal's life as sacred, affirms for pet owners (and viewers) that the lives of these animals have value, that they are, to borrow language from Judith Butler, "grievable" (Butler, 2006). The veterinarian is often seen or heard offering emotional support—through the touch of a hand on a shoulder, for example, and through verbal reassurance. The veterinarian is also seen offering practical support in preparing the body for disposal and, in some cases, taking the body away with them for cremation. This practical support may form "a bridge to compassion and empathy" (Kemp et al., 2016, p. 553). The film also shows veterinarians making clay paw prints, providing support for continuing bonds.

Addressing Social Isolation

The grief associated with the death of a pet is often experienced in isolation because social acceptance of and support for such grief are lacking. Social isolation can intensify feelings of distress. People can experience either short-term or long-term depression resulting from traumatic events. Depression, in turn, often leads to increased isolation. Social isolation is associated with increased mortality (see, for example, Laugesen et al., 2018).

If documentary can help people feel less isolated after a traumatic loss, it serves a vital social function. Social support and external validation are known to be important factors in aiding healing after trauma or loss. As we suggested above, people experiencing the death of a pet often want to be heard and acknowledged. Having someone to talk to about their experiences has been found to be helpful for those dealing with pet loss (e.g., Davis et al., 2003). And as Kemp et al. (2016) note, "a strong need for acknowledgement" is evidenced by the millions of dollars spent

annually on pet burials and cremation, memorial urns, and objects of remembrance such as clay paw prints, customized paintings, and jewelry made from crystalized remains (p. 554). One way of hearing people is to document their experiences. Simply having the chance to tell their story to a documentarian may offer comfort to those going through the experience of pet death.

Another way to acknowledge and assuage people's suffering is through the community-building function of documentary. Seeing these stories documented on film may help viewers feel the sense of a broader community, by knowing that others have been through a similar experience. With pet loss, community-building is particularly salient because "community" is such a limited commodity.

The benefit of a shared community in addressing isolation in trauma has been explored by noted author and filmmaker Sebastian Junger, who spent a year documenting a forward-operating military base in Afghanistan. His written and filmic work did not simply document the experiences of the soldiers while they were on their tours of duty, but built a community which extended into time, even after the soldiers returned home. As he later noted about the soldiers he filmed, "Even if he or she is in a family, that is not the same as belonging to a large, self-sufficient group that shares and experiences almost everything collectively. Whatever the technological advances of modern society—and they're nearly miraculous—the individual lifestyles that those technologies spawn may be deeply brutalizing to the human spirit."[11] The need for a sense of community may be what motivates many people who have lost an animal to search online for emotional connection, by accessing virtual pet loss support communities such as petloss.com.

Documentary also builds community by building empathy. Smith-Rodden, reflecting on the experience of pet loss, says,

> "It's surprising to some people the extent that the loss of a companion animal can devastate a person. It was even surprising to me, as a pet owner (and psychologist) the extent that I felt the loss, each time one of our pets passed away over the years. We are never quite prepared for it. To the extent that documentary reporting can facilitate understanding of people who experience loss, both the documentation and consumption of these types of stories has strong functional value. These stories can help transfer empathy to our audiences. At their best, they can just help make us *better people.*"[12]

Documentary as Awareness-Raising

One of the most important functions that documentary can serve in relation to in-home euthanasia is exceedingly practical: it can raise awareness among the public about the range of options available to people with an ill or aged animal that is nearing the end of life. Many people are unaware that in-home euthanasia is an option for animals. The number of providers of in-home end-of-life care is still small but would likely grow in response to increased interest and demand from pet owners.

[11] https://www.vanityfair.com/news/2015/05/ptsd-war-home-sebastian-junger

[12] Email communication to Ross Taylor, Dec. 8, 2018.

If in-home euthanasia is a better option than clinic-based euthanasia—and there are good reasons to think it is—then greater access and awareness would be a benefit to animals and the people who love them.

The Ethics of Filming Death

The ethical dimensions of filming and photographing an animal's death, and a family's witnessing of this process, are complex. People are in a heightened emotional state and are vulnerable. For many, this is not only one of the hardest days of their lives, but it might also be their first time experiencing the passing of a loved one, much less planning and orchestrating a death. To approach documentation without deliberate ethical thought would be irresponsible and would have the potential to emotionally damage family members. For animals, whatever their level of understanding about the events unfolding around them—and we should perhaps err on the side of assuming they grasp what is happening to them at some level—these are the final moments before their life comes to an end and are thus of ethical significance.

For a documentarian, the ethical meditation is part of the fabric of story generation. An ethical approach to filming trauma has crystalized for Ross over many years, during his work photographing in some extraordinarily fragile spaces. In each case, he begins by first understanding the core intent of the documentary work. By clearly understanding the purpose of filming, he is able to communicate this to others effectively and respectfully. In his experience, it is only when people understand the documentarian's motivation that they are willing to share their story. Trust is built from such exchanged understanding between a documentarian and those they document. At root, people want to feel safe and people want to feel heard. If people feel safe, almost any experience can be documented because trust has been established.

Ross once had an intern ask, "What happens when people say no?" "They don't," was his reply. What he meant by this was not that people always say yes to everything, but that he chooses projects with intent and expresses this intent with the deepest respect possible, with ethical behavior in mind all along. He operates on the notion that most people pass through each day without someone genuinely asking them, "How are you doing?" In his mind, documentation is an expression of respect.

In terms of specifics, he often begins by approaching an organization or an agency that works with the topic he is interested in documenting. He arranges meetings—often many—with those in a position of influence (e.g., a project manager, a communication manager, a CEO). He gives a presentation that always begins with an origin story "Why am I doing this?" and explains what he hopes to accomplish with the documentary work. For *The Hardest Day* and *Last Moments*, Ross approached two in-home euthanasia services, and both agreed to allow him to spend time with them: Lap of Love, based in Tampa, Florida, and Caring Pathways, based in Denver, Colorado.

On each visit into a home to document a euthanasia, Ross followed a code of ethical conduct:

1. He follows any order, or direction, of the veterinarian. They have the final say, and he respects whatever they express.
2. Although people have already given prior consent, he tries to present his introduction with a kind tone, soft and direct. For example, he will state: "My name is Ross Taylor. I'm a professor at the University of Colorado Boulder, and I'm working on a project on the human-animal bond. Thank you for allowing me into your home." There's no need to speak much more than that, because people are already in such a state of stress.
3. He always asks if they would like a portrait of them with their dog before the euthanasia, as a small token of appreciation for their time. It's the right thing to do. This gives them an option to have one final group memory.
4. Most cases also involve storytelling about the pet. The owner will often begin by telling both the vet and Ross a bit about the story arc of the pet's life. It's a way that they seem to add a sense of validity, thoughts that strike at the declaration, "I once was here." This storytelling gives a fuller view of who the pet is as an individual, and what the pet means within the narrative of the family. It's crucial to hear this and to make sure that it comes from a genuine space.
5. Once the procedure starts, he tries to limit his movements. When he does move, he tries to reduce his size and move as quietly as possible. He says very little as well, unless he is spoken to.
6. Finally, he makes images as infrequently as possible. He prefers to photograph only when he knows it's a key moment, as he doesn't want to distract from the process.
7. He always follows up with a "thank you" to the family and asks if they want him to send images (either the portrait or the process). Many people do want to see some images, so they exchange emails.
8. Finally, he sends them a follow-up email either that night or the next day thanking them again for their time. In the email, he lets them know that whenever they're ready, they can indicate which pictures, if any, they would like to have. It's worth noting that in a couple of cases, the families wanted all the pictures from the entire shoot.

How do you film something so private and powerful without making the pain worse for those experiencing it? By paying close attention, always, to the ethical contours and reverberations of the documentary work. A cornerstone of Ross's work is to help people going through traumatic experiences know that they are not alone; the work is meant, above all, to be healing to those involved in the filming. People intrinsically understand the importance of documentary (they document their own lives and express it through social media daily), and often welcome the opportunity to have their story told by another. The healing power of the work extends beyond the actors in the drama to those invited to watch, to bear witness. For those who have experienced the death of a pet, seeing the images and watching the film will pull them into a community of others, dissipating some of the isolation that can surround

pet loss. Hopefully the power of the documentary images extends even further by offering the experience of animal death to an audience of people who have not been through the experience, building a reservoir of empathy and understanding that is currently unavailable to them.

Avenues for Further Research

The film and photographic footage of in-home euthanasia in *Last Moments* and *The Hardest Day* contain a treasure trove for future research. The material captured on film will be of potential interest to scholars working in a range of fields, including death studies, media studies, human-animal relationships, animal ethics, psychology, ethnography, and veterinary medicine. We have sketched a few of the possibilities below.

Is In-home Euthanasia Beneficial for Animals?

The main reason people report choosing in-home euthanasia is that they believe it will be better for their animal than going to a veterinary clinic or hospital. Animals who are ill or aged are often in some degree of pain or discomfort and may have limited mobility. Loading into the car for a ride to the veterinary office can be physically uncomfortable. Although not all animals "hate the vet," many find veterinary offices distressing and will be more at ease in their own home, making their final moments of life more peaceful. One of the powerful messages of this documentary work is that companion animals can and should be given the opportunity for a good death and understanding how exactly to create the conditions for a good death is worth careful study and attention.

An often-overlooked component of companion animal death is the effect that the loss of an animal has on other animals in the home. When an animal dies in the clinic setting, it is almost always separated from other animals with whom she may have shared a home. Allowing euthanasia to take place in the home increases the likelihood that other animals will be present. Whether "saying goodbye" is important to an animal that is dying, or to the animals left behind, is unknown at this point and research into animal-animal attachments and animals' experience of loss is needed. Anecdotally, animals allowed to "witness" the death of a friend either do not seem to respond at all or appear to actively respond in ways we might describe as grieving and "paying respects" (e.g., through olfactory investigation or remaining in close proximity to the body for an extended period of time). It remains an open question whether and under what conditions such togetherness is beneficial for the animal that is dying or the animals that are left behind, and more research in this area is needed (see Dickinson & Hoffmann, 2016, for some interesting preliminary work). The American Veterinary Medical Association and the American Animal

Hospital Association—the two largest professional organizations representing veterinarians—both recommend against allowing other animals within the home to be present during a euthanasia. But these recommendations are not based on data and may be misguided.

The Impact of In-Home Euthanasia on Veterinary Professionals

Veterinarians report worrying levels of depression and anxiety, and the veterinary profession is currently struggling to understand and respond to high suicide rates (Tomasi et al., 2019). Moral distress is likely one of the key drivers of poor mental health among veterinary professionals, and much of this distress may revolve around the issue of euthanasia—specifically, being tasked with killing animals at the request of pet owners, where death is clearly not in the best interests of the animals—the so-called convenience euthanasia (Whiting & Marion, 2011). Mobile euthanasia or hospice veterinarians who work solely or primarily in the home are probably less likely to be asked to provide convenience euthanasia, and more likely to serve clients with a strong commitment to their animal's well-being. Mobile euthanasia veterinarians report high levels of job satisfaction and, while admitting that their work is emotionally draining, do not generally find it ethically compromising.[13] The interests of the human pet owner and the animal may appear more closely aligned, and veterinarians may feel that their work is benefitting both the animal and the family. More research into the psychological impact of in-home euthanasia on veterinarians can identify which aspects of veterinary work exact the worst toll and where efforts to reform pet-keeping practices may help ease the distress experienced by those in this line of work.

Impact of In-Home Euthanasia on Pet Owners

It is plausible to suppose that pet owners who euthanize in the home feel less protracted grief and are less likely to feel traumatized, compared to those who take their companion animal to a veterinary clinic to be euthanized. Why might this be? In-home euthanasia tends to be more deliberately timed and chosen, and there is often a feeling that an animal is comfortable and peaceful prior to death. Within the home setting, the process is allowed to proceed organically, in its own time, allowing pet owners space to say their final farewells. People may be able to grieve more openly within their home, and may be able to add ritual, space, and silence.

Veterinarians and nurses (depending on the US state) who focus their practice on end-of-life care may be a self-selecting group of practitioners—those with a special

[13] Personal email communication from Mary Gardner to Jessica Pierce, Dec. 18, 2018.

draw toward helping in the final moments. Often these people have completed additional training in pet loss and bereavement, which enables them to more effectively empathize with grieving pet owners, perhaps decreasing the potential for negative euthanasia experiences that can leave people feeling traumatized. Moreover, veterinarians who specialize in end-of-life care may have a more advanced set of technical euthanasia skills, making them more likely to perform the procedure without causing distress to the animal or the witnessing family.

Although research suggests that some people have pathological grief responses after the death of a pet, we do not understand what drives these extreme responses. Poorly handled end-of-life care/decision-making appears to be a significant source of suffering for pet owners, and these may be variables that could be addressed, if we understood better what makes pet death traumatic for certain individuals. Is it lack of social support, suddenness of death, reason for death, support during the decision-making process, peacefulness of the procedure, or how the animal is handled?

Carefully watching the interactions between humans and their pets, between veterinary professionals and pet owners, and among animals within the home during the moments before, during, and after death may tell us a great deal about what people and animals need during these times of transition and how to make these profoundly important moments sacred and safe. These interactions have far-reaching consequences and reverberations and are rich with potential for further interdisciplinary research.

Conclusion

The use of visual media, particularly the documentary form, to better understand companion animal death is an untapped resource for scholars from a range of disciplines. The implications of in-home euthanasia of animals are far-reaching, for animals and the people who love and care for them. Better understanding the dynamics of how people say goodbye, and how veterinarians can help ease animals and humans through this difficult transition, has the potential to relieve suffering among those experiencing loss and build empathy among the broader community.

References

Butler, J. (2006). *Precarious life: The powers of mourning and violence*. Brooklyn, NY: Verso.

Cordaro, M. (2012). Pet loss and disenfranchised grief: Implications for mental health counseling practice. *Journal of Mental Health Counseling, 34*, 283–294.

Davis, H., Irwin, P., Richardson, M., & O'Brien-Malone, A. (2003). When a pet dies: Religious issues, euthanasia and strategies for coping with bereavement. *Anthrozoös, 16*, 57–74.

Dawson, S. E. (2010). Compassionate communication: Working with grief. In C. Gray & J. Moffett (Eds.), *Handbook of veterinary communication skills* (pp. 62–99). Oxford: Blackwell.

Dickinson, G. E. (2014). Household pet euthanasia and companion animal last rites. *Phi Kappa Phi Forum, 94*, 4–6.
Dickinson, G. E., & Hoffmann, H. C. (2016). The difference between dead and away: An exploratory study of behavior change during companion animal euthanasia. *Journal of Veterinary Behavior, 15*, 61–65.
Kemp, H. R., Jacobs, N., & Stewart, S. (2016). The lived experience of companion-animal loss: A systematic review of qualitative studies. *Anthrozoös, 29*, 533–557.
Laugesen, K., Baggesen, L. M., Schmidt, S. A. J., Glymour, M. M., Lasgaard, M., Milstein, A., et al. (2018). Social isolation and all-cause mortality: A population-based cohort study in Denmark. *Scientific Reports, 8*, 4731.
MacNair, R. M. (2002). *Perpetration-induced traumatic stress*. London: Praeger.
Pierce, J. (2016). *Run, spot, run: The ethics of keeping pets*. Chicago, IL: University of Chicago Press.
Smith-Rodden, M. (2019). Commentary: The case for empathy. *Journalism and Communication Monographs., 21*(1), 73–78.
Tomasi, S. E., Fechter-Leggett, E. D., Edwards, N. T., Reddish, A. D., Crosby, A. E., & Nett, R. J. (2019). Suicide among veterinarians in the United States from 1979 through 2015. *Journal of the American Veterinary Medical Association, 254*, 104–112.
Whiting, T., & Marion, C. (2011). Perpetration-induced traumatic stress: A risk for veterinarians involved in the destruction of healthy animals. *Canadian Veterinary Journal, 52*, 794–796.

Further Reading

Bussolari, C. J., Habarth, J., Katz, R., Phillips, S., Carmack, B., & Packman, W. (2018). The euthanasia decision-making process: A qualitative exploration of bereaved companion animal owners. *Bereavement Care, 37*, 101–108.
Cooney, K. (2016). *In-home pet euthanasia techniques: The veterinarian's guide to helping pets and their families say goodbye in the comfort of home*. kathleencooneydvm.com.
Dickinson, G. E., & Hoffmann, H. C. (2017). Saying goodbye to family: Caretakers' experiences with euthanasia and honoring the legacy of companion animals. *Society and Animals, 25*, 490–507.
Hunt, M., & Padilla, Y. (2006). Development of the pet bereavement questionnaire. *Anthrozoös, 19*, 308–324.
Kogan, L., & Blazina, C. (2018). *Clinician's guide to treating companion animal issues*. Cambridge, MA: Academic Press.
Luiz Adrian, J. A., & Stitt, A. (2017). Pet loss, complicated grief, and post-traumatic stress disorder in Hawaii. *Anthrozoös, 30*, 123–133.
Pierce, J. (2012). *The last walk: Reflections on our pets at the ends of their lives*. Chicago, IL: University of Chicago Press.
Pierce, J. (2013). The dying animal. *Journal of Bioethical Inquiry, 10*, 469–478.
Sugita, H., & Irimajiri, M. (2016). A survey of veterinarians' attitudes toward euthanasia of companion animals in Japan. *Anthrozoös, 29*, 297–310.
Testoni, I., De Cataldo, L., Ronconi, L., & Zamperini, A. (2017). Pet loss and representations of death, attachment, depression, and euthanasia. *Anthrozoös, 30*, 135–148.

The Evolution of American Perspectives Concerning Treatment of the Dead and the Role of Human Decomposition Facilities

Katie Zejdlik and Sarah E. Burke

Treatment of the body after death varies considerably around the world, with death as a personal and intimate event being the common practice for many contemporary, non-Western cultures. The perception of death as disconcerting and toxic is a Westernized concept, and relatively recent within the span of humanity's cognitive ability to recognize death and its meaning. Perceiving death as a form of corruption has been a part of American culture since the late eighteenth century when people began to physically and mentally separate themselves from death and its attributes though action, consolation, ritual, and even word choice. Schillace (2015), in discussing current American perceptions of death, writes: "We find ourselves in a culture of opposites: bent on living forever, but committed to the disposable nature of absolutely everything else" (Schillace, 2015, p. 5). It is the denial of our temporary time as animated bodies that, some argue, leads to negative perceptions of death and the dead.

Literature about death and dying is immense, with forays down paths focused on the psychology, politics, artifacts, poetry, and other aspects related to the experience. This chapter focuses on the treatment of the dead. It begins with a contemporary global perspective, and then narrows to examine how American perceptions of death and the dead have changed since the seventeenth century. Finally, this chapter discusses death from the perspective of a human decomposition research facility and its increasingly relevant role in the postmortem life of human remains.

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T. K. Shackelford, V. Zeigler-Hill (eds.), *Evolutionary Perspectives on Death*,
Evolutionary Psychology, https://doi.org/10.1007/978-3-030-25466-7_9

Contemporary Global Perspectives

An exhaustive discussion of contemporary, non-American death practices is outside the parameters of this chapter; however, it is important to demonstrate that the American aversion to death is cultural in origin and not universal, that, in fact, the "American way of death" (Mitford, 2000) is as unusual to non-Westerners as non-Western traditions are to Americans.

The most well-known celebration of the deceased is the *Día de Muertos* ("Day of the Dead") celebrated in Mexico. The celebration's origins are pre-Hispanic but were later blended with colonial Spanish beliefs to eventually be promoted by the secular Mexican state. They are now capitalized on by various cultures not associated with those from which the traditions derived (Arredondo & Capistrán-López, 2017). Despite the secularized, nonreligious, capitalistic slant that many modern celebrations have (Arredondo & Capistrán-López, 2017), the small village of Pomuch in the Campeche region of Mexico still practices an annual handling of the dead. After a person dies, they were placed in a coffin. The coffin was put in a sealed niche in the village cemetery and left untouched for approximately 3 years. After 3 years, it was opened. The body was taken out and the remaining soft tissues were removed. The bones were left to dry for a few hours, then cleaned, sprinkled with holy water, and placed in a decorated and lined wooden box ossuary specifically made and decorated for that individual. The bones were not placed in a specific order within the ossuary except for the skull, which was always on top and often set so that it appeared as if the person was peering over the edge of the box. The bones were finally replaced in a niche at the cemetery and left on display for family, friends, and visitors. Every year, during the last week of October, family members would return to the cemetery to collect their ossuaries and to clean the bones (Benítez & Chung, 2015). Unlike the secular festival of the dead that has been co-opted and commoditized by secular Mexicans and non-Mexicans alike, the villagers of Pomuch demonstrate an acceptance, respect, and intimacy with the dead uncommon in the rest of the region or other Westernized cultures.

Another cultural group well known for their treatment of the dead is the Torajans of Sulawesi, Indonesia. Upon death, individuals are not treated as dead but as sick or sleeping. Unlike American euphemisms about sleeping and death meant to ease the pain of the loss, the Torajans care for their deceased as if they were actually in that living biological state. The practice lasts until an appropriately elaborate funeral can be planned, which could take years (Waterson, 1993). The importance of the funeral ritual lies in the belief that by performing the ritual correctly, the soul of the deceased would reach *puya*, the land of the souls (Budiman, 2013; Waterson, 1993). By reaching this realm, the soul would be content and would not affect the living. If the ritual is not performed correctly, the soul will wander in *lino*, the realm of the living, where it will bother the living until the appropriate sacrifices are made and it could move on (Budiman, 2013; Waterson, 1993). Curation of the dead is accomplished through mummification, which was originally carried out via the use of plants but is currently done with formalin, a chemical preservative. Once

mummified, the deceased is dressed in their own clothes, wrapped in a special fabric, and placed in the south section of the house to await the funeral. During this intervening time, the individual is kept company by a close relative, including children, who share the room with them. They are biologically dead but culturally alive such that companionship with inanimate family members is not considered unusual.

A third culture that has embraced death and did not avoid interacting with the dead was the Wari of Peru. The Wari practiced endocannibalism, the consumption of the remains of someone within one's own social group, until the 1960s when the government forced them to stop (Conklin, 2001). For the Wari, mortuary cannibalism was done as a means of affection for the dead and for their ancestors. The Wari believed that they were part of a system of nature, birth, death, and recycling of spirit, that every living organism has a humanlike soul and must be treated respectfully. This perspective was especially observed with nonhuman animals, which they viewed as having the spirits of already deceased humans, possibly their own ancestors and kin. Therefore, they hunted, processed, and consumed animals with calculated care so that they may be protected and provided for in the future (Conklin, 2001). After the death of an individual, family and friends were notified and they came immediately. During the first part of the funeral, the deceased individual was embraced by kin in displays of grief so intense that sometimes the living would pile on top of the dead individual expressing that they wanted to join them in death. Next, a roasting rack was prepared with special attention paid to construction and decoration. Bread was also prepared to eat along with the body. Third, the body was prepared. It was cut into pieces to be roasted. The Wari perceived the body fluids as polluting and protected themselves against the fluids by painting their own bodies with red annatto, a strong-smelling berry found in local trees. However, it was also important that no part of the corpse be lost to the earth so someone would take the role of lying under the corpse during the cutting to capture the fluids on his or her own person. Next, the body was disemboweled and most of the organs as well as genitals were thrown into the fire. The body was then dismembered and the various parts were washed and placed on the roasting rack. When the body parts were well roasted, they were consumed with the bread. The goal was to consume as much of the flesh as possible. Whatever was not consumed was burnt in the fire (Conklin, 2001).

The Wari expressed that they did not enjoy eating the deceased and that often the smell was revolting and made them ill. They did it out of obligation and reverence for the dead, their ancestors, and their commitment to future hunts and survival. Additionally, consumption of human remains was done as an act of love. They felt that the Western practice of disposing of a body via burial was an abhorrent act of abandonment, of leaving a loved alone in the cold ground for eternity (Conklin, 2001).

The Mexicans, Torajans, and Peruvians are examples of disparate cultures with unrelated mortuary traditions that shared a common interest in demonstrating their affection and veneration of the dead through interacting with the body after death. They were not afraid of the dead body or the process of decomposition. Their

intentions were focused on the deceased individual and his or her transition into the next step. These sentiments are not unlike those expressed by colonial Euro-Americans. However, by the mid-eighteenth century, Americans were becoming afraid of death, avoided interacting with the dead, and focused on their own needs rather than those of their loved ones.

The United States

Early Perspectives

It is acknowledged that the term "American" has myriad translations and encompasses a broad range of histories, cultures, and experiences. However, literature discussing the American treatment of the dead is biased toward the experience of middle-class, White Protestants in the United States. In some cases, it approaches the American experience through general practices that occurred within the United States such as embalming.

French historian Philippe Ariès's, 1974 book "Western Attitudes toward Death: From the Middle Ages to the Present" is one of the most cited pieces of scholarship discussing American perceptions of death. Despite being 45 years old, the perspectives espoused in his book are still relevant. He begins the book with a discussion of what he terms "tamed death," meaning that death was not a wild, dangerous thing but a routine, expected occurrence. This was a perspective shared in much of European history and in the United States, prior to nineteenth century (Ariès, 1974). Early Euro-Americans would gather around the bed of the dying individual. They would offer comfort, companionship, and seek absolution for misdeeds. It was a public affair with family, friends, neighbors, and children; everyone was allowed to enter the death chamber (Ariès, 1974; Bowman, 1977; Earle, 1977; Laderman, 1996).

The event of death was a common part of life during the seventeenth and eighteenth centuries in America (Habenstein, 1962; Zlomke, 2013). Averaging the data provided in Kunitz (1984), infant mortality in the United States in the seventeenth and eighteenth centuries was nearly 16%. Average life expectancy was 32 years (Kunitz, 1984). Stannard (1975) reports that using Andover, Massachusetts, as an example, the average family had 8.8 children but only 5.9 of them were expected to live to adulthood. Saum (1974) reinforces this perspective through his recounting of diaries documenting stress over receiving death notices in the mail. He also notes a conversation between a husband and wife regarding a death witnessed by the husband. Saum writes that the details were not withheld, and in contrast to the muted language of today's death culture, the account was honest and real. He adequately sums up the perspective of death during that time by writing the presence of "[t]hat grimly reminded reservation—that if life is spared—resonated around pre-Civil War America. It went to the self, where perhaps it was most needed; but with palsy-

ing frequency it went to others, to the old who least required reminding, to the sound and the active who might forget, and to the very young who might not understand" (Saum, 1974, p. 37).

Individuals in small communities across colonial America were affected by the passing of their members and were tasked with cooperative laying out of the dead and attending the body. Deceased individuals were laid out in their homes, usually in the front parlor commonly called the death parlor. Friends and family members participated in the preparation of the body. In citing Brigham Nims's 1846 diary, Saum (1974) writes that Nims, though potentially having his first encounter handling the dead, did so with the knowledge of a routinized function. He described how he laid out the deceased and shaved him. Saum also notes the participation of a Maryland store clerk in 1834 who attended the death preparation of a friend, daughter of a friend, and a cousin within a 4-month period. Like Nims, she also participated in the activity of washing and shaving the deceased (Saum, 1974). These acts appear to have been standard practices related to death. Preparation of the body was thought to preserve the deceased's integrity and dignity (Laderman, 1996). The laying out, washing, shaving, and re-dressing were all part of the continuance of a social connection. The re-dressing was often in a winding cloth or sack made by friends and relatives rather than the immediate family. Females were usually in attendance because death was considered a part of the domestic sphere and women oversaw those details (Habenstein, 1962; Zlomke, 2013). Women were midwives, mothers, nurses, and caretakers of the dead. They were present for every stage of life.

Once the body had been prepared, friends and relatives would take turns sitting with the dead so that there was a continuous watch. During this time, attendants would place a block of ice under the corpse or apply vinegar or alum to the skin to aid in preservation. The vigil was to ensure that the individual was indeed dead and had no chance of being buried alive. This practice was the original purpose for what is known as the "wake" in modern American Christian funerals (Laderman, 1996). Once a body had laid long enough for viewing and certainty that the individual was dead, the funeral took place within the home (Earle, 1977; Laderman, 1996). In the intervening time between the death and the funeral, community members would dig the grave. In many cases, burial took place on family farms. Community participants would construct the coffin, dig the grave, and transport the deceased to the resting place (Earle, 1977). Interment sites were often small, family plots on the edge of the property (Bowman, 1977; Earle, 1977). The deceased were kept close to home and tended to by family members.

The funeral service had many variations depending on social status, economic status, availability of clergy, and other factors. After the service, the processional to the burial place begins. Coffins were constructed by family members, friends, cabinet makers, or local carpenters. In some cases, an individual would have the coffin made prior to their death (Laderman, 1996). The coffin was then carried to the burial location, often on foot, though horse-drawn carriages were used if the destination was distant. If a child had died, the coffin was sometimes carried by children. Individuals were buried or entombed. Cremation and embalming were not

known or were thought to be impractical by many people. The event ended with interment of the coffin into the grave and refilling of the soil on top of it (Laderman, 1996). Interactions were controlled and routine, almost banal, with no dramatic reactions. "The old attitude toward death was both familiar and near, evoking no great fear or awe, offers too marked a contrast to ours, where death is so frightful that we dare not utter its name" (Ariès, 1974, p. 13).

Perspective Shift

There are several ideas concerning what caused the drastic shift in the American psyche away from an acceptance of death and the handling of it toward current American perspectives of death as fearsome and polluting. These include the natural, science-leaning views of the Enlightenment, the American Revolution, Evangelism, Puritanism, Unitarianism, and eventually Romanticism. People began to see their lives as explainable and, to some degree, controllable. Perspectives toward death changed as did an attachment to life and an uncertainty about what would come next (Ariès, 1974; Farrell, 1980; Jackson, 1977). Shifts from God to nature to humanity in this welter of changing ideas meant that death became something to sentimentalize, fear, avoid, postpone, or transcend (Farrell, 1980; Stannard, 1975; Zlomke, 2013). This change in perceptions of death was further seen through the ways people physically dealt with it. One of the most interesting patterns is that the death of an individual became less about the deceased and more about the *survivors*: about their happiness and emotional coping; their displays of wealth and status; and their ability to commoditize the corpse and mortuary events.

Over time, people seemed to become simultaneously more and less aware of death. The Civil War's creation of so many dead also created a desensitization of death. Either people became used to it or realized that they had to control their emotional reactions to continue with daily routines (Laderman, 1996). At the same time, changes in religious beliefs made people less certain of a heavenly welcome and more aware that death may be a very real end. Mortality rates dropped as science made discoveries about health, hygiene, and contagions. Interactions with death became so few and far between that the routine, practiced rituals became less practiced. Survivors shifted their energy from the deceased to preservation of their own feelings and happiness (Ariès, 1974). A new separation anxiety became apparent in the reactions toward losing someone. Even tombs and places of visitation and veneration moved from locations of solace to a reminder that someone had passed (Ariès, 1974).

Part of this change in perspective took hold when people began dying in hospitals. The new perspective was a combination of sparing the sick person from death, albeit temporarily, and sparing the survivor from the dead (Blauner, 1966). Sterile institutions took the place of the bedchamber. Strangers (e.g., doctors, nurses) took the place of friends and family at the death. These changes led to a distancing of death and the dead from the living (Ariès, 1974; Blauner, 1966; Laderman, 1996).

After death, the body was given to a mortuary professional rather than taken home to be prepared by the family. The mortuary professional was tasked with completing the duties previously provided by the family such as washing, dressing, watching, transporting, and burying the dead.

These increases in physical and emotional distance from the deceased allowed for disassociation from, and repression of, the grimness of death. Additionally, people began to view the dead body as something toxic and polluting. This perception is thought to have come from multiple lines of influence. As religious views were changing and atheism was increasing, the body became less a creation in God's image and more a vessel for the soul. The body had been separated from the soul and therefore was not of God but of the earth and linked to corruption, decomposition, worms, and dirt (Ariès, 1974). Additionally, there was a transition from family burial plots on private land to church graveyards and burial spaces outside of the town, where there was less attention paid to the process of interring the body. This led to overcrowding and a lack of maintenance resulting in putrefaction sights and smells becoming observable. Decomposition was then connected to hygiene and the epidemics that had previously caused so much death and heartache. A new image of the physical dead body was created as toxic and infectious (Ariès, 1974; Blauner, 1966; Laderman, 1996).

The combination of the need to separate oneself from the death to preserve emotional health and beautify the dead to ignore the inevitable decomposition created an environment perfect for the commodification of the dead. It was easier to let someone else take care of it and there were people willing to do so. Furthermore, society had changed. Urban centers were growing and so were the numbers of dead within them. Families became more nuclearized and separated by distance. Neighbors became less neighborly. Houses got smaller. There was no one to assist in preparations for the dead and nowhere to do it. Jobs were changing and the death of a single individual did not cause the same amount of disruption as the death of someone in a small community had (Bowman, 1977). Someone had to manage the dead and the associated rituals, and cue the funeral director.

Many identify the use of embalming on human cadavers during the Civil War as the beginning of the commodification of the dead and a change in ideas about treatment of the deceased. Embalming was an example of "necessity is the mother of invention." The high number of dead meant that traditional rituals surrounding death could not be honored. Sometimes soldiers were buried where they died, and sometimes by opposing armies, such that it was unknown what kind of burial an individual would receive. This was concerning to family members back home who wanted to provide their loved ones with a proper funeral and burial. Unfortunately, there was no way to transport bodies across long distances without the challenges of decomposition for everyone involved. Embalming, though a relatively unknown process, was thought to be the most hygienic way to slow decomposition (Laderman, 1996).

Early embalming was conducted through arterial injection of a chemical cocktail of the embalmer's creation, often involving arsenic, zinc, mercury, and other chemicals. If the injection could not be performed, the trunk of the corpse was

eviscerated and filled with sawdust, charcoal, lime, cloth, and other materials (Laderman, 1996). Gannal (1840) wrote that embalming was already familiar to the medical community for use on dissection cadavers, as well as by other scientists interested in preserving their biological specimens. Because the process was already in use by some in the medical field, it immediately made embalming a professional science with only qualified professionals able to do it. Because it was expensive, it also was part of the social class divide that became apparent in later funeral rituals (Gannal, 1840; Laderman, 1996).

The time, resources, and space necessary for the treatment of the dead outside of the traditional in-home methods were considerable and, therefore, potentially lucrative business. Women, who previously acted as death attendants, were removed from the process. Treatment of the dead had become a science, which women were not seen as capable of doing. They were denied access to the death trade and their own methods of preparing the dead. "Finally, by funeral directors consolidating all aspects of the death trade under their control, they fully dominated and controlled the economics of the death" (Zlomke, 2013, xvii-xviii). Furthermore, the body and its attendant rituals were becoming a commodity that needed regulation. Various boards of health wanted to know who was dying, how, and when. They wanted to know where they were being disposed of, and how. The agency of private death attending was being removed from dying individuals and families, and placed in the hands of professional strangers (Laderman, 1996).

By the mid to late nineteenth century, American funeral processes began to resemble a service occupation, with a set of tasks and functions organized into a pattern of behavior toward the dead (Habenstein, 1962). Vernacular changed to make discussions of death and processing more pleasant: "passed" instead of "died," and "slumbers" instead of "molders" (Schillace, 2015). "Casket" replaced "coffin" to indicate that the contents were precious (Habenstein, 1962; Laderman, 1996). More recently, "human remains pouch" replaced "body bag."

Cemeteries began to hold influence as places where the rich or the poor were buried. Spaces were delimited to clarify social class with territorial distinctions related to preferential grave plot areas. People competed for space, and ostentatious monument displays carried a sense of status even into death where all was no longer "equal" (Stannard, 1975). With the commodification of mortuary treatment, the poor began to be denied much of the treatment that was routine for rural individuals simply because they could no longer afford it, and instead were disposed of as quickly and cheaply as possible. Middle-class and upper-class people were still given the same treatment of families attending the death, preparing the dead, and transporting them to deposition location but differed in the increasing pomp and festivities, adornment, and ornamentation with increasing wealth (Laderman, 1996). The commodification of death along with its ostentatiousness and sentimentalization has been termed the "American Way of Death" by Jessica Mitford (2000). We argue that the American way of death is further defined by a focus on the survivor rather than the deceased, not unlike the independent, self-serving reputation that Americans have created for themselves. However, the American way of death may be changing.

Contemporary Mortuary Practices in America

The estrangement of Americans from death is reflected in the most common methods of disposal of the dead: burial, cremation, and donation. Often when someone dies, a funeral home is contacted. A representative from the funeral home comes to the home, hospital, or morgue, and the body is taken away. Arrangements are made for the funeral and the body, and then carried out in the absence of family members, who will not see their loved one again until the planned ceremony.

The two most common types of disposal are burial and cremation. In both cases an individual may be embalmed and beautified so that they can be viewed before deposition or cremation. This harkens back to the need for the survivors to feel as if the dead are not dead, but sleeping. Families want to live in their memories of the person and will even ask to have the family member dressed in clothing they find nostalgic, without caring if the clothing fits or not. The desire to make a deceased person appear alive and heathy can result in a lot of beautification work for a funeral home (Doughty, 2014).

Embalming is invasive. First, blood is drained from the body and replaced with a formaldehyde-based chemical meant to slow the process of decomposition. The skin is injected with dyes and fillers to make the deceased look more like they are resting rather than dead. The eyes are glued shut. Makeup is then applied and the deceased is dressed (Doughty, 2014). Embalming is part of a distinctly American way of death (Mitford, 2000). Currently, the United States and Canada are the only two countries in the world that regularly practice chemical conservation of the dead (Bergman, 2017; Welton, 2003).

Traditional burial changed from simple wood boxes to elaborate, lacquered, satin-lined beds. An Internet keyword search will produce hundreds of coffin styles and even the ability to order online. These beautiful burial containers are then lowered into the ground and covered with dirt.

Cremation

Professional cremation was first practiced in the United States in 1876 when Baron Joseph Henry Louis Charles De Palm was cremated (Prothero, 2001). It remained an unusual and rarely used method of body disposition until the early twentieth century; even by 1945, only ~3.7% of Americans were choosing cremation as a form of mortuary treatment. In 1963, two poignant and influential things occurred. The Catholic Church allowed cremation as an acceptable practice, and Jessica Mitford wrote her exposé of the greed of the funeral industry (Mitford 2000). These two events caused a surge in cremations from approximately 5% in 1963 to almost 25% in 1996 (Prothero, 2001). In 2016, for the first time ever, cremation outpaced burial as the most common human remains disposal type in the United States (Sanburn, 2016).

Cremation essentially turns the body's organic matter into a gas. To do this, the body is placed inside a retort (the machine used for cremation) and subjected to temperatures between 1400 and 1600°F. At these temperatures, the body minus the bones turns into a gas and passes into a second chamber in the retort where it continues to combust. Finally, the gasses are vented into the atmosphere. The calcined bones remain in the primary chamber. They are collected, cooled, pulverized into a sand-like powder, and returned to the next of kin (Cremation Association of North America, n.d.).

Two notable critiques of burial and cremation are cost and associated environmental damage. Approximately 30 million feet of hardwood, 2700 tons of copper and bronze, 104,272 tons of steel, 1,636,000 tons of reinforced concrete, and 827,000 gallons of embalming fluid, mostly formaldehyde, are annually buried along with a body in a conventional burial (Barnett, 2018; Harker, 2012). There is enough metal buried under the ground to build another Golden Gate bridge. Around 1800 single-family homes could be built annually with the amount of hardwood that Americans use to bury the dead. There is enough formaldehyde pumped into dead to fill eight Olympic-sized swimming pools each year (Harker, 2012). Formaldehyde is toxic and has been shown to cause multiple types of cancer in funeral personnel (Holness & Nethercott, 1989). Furthermore, formaldehyde, arsenic, glutaraldehyde, and approximately 40 other federally regulated dangerous chemicals used in embalming have been found leaked into groundwater from gravesites, endangering the public (Chiappelli & Chiappelli, 2008; Stowe, Schmidt, & Green, 2001). The irony is while Americans are trying to preserve the dead, they are having a profound deleterious public health effect on the living (Chiappelli & Chiappelli, 2008).

Although cremation is seemingly more environmentally friendly than burial, it is not. A single cremation event releases fossil fuel energy equivalent to a 500-mile car trip (Doughty, 2014). Annually, 600 million pounds of carbon dioxide are released into Earth's atmosphere from the energy needed for the cremains combustion process (Spade, 2016).

The traditional ritual of laying out the deceased in their homes surrounded by family and friends has transformed into a widespread "industrial operation" that relies on large amounts of energy and natural materials, causing substantial environmental damage (Barnett, 2018). America's two most common methods for body disposal are causing more long-term environmental harm than good, but that appears to be changing, even if slowly.

Death Positivity and Acceptance

In their 1965 book *Awareness of Dying,* Glaser and Strauss write, "Death is, after all, one of the characteristic features of human existence, and the people of any society must find the means to deal with this reoccurring crisis. Presumably one way to deal with it is to talk and read about it" (Glaser and Strauss, 1965, p.3). Bernard Crettaz, a Swiss sociologist, was the first to advance the idea of *Café*

Mortel, a Death Café, upon the passing of his wife. A Death Café is not a physical place but rather a space where people can meet, enjoy a refreshment, and talk openly about death. The café part of the term is intentional and meant to create a lighter mood, something warm and inviting rather than dark and heavy. Death Cafés are "pop-up" events, which means that they are relatively spontaneous rather than a scheduled support group event; their purpose is to help people become more comfortable with death through conversations with other people feeling and experiencing similar things.

Crettaz wrote a book called *Cafe´ mortels: Sortir mort du silence* (Crettaz, 2010), which was reviewed by the *The Independent* (Guinness, 2010). John Underwood was working on projects related to conversations about death when he read Crettaz's book (Miles & Corr, 2017). He embraced this idea and decided to pursue the work that Crettaz was doing. Underwood held his own Death Café at his house in Hackney, East London, in September 2011. The popularity of the movement has rapidly increased and Death Café events can be found all over the world (deathcafe.com, n.d.).

In the United States, Caitlin Doughty, a mortician from Los Angeles, California, is arguably the most vocal and recognized individual associated with the movement to change American perceptions about death. Doughty has written a best-selling memoir, *Smoke Gets in Your Eyes and Other Lessons from the Crematory* (2015); hosts a series on YouTube called *Ask a Mortician*; and has founded *The Order of the Good Death* (http://www.orderofthegooddeath.com/), a death acceptance collective, which encourages people to think about death in a positive way. In a 2013 interview with The Independent's Tim Walker, Doughty said that the removal of the corpse from our culture has directly, and negatively, affected Americans' relationship with death (Walker, 2013).

Doughy and members of The Order seek to recreate the relationship with death in America and show people that death is not scary, toxic, and unknown. They are trying to do this through what has become known as *The Death Positive Movement*. This movement works to create a healthy perspective of death as a normal consequence of life and an acceptance that it is inevitable and, therefore, should be embraced rather than ignored (Carroll, 2018). They are attempting a grassroots effort to generate a cultural shift that recognizes death as part of life (Doughty, 2017).

One of the ways that The Order has demonstrated the utility of this perspective is by encouraging families and friends to be more involved with the preparation and handling of their deceased through "home-after-death" care. Home-after-death care poetically takes contemporary Americans back to the early American practices of death handling when family and friends tended to the deceased and managed the related rituals and preparations. The movement has the potential to be effective and to shift American perspectives. The range of body deposition options that have become available over the last couple of decades suggests that people are reconsidering the importance of traditional body-disposal practices.

Contemporary Alternative Forms of Mortuary Treatment

Conservation Burials

Conservation burials are "natural burials"; the bodies are not embalmed or treated with fillers, and do not have cosmetics applied. No wooden caskets, hard metals, or concretes are used at the burial site. The remains are buried in their natural state. The result is no detrimental effects to the environment and no inorganic processing of the body. Unfortunately, most cemeteries will not allow natural burials for a variety of reasons. Instead, large plots of land have been purchased for this specific purpose. The first land preserve dedicated to natural burial in the United States was Ramsey Creek Preservation in South Carolina, opened in 1998. Since Ramsey Creek Preservation opened, at least eight more have been developed across the country. The preservation of this land is maintained by burial plot sale, which is much less expensive than plots sold in conventional cemeteries (Harker, 2012). In conservation cemeteries, there are no headstones or typical burial markers; instead graves may be marked with a large rock, metal disk, or even a local plant. There are even instances in which graves are locatable only by GPS (Doughty, 2016). These measures are meant to keep the land healthy and beautiful in addition to keeping the connection between the living and the dead.

Infinity Mushrooms and the Infinity Burial Suit

For those interested in mediating the natural toxins within the human body, Infinity Mushrooms are an alternative. Jae Rhim Lee argues that although conservation burials are progress toward a more environmentally friendly burial, they do not address the 219 toxins, preservatives, pesticides, and heavy metals, such as lead and mercury that are present in the human body. Jae Rhim Lee and her partner Mike Ma of Coeio sought a way to rid the body of those toxins without releasing them into the environment (Lee, 2011).

Lee's original plan for the Infinity Mushrooms was to create a hybrid mushroom to clean the toxins out of human remains as well as to accelerate the decomposition process, eventually delivering nutrients to plant roots. Lee took common varieties of mushrooms and used an imprinting and selective breeding process to achieve her goal. She took the hair, skin, and nails that she discarded daily and fed them to the mushroom spores. Mushrooms are natural detoxifiers and will consume this kind of detritus. The strongest eaters were artificially selected over many generations and became the Infinity Mushrooms (Coeio, n.d.).

With the new knowledge that the spores would eat human material, Lee pushed her idea further and created a suit infused with the mushroom spores, The Mushroom Death Suit (Lee, 2011). A deceased individual is placed in the death suit before being buried in a conservation-style burial. The mushrooms infused in the suit will

detoxify the remains while in the ground. After the toxins from the remains have been removed, the body can naturally decompose and the soil will be toxin free (Coeio, n.d.).

To do this the mushrooms remove and eliminate toxins through a process called mycoremediation. Organic toxins are removed by breaking down the toxin's molecular bands, thereby neutralizing the toxin. Heavy metals are removed through an ion-bonding process called chelation that makes the toxins innocuous (Coeio, n.d.). In 2015, Dennis White, diagnosed with primary progressive aphasia (PPA), was the first to donate his body to test the Mushroom Death Suit. Upon White's death in September, 2016, his body was buried in the suit (Nai & Meyer, 2016). Coeio has not provided an update regarding the suit's success.

Recomposition

Recomposition is an in-progress, environmentally friendly method of using decomposed human remains to nourish the earth. This is different from natural burial in that it speeds up the decomposition process from several years to 2–4 weeks. The inventor is Katrina Spade, who plans to establish the first Human Composting Facility in Seattle, Washington, by the year 2023. This facility will not just serve as a composting facility but also as an aesthetic space for end-of-life planning and memorial services. Its placement within a large population center is also what makes it unique and innovative because the model recognizes that land is scarce and is proactively seeking a way to solve the problem of human remains disposal.

The recomposition process takes place in a modular, reusable vessel within the facility (Recompose, n.d.). The process starts with friends and family wrapping their loved one in a shroud and carrying them to the top of the core. The core is a multistory structure, holding several recomposition pods. Friends and family will conduct their own "laying in ceremony" where they place their loved one into the core and cover them with woodchips. Within a few weeks, the remains will decompose naturally via microbes and bacteria that break down carbon and protein. The result is an enriched soil. The soil is then returned to the family and they can use it to support new life, if they choose (Recompose, n.d.; Kiley, 2016; Spade, 2016).

Capsula Mundi

Italian designers, Anna Citelli and Raoul Bretzel, collaborated to create a biodegradable burial container to replace commonly used metal or wooden coffins. The capsule would be buried and a tree sapling would be planted on top of the location. As the walls of the capsule degrade, nutrients from the body's decomposition would nourish the tree. The bioplastic used for construction of the capsule is carbon. A human body is high in nitrogen. When the carbon and

the nitrogen mix, they will nourish the microbes that facilitate decomposition. Their original design was only adequate for cremated remains, but there has been work dedicated to creating a capsule for full bodies to be laid inside in the fetal position (Capulsa Mundi, n.d.; Erizanu, 2018).

Citelli and Bretzel's goal is to create life out of death, a heartening future-facing perspective rather than the separation and loss more commonly associated with burial of the deceased. Citelli and Bretzel have taken their perspective a step further by incorporating symbols of life and rebirth such as the egg, tree, and fetal position into product design and marketing. They state that the *Capsula Mundi* project can change the way people think about symbols surrounding death, and then maybe it will move culture a step closer to death positivity (Capulsa Mundi, n.d.).

Alkaline Hydrolysis

Alkaline hydrolysis was first developed in 1888 by Amos Herbert Hobbs (1888). It was officially adopted a century later by the Albany Medical College who was seeking an efficient way to dispose of animal remains. Alkaline hydrolysis allowed the researchers to conveniently dispose of the animal waste directly into the city sewer system (Olson, 2014). In the early 2000s, the company WR2 designed, manufactured, and sold alkaline hydrolysis machines for animal remains disposal. They later built a machine that could be used with human remains, which was used primarily by medical schools for disposal of donated human cadavers (Olson, 2014). It took until 2010 for the alkaline hydrolysis machine to be accepted in the human death care industry, although reservations about the process remain (Wilson, n.d.; Olson, 2014).

Alkaline hydrolysis is a "flameless" cremation process that has a similar result as traditional cremation, but with less environmental damage. Alkaline hydrolysis results in a 75% reduction of the carbon footprint—only 1/8th of the energy needed to complete a traditional cremation. Furthermore, the method is more sustainable for bone fragment preservation; implanted pacemakers and other modification technologies do not have to be removed, and the mercury in dental fillings is "contained" and recycled instead of being released into the atmosphere (Funeral Consumers Alliance of Minnesota, n.d.). The process also uses ingredients found in personal hygiene products such as soap, which makes it less toxic to handle and process (Wilson, n.d.). The sterile solution produced with the bone fragments is sent to a wastewater treatment facility and recycled. The solution itself is an excellent resource for nutrition for anaerobic and aerobic sewage and, therefore, the quality of the treatment center is increased.

The alkaline hydrolysis process starts by putting the body into a basketlike case inside a pressurized, stainless-steel container. Inside the container, the temperature is raised to 350 degrees Fahrenheit and a mixture of 95% water and 5% alkali is added. The combination of pressure, heat, water, and alkali initiates a reaction that quickens the breakdown of the soft tissues. This process takes about 2–3 h. The

result is soft bone fragments and sterile solution, which is drained from the steel container. The solution is sent to wastewater treatment for recycling and the bone fragments are processed and returned to the family (Funeral Consumers Alliance of Minnesota, n.d.).

Donation

Donation is one of the most common alternative methods of body disposal. Derbyshire (2015) notes that tens of thousands of people have donated their bodies to science, averaging about 600 per year. The benefits of body donation for scientific inquiry are undeniable. Human remains are used to train doctors and other health professionals, create safety standards, and establish methods used in the medicolegal system for interpreting crime scenes and testifying in court. The legacy of altruism inherent in body donation to science makes this method of disposal unusual in its societal impact.

Donation requirements and regulations vary by state and county jurisdiction (Saker, 2009). In cases where bodies are donated to medical schools and most other whole-body donation programs, donation arrangements must be made beforehand. For example, donation of a body to a North Carolina medical school requires preregistration. Then, when an individual dies, other requirements must be met. The deceased must have been relatively healthy, fall within weight minimums and maximums, be free of trauma, and arrive at the medical school within a 4–6-h timeframe after death (Donate Life North Carolina, n.d.). The postmortem restrictions for donation to a human decomposition facility are more relaxed but still require several steps. For example, to have a loved one donated to Western Carolina University's (WCU) Forensic Osteology Research Station (FOREST), the outdoor decomposition facility, the pre-donor paperwork must be signed by two witnesses. If a legal next of kin is donating a body after the death of the individual, the paperwork must also be notarized. Stipulations for health, weight, and trauma are less rigid and often decisions are made on a case-by-case basis (Western Carolina University, 2017). Despite the potentially cumbersome process, donation is an important method of body deposition and its positive, long-lasting impact cannot be stressed enough.

Human Decomposition Facilities

Human decomposition facilities provide a means to donate a body to science without the invasiveness of dissection or surgery. As stated, the rules regarding donation to a human decomposition facility are more relaxed than other scientific study programs (e.g., medical schools) and thereby this makes donation an option accessible to a broader range of the population. What makes body donation unique is that,

unlike all the other body disposition methods discussed, human decomposition facilities were not created to offer alternative disposal options. Conversely, they have become an environmentally conscious burial option simply by existing. Human decomposition facilities were created to serve a different purpose but their passive involvement as a natural, alternative disposal option is an interesting and important aspect of their continued relevancy.

The first human decomposition facility in the world was started by William Bass at the University of Tennessee, Knoxville, in 1981. Bass is a forensic anthropologist that had a lifetime of experience he drew from in his recognition that human bodies decompose in unpredictable ways. He knew that modifiers to the body such as insects, animals, and weather could leave distinct, discernable marks. He also recognized that without controlled scientific study, these patterns were conjecture. He had participated in many court cases where it became an issue of his opinion versus the opinion of another scientist. He knew that something had to change and so the first "Body Farm" was started (Bass & Jefferson, 2004).

Human decomposition facilities exist to provide a place for research regarding human decomposition and how decomposition can be interpreted and even predicted. This information is useful for medicolegal professionals to understand how long a person has been dead and what variables might have affected the body in the interval between death, deposition, and discovery. There are currently eight decomposition facilities in the United States and each one exists in a different physiographic zone with different weather patterns, organisms, urbanization, and numerous other variables that influence the way a human body decomposes (Zejdlik, Passalacqua, & Williams, 2017).

In his memoir about his career and founding of the Anthropology Research Facility (ARF), *Death's Acre* (2004), Bass recounts the reservations people had regarding his kind of science and the negative outspoken opinions of his fellow scientists and community neighbors. Even 24 years later (2005) when WCU established the second human decomposition facility in the world, there was pushback from the community. People react in a variety of ways when it comes to how death should be treated—especially when it directly involves them. As the director of the WCU's facility, part of my role (Zejdlik) is to talk about the facility with a range of groups from university administrators to general community members. Each group has a different reaction. Some share their stories of seeing and handling death, and some shrink away from me even as I stand in front of them. You can see the myriad thoughts and emotions people process as they think about the dead, and for those that come out to the facility, see it.

A range of reactions to death draw people to human decomposition facilities. The FOREST facility at WCU is small, and when someone is interested in donating themselves or their next of kin, they speak to a person rather than an answering service. It is a part of the job that is difficult to prepare for, but also offers an otherwise unachievable education in perceptions of death. People donate to the FOREST for many reasons. Most commonly, they want to contribute to something after they have passed. People recognize that their body is a valuable resource and do not want to waste that resource, or the money required, to dispose of it in another

way. Others just see it as the least expensive way to dispose of a body (they only pay for transportation to the facility) and do not care if they contribute to knowledge. Some people like the idea of having their body lying under the trees in the Blue Ridge Mountains while their remains return to the earth. In conversations when someone is being donated posthumously by their legal next of kin, family members express that their loved one always wanted to be donated to science but did not make prior arrangements and therefore could not be donated to a medical school or preferred the less invasive science of decomposition research. Those grieving a loss due to a tragic death say that they want something positive to come from the tragedy. Sometimes family members call back later to see if we are learning from their loved one's donation. This is a side of human decomposition facilities that the public rarely sees. Discussions of "Body Farms" (Bass & Jefferson, 2004) often overlook the important human and emotional aspects of body donation.

WCU's FOREST facility is a relatively non-descript fenced yard on west campus. There are two enclosures, one for observation of the decomposition of bodies on the ground surface, and one for burials. Both enclosures are surrounded by 10-ft-high chain-link fence with barbed and razor wire at the top. The enclosure where bodies are placed on the ground surface also has a 10-ft-high wooden privacy fence just inside the chain link. The tree canopy at this quiet place in the Blue Ridge Mountains is dense enough that drones cannot get a good view of the ground.

When a body arrives at the FOREST it is either buried or placed on the surface. When a body is buried, it is buried naturally, similar to the conservation burial method described previously. A hole is dug and the body is placed in it. Then the hole is backfilled. Nothing is added or removed. The only marker is a wooden stake with the date and identification number assigned to that specific donor. When a body is placed on the surface, it is simply carried to its previously chosen location within the enclosure and laid down face up, with arms and legs at the sides. These individuals are also marked with a wooden stake indicating date and number. Individuals placed on the surface are observed for rates and stages of decomposition via note taking, photographs, and motion-activated cameras. The bodies remain at the facility until they are skeletonized, after which they are recovered and brought into the lab where they are washed, numbered, and curated as part of the research collection.

This type of human remains deposition is entirely natural. Unless specifically required for a research project, no modifiers are placed on the body to increase or inhibit decomposition. Insects and animals are allowed access to the body as part of the natural decomposition process. A decaying body will attract a range of organisms, from large bacteria colonies to bumble bees and butterflies, producing a unique biome. From the moment a body is deposited at the facility, it begins to give back to the earth *and* contribute to science. It is, in a way, a combination of many different mortuary treatments. The body is laid out. It is observed. It becomes a part of nature through consumption (insects, animals) and decomposition. Eventually the bones are washed and placed in a niche (i.e., documented human skeleton collection) for future visitors (i.e., researchers, students).

In further contrast to contemporary American perceptions of death and the assumption that death is the end, human decomposition facilities and forensic anthropologists demonstrate that a dead body is an interminable source of knowledge. The often-repeated phrase, and title of Maples and Browning's (2010) book, *Dead Men Do Tell Tales*, is true. Using methods created from the study of human skeletal remains, forensic anthropologists can estimate age, sex, ancestry, and stature, among other parameters (Christensen, Passalacqua, & Bartelink, 2013). The study of bones has aided in recognizing how various diseases and infections, types of trauma, and repeated activity are represented on the skeletal system. All this knowledge comes together when a forensic anthropologist is asked to help connect an identity to an unknown set of remains. Furthermore, these methods must be continually updated as technology improves and human bodies go through secular change. This means that documented skeletal collections derived from willed body donation programs like the one at WCU remain important and will be consulted repeatedly (Collins et al., 2019). The individuals in the collection will continue to be an important part of scientific research for decades. They leave a legacy in a way that most body disposal options do not allow.

Conclusion

Perspectives regarding death and the treatment of the dead in the United States have gone through several shifts. Early Euro-Americans approached death as familiar and expected. They were not afraid of it. Early treatment of the dead was intimate and carried out by family and close friends who waited with the dying individual so that they would not approach death alone. Once the individual died, family and friends would participate in the tasks necessary to prepare the dead for the funeral and then burial, such as washing, dressing, watching, and transporting.

The Civil War, along with changes in political agenda and religious beliefs, led to a climate that was both desensitized and emotionally devastated by death and the dead. Additionally, America was going through other social changes, such as the nuclearization of families and urbanization, that led to practical adjustments in the treatment of the dead. All of this resulted in a distancing of the living from the deceased. People were not dying as frequently and, when they did, someone else handled it. A loss of the traditional practices associated with treatment of the dead meant that these practices were forgotten. Death became viewed as toxic and, over time, few were willing to care for the dead. However, modern perceptions of death, burial, cost, and the environment are leading people to seek out alternative methods for body disposition.

A range of unique, relatively inexpensive, and environmentally conscious options exist for human remains disposal. One of them is donation to a human decomposition facility. This option allows an individual to be disposed of in an environmentally friendly way that benefits science. Decomposition facilities were not established as a means of alternative burial but to contribute to the science of forensic anthropology.

Although they are passive participants in the trend for environmentally forward burial options, this aspect of their relevance is part of their evolution from niche research facilities to socially aware, community institutions.

References

Ariès, P. (1974). *Western attitudes toward death: from the Middle Ages to the present*. Baltimore, MD: Johns Hopkins University Press.

Arredondo, A., & Capistrán-López, C. (2017). Pedagogy of death in popular traditions and in the institutionalization of the day of the dead in México. *History of Education & Children's Literature, 12*, 297–319.

Barnett, J. (2018). On dying ecologically in the Anthropocene. *The Ecological Citizen, 2*, 23–29.

Bass, W. M., & Jefferson, J. (2004). *Death's acre: Inside the legendary forensic lab-the Body Farm-where the dead do tell tales*. New York, NY: Penguin.

Benítez, B., & Chung, H. (2015). Food for the soul: Eternal co-existence in the Mayan-Catholic traditions of Pomuch, Mexico. *International Journal of Intangible Heritage, 10*, 74–83.

Bergman, J. (2017). The difficult business of dying. *New Republic*, 1–5. Retrieved from https://newrepublic.com/article/146087/difficult-business-dying

Blauner, R. (1966). Death and social structure. *Psychiatry, 29*, 378–394.

Bowman, L. (1977). The effects of city civilization. In C. O. Jackson (Ed.), *Passing: The vision of death in America*. Santa Barbara, CA: Praeger.

Budiman, M. (2013). *Contemporary funeral rituals of Sa'dan Toraja: From Aluk Todolo to "new" religions*. Prague: Karolinum Press.

Capsula Mundi. (n.d.). *Capsula Mundi*. Retrieved from https://www.capsulamundi.it/en/

Carroll, S. (Producer). (2018, August 20). *Episode 10: Megan Rosenbloom on the death positive movement* [Audio podcast]. Retrieved from https://www.preposterousuniverse.com/podcast/2018/08/20/episode-10-megan-rosenbloom-on-the-death-positive-movement/

Chiappelli, J. D., & Chiappelli, T. (2008). Drinking grandma: The problem of embalming. *Journal of Environmental Health, 71*, 24–28.

Christensen, A. M., Passalacqua, N. V., & Bartelink, E. J. (2013). *Forensic anthropology: Current methods and practice*. London: Elsevier.

Coeio. (n.d.). *Frequently Asked Questions*. Retrieved from http://coeio.com/faqs/

Collins, C., Johnson, C., McLawhorn, J., Passalacqua, N.V., Zejdlik, K., Bailey, C. &Williams, J. (2019). The John A. Williams documented skeletal collection. *Artifact Bones Discourse: An interdisciplinary Student Journal, 6*, 27–36.

Conklin, B. A. (2001). *Consuming grief: Compassionate cannibalism in an Amazonian society*. Austin, TX: University of Texas Press.

Cremation Association of North America. (n.d.). *Cremation process*. Retrieved from https://www.cremationassociation.org/page/CremationProcess

Crettaz, B. (2010). *Cafés mortels: Sortir la mort du silence*. Geneva: Labor et Fides.

Derbyshire, D. (2015). Why people leave their bodies to medical research—and what happens. *The Guardian.* Retrieved from https://www.theguardian.com/science/2015/mar/10/body-medical-research-donate-death-science-brain

Donate Life North Carolina. (n.d.) *Frequently Asked Questions*. Retrieved from https://www.donatelifenc.org/content/frequently-asked-questions

Doughty, C. (2014). *Smoke gets in your eyes: And other lessons from the crematory*. New York, NY: Norton.

Doughty, C. (2016, November). *A burial practice that nourishes the planet* [video file] Retrieved from https://www.ted.com/talks/caitlin_doughty_a_burial_practice_that_nourishes_the_planet?language=en

Doughty, C. (2017). *From here to eternity: Travelling the world to find the good death*. New York, NY: Norton.
Earle, A. M. (1977). Death ritual in colonial New York. In C. O. Jackson (Ed.), *Passing: The vision of death in America* (pp. 30–41). Santa Barbara, CA: Praeger.
Erizanu, P. (2018). The biodegradable burial pod that turns your body into a tree. *CNN*. Retrieved from https://www.cnn.com/2017/05/03/world/eco-solutions-capsula-mundi/index.html
Farrell, J. J. (1980). *Inventing the American way of death, 1830–1920*. Philadelphia, PA: Temple University Press.
Funeral Consumers Alliance of Minnesota. (n.d.). Alkaline hydrolysis: Green cremation. *Funeral Consumers Alliance of Minnesota*. Retrieved from http://fcaofmn.org/alkaline-hydrolysis-green-cremation.html
Gannal, J. N. (1840). *History of embalming, and of preparations in anatomy, pathology, and natural history: Including an account of a new process for embalming*. Philadelphia, PA: J. Dobson.
Glaser, B. G., & Strauss, A. L. (1965). *Awareness of dying*. New York, NY: Transaction.
Guinness, M. (2010). Never say die? Far from it in Paris Death Café. The Independent. Retrieved from https://www.independent.co.uk/news/world/europe/never-say-die-far-from-it-in-paris-death-caf233-2121850.html
Habenstein, R. W. (1962). Sociology of occupations: The case of the American funeral director. In A. Rose (Ed.), *Human behavior and social processes* (pp. 225–246). Boston, MA: Houghton Mifflin.
Harker, A. (2012). Landscapes of the dead: An argument for conservation burial. *Berkeley Planning Journal, 25*, 150–159.
Hobbs, A.H. (1888). Process of separating gelatine from bones. US patent 394982. December 5, 1888.
Holness, D. L., & Nethercott, J. R. (1989). Health status of funeral service workers exposed to formaldehyde. *Archives of Environmental Health: An International Journal, 44*, 222–228.
Jackson, C. O. (1977). *Passing: The vision of death in America*. Santa Barbara, CA: Praeger.
Kiley, B. (2016). Seattle could get an Urban Death Project human composter in just 7 years. *The Seattle Times*. Retrieved from https://www.seattletimes.com/life/from-corpse-to-compost-the-urban-death-projects-modest-proposal/
Kunitz, S. J. (1984). Mortality change in America, 1620-1920. *Human Biology, 56*, 559–582.
Laderman, G. (1996). *The sacred remains: American attitudes toward death, 1799–1883*. New Haven, CT: Yale University Press.
Lee, J. R. (2011, July). *My mushroom burial suit* [video file] Retrieved from https://www.ted.com/talks/jae_rhim_lee#t-422763
Maples, W. R., & Browning, M. (2010). *Dead men do tell tales: The strange and fascinating cases of a forensic anthropologist*. New York, NY: Broadway Books.
Miles, L., & Corr, C. A. (2017). Death cafe: What is it and what we can learn from it? *OMEGA-Journal of Death and Dying, 75*, 151–165.
Mitford, J. (2000). *The American way of death revisited*. New York, NY: Vintage.
Nai, C., & Meyer, V. (2016). The beauty and the morbid: Fungi as source of inspiration in contemporary art. *Fungal Biology and Biotechnology, 3*, 10.
Olson, P. R. (2014). Flush and bone: Funeralizing alkaline hydrolysis in the United States. *Science, Technology, & Human Values, 39*, 666–693.
Prothero, S. (2001). *Purified by fire: A history of cremation in America*. Oakland, CA: University of California Press.
Recompose. (n.d.). *FAQ*. Retrieved from https://www.recompose.life/faq/.
Saker, A. (2009). Disposition of unclaimed bodies in U.S. varies by state, jurisdiction. *The Oregonian.* Retrieved from https://www.oregonlive.com/special/index.ssf/2009/06/disposition_of_unclaimed_bodie.html
Sanburn, J. (2016). Cremation is now outpacing traditional burial in the U.S. *Time*. Retrieved from http://time.com/4425172/cremation-outpaces-burial-u-s/
Saum, L. O. (1974). Death in the popular mind of pre-Civil War America. *American Quarterly, 26*, 477–495.

Schillace, B. (2015). *Death's summer coat: What the history of death and dying teaches us about life and living*. Farminton Hills, MI: Pegasus Books.

Spade, K. (2016). When I die, recompose me. [video file]. Retrieved from https://www.ted.com/talks/katrina_spade_when_i_die_recompose_me?language=en

Stannard, D. E. (1975). *Death in America*. Philadelphia, PA: University of Pennsylvania Press.

Stowe, J. P., Schmidt, E. V., & Green, D. (2001). Toxic burials: The final insult. *Conservation Biology, 15*, 1817–1819.

Walker, T. (2013). Death becomes her: Meet the very modern mortician who champions 'cool' funerals. Independent. Retrieved from https://www.independent.co.uk/news/people/profiles/death-becomes-her-meet-the-very-modern-mortician-who-champions-cool-funerals-8627550.html

Waterson, R. (1993). Taking the place of sorrow: The dynamics of mortuary rites among the Sa'dan Toraja. *Southeast Asian Journal of Social Science, 21*, 73–96.

Welton, N. (2003). Embalming toxins. E: The Environmental Magazine. Retrieved from https://www.emagazine.com/embalming-toxins/

Western Carolina University. (2017). Forensic anthropology program and facilities body donation program policies. Retrieved from https://www.wcu.edu/WebFiles/FANT2-BodyDonationPolicies.pdf

Wilson, J. H. (n.d.). The history of alkaline hydrolysis. *Good Funeral Guide*. Retrieved from https://www.goodfuneralguide.co.uk/wp-content/uploads/2013/09/History-of-Alkaline-Hydrolysis.pdf

Zejdlik, K., Passalacqua, N. V., & Williams, J. A. (2017). A force for good: The what, where, and why of human decomposition facilities. *The Pathologist, 43*, 23–26.

Zlomke, B. D. (2013). *Death became them: The defeminization of the American death culture, 1609–1899*. (Unpublished Master's thesis). University of Nebraska, Lincoln, NE.

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T. K. Shackelford, V. Zeigler-Hill (eds.), *Evolutionary Perspectives on Death*, Evolutionary Psychology, https://doi.org/10.1007/978-3-030-25466-7