T

Tinbergen's Four Questions

Ian D. Stephen[1,2,3] and Danielle Sulikowski[4]
[1]Department of Psychology, Macquarie University, North Ryde, NSW, Australia
[2]Perception in Action Research Centre, Macquarie University, North Ryde, NSW, Australia
[3]Body Image and Ingestion Group, Macquarie University, North Ryde, NSW, Australia
[4]School of Psychology, Charles Sturt University, Bathurst, NSW, Australia

Synonyms

Levels of explanation; Proximate and ultimate explanations; Tinbergen's four whys

Definition

The four levels of explanation at which Tinbergen (1963) argued that a behaviour can and should be understood.

Introduction

In one of the founding texts of the field of ethology, *On Aims and Methods of Ethology*, Niko Tinbergen (1963) proposed that a complete understanding of any given behavior necessitates explanation at four different levels (the "four major problems of biology"): causal (or mechanistic), ontogenetic, phylogenetic, and functional. These levels of explanation have variously been referred to as Tinbergen's four questions and Tinbergen's four whys. They can be further classified into proximate (causal/mechanistic and ontogenetic) and ultimate (phylogenetic and functional) levels of explanation, distinctions originally proposed by Ernst Mayr (1961). Proximate levels of explanation consider the mechanisms of how a behavior is produced, while ultimate explanation accounts for why, from an evolutionary perspective, the behavior exists (Tinbergen 1963). This entry will define these levels and briefly discuss their significance for evolutionary psychology.

Causal/Mechanistic Explanations

Causal, or mechanistic, explanations for behavior consider the immediate neurophysiological, hormonal, psychobiological, and environmental causes of a given behavior. Such explanations often concern the necessary and sufficient conditions required to produce the behavior. For example, causal/mechanistic explanations for breastfeeding could refer to the roles of prolactin and oxytocin in milk production and letdown, the role of physical stimulation on the breast and nipple that promotes oxytocin production, and

T. K. Shackelford, V. A. Weekes-Shackelford (eds.), *Encyclopedia of Evolutionary Psychological Science*,
https://doi.org/10.1007/978-3-319-16999-6_1347-1

the relationships between breastfeeding and a mother's heightened neurophysiological response to the sound of her own baby crying (Jonas and Woodside 2016).

Ontogenetic Explanations

Ontogenetic explanations for a behavior concern the development of the behavior across the life span, including cognitive development, learning, and other experiential effects. Ontogenetic explanations for breastfeeding might include the role of early mother-infant bonding and the importance of initial breastfeeding attempts (Jonas and Woodside 2016). Ontogenetic explanations also encompass much more long-term experiential influences on behavior, such as learning experiences surrounding breastfeeding during the mother's own development (Hoddinott and Pill 1999).

Phylogenetic Explanations

Phylogenetic explanations for behavior consider the evolutionary history of the behavior: as it manifests in the extant species in question, and how this has changed over evolutionary time, across multiple speciation events. It frequently includes consideration of exaptations (where structures originally selected for one purpose become co-opted for a different purpose in subsequently evolving forms). Our breastfeeding mother may be understood as breastfeeding her child because humans descended within the mammalian clade and thus inherited the physical (mammary glands, nipples) and physiological (oxytocin and prolactin neuroendocrine pathways) structures that support breastfeeding from ancestors in whom these structures appeared more than 160 mya. A phylogenetic explanation may also consider that mammary glands likely evolved from reptilian abdominal epidermal glands, which were exapted for nutritional purposes as newborn lizards acquired nutrients and immunologic compounds from their secretions (Goldman et al. 1998).

Functional Explanations

Functional explanations of behavior (also referred to as adaptive significance, or current utility, Bateson and Laland 2013) consider the survival value (and ultimately, the reproductive value) of the behavior. They seek to describe the selection pressures that lead to the emergence, shaping, and maintenance of behaviors over evolutionary time. As such, breastfeeding can be understood as evolving in response to selection pressures to provide nutrients and immunocompetence to offspring. In humans, at least, it has also likely been shaped to serve mother-infant bonding functions (Jonas and Woodside 2016).

Tinbergen's Four Questions in Psychology

While much of the discipline of psychology is traditionally focused on proximate explanations of behavior, ultimate, especially functional explanations are the level of explanation most often associated with evolutionary psychology. Tinbergen, however, was clear in his argument that any given behavior can be simultaneously understood at all four levels of explanation, and indeed to fully understand the causes of any behavior, it is necessary to incorporate complete explanations at all four levels (Tinbergen 1963). Indeed, the key insight of Tinbergen's 1963 essay was not simply the content of the four levels of explanation but the complementary and integrative nature of them (Nesse 2013). In spite of its traditionally strong focus on ultimate questions, the discipline of behavioral ecology has more recently shifted toward an appreciation of the importance of integrating explanations across the four levels of explanation (Bateson and Laland 2013). Such integration, however, is still less common within the broader discipline of psychology (Sulikowski and Burke 2015).

Critics of evolutionary psychology (and of adaptive and biological explanations of human behavior more broadly) often mistakenly presume that different levels of explanation are mutually exclusive and competitive. Much confusion, in

particular, surrounds the proximate/ultimate distinction. Stephen Jay Gould, for example, argued that "the [*ultimate*] question, 'what is it for?' often diverts attention from the more mundane but often more enlightening [*proximate*] issue 'how is it built?'" (Gould 1981). Rose and Rose (2001) protest that evolutionary psychologists "insist on... ultimate... explanations when proximate ones are so much more explanatory" (p. 4). Persistent misunderstandings about the complementary nature of proximate and ultimate explanations currently impede an integrative application of Tinbergen's four questions to understanding human behavior.

To return to our breastfeeding mother, critics of evolutionary approaches to behavior may argue that an understanding of the behavior may be satisfactorily provided by a description of the stimulus (her infant crying) and associated neural and hormonal responses to the stimulus [a *causal* explanation] and of the experience and learning surrounding breastfeeding during her own development [*ontogeny*]. A Tinbergian understanding, however, demands that we also consider the evolutionary history [*phylogeny*] of breastfeeding, perhaps through the lens of comparative psychology, and the *functional* value of breastfeeding in providing nutrients and immunocompetence benefits to the infant in order to help him survive and develop successfully in order to pass on his mother's genes to the next generation.

Conclusion

While evolutionary psychologists and other researchers who take an evolutionary approach to understanding human behavior provide valuable insight into the ultimate causes of behavior, it has been argued that adopting a formal Tinbergian framework, considering a behavior at all four levels of explanation, can provide a fuller understanding of the behavior in question (Stephen et al. 2017).

Cross-References

- ▶ Adaptation and Natural Selection
- ▶ Controversies in Evolutionary Psychology
- ▶ Development
- ▶ Field of Comparative Psychology, The
- ▶ Spandrels

References

Bateson, P., & Laland, K. N. (2013). Tinbergen's four questions: An appreciation and an update. *Trends in Ecology & Evolution, 28*, 712–718.

Goldman, A. S., Chheda, S., & Garofalo, R. (1998). Evolution of immunologic functions of the mammary gland and the postnatal development of immunity. *Pediatric Research, 43*, 155–162.

Gould, S. J. (1981). Hyena myths and realities. *Natural History, 90*, 16–24.

Hoddinott, P., & Pill, R. (1999). Qualitative study of decisions about infant feeding among women in east end of London. *BMJ, 318*, 30–34.

Jonas, W., & Woodside, B. (2016). Physiological mechanisms, behavioral and psychological factors influencing the transfer of milk from mothers to their young. *Hormones and Behavior, 77*, 167–181.

Mayr, E. (1961). Cause and effect in biology. *Science, 134*, 1501–1506.

Nesse, R. (2013). Tinbergen's four questions, organized: A response to Bateson and Laland. *Trends in Ecology & Evolution, 28*, 681–682.

Rose, H., & Rose, S. (2001). Introduction. In H. Rose & S. Rose (Eds.), *Alas, poor Darwin: Arguments against evolutionary psychology*. London: Vintage.

Stephen, I., Burke, D., & Sulikowski, D. (2017). Tinbergen's "four questions" provide a formal framework for a more complete understanding of prosocial biases in favour of attractive people. *Behavioral and Brain Sciences, 40*, 37–38.

Sulikowski, D., & Burke, D. (2015). From the lab to the world: the paradigmatic assumption and the functional cognition of avian foraging. *Current Zoology, 61*(2), 328–340.

Tinbergen, N. (1963). On aims and methods of ethology. *Zeitschrift für Tierpsychologie, 20*, 410–433.