EVOLUTIONARY EXPLANATIONS IN PSYCHOLOGY: A PARADIGM FOR INTEGRATING PSYCHOLOGY WITH SCIENCE

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ABSTRACT

Evolutionary psychology has recently developed out of dissatisfaction with the Standard Social Science Model utilised by mainstream psychology. This model focuses on culture and reason as the underlying cause of human behaviour and proposes that the mind is a ‘general purpose learning device’ (Siegert & Ward, 2002). Here the mind is seen as a blank slate at birth, which is subsequently influenced by experience, environment and culture. Biological variables are minimised or ignored. However it seems that all human behaviour cannot fully be explained by the focus on nurture in the Standard Social Science Model; sexual jealousy, parental investment, and mating preferences are examples which are not fully explained by learning or environmental experience. On the other hand, evolutionary psychology, founded on the principles of cognitive science and evolutionary biology, argues that a person’s nature is the primary cause of their behaviour, with the influences of nurture being of lesser importance. According to these principles, evolutionary psychology has been very successful in providing explanations, for example in the areas of human mate selection and parental investment. However evolutionary psychology has received criticism on a number of counts, including its supposed reductionism, and, its reliance on ‘just so’ stories which are untestable, hypothesised scenarios which look to the past in order to explain the evolution of human behavioural features.

With the above mentioned matters as background, this thesis investigated whether evolutionary psychology offers a new paradigm for integrating psychology with science, and if so, how it accomplishes this. In investigating this, conceptions of science, psychology, and evolutionary theory, in particular evolutionary psychology, were examined. More specifically, issues addresses included why evolutionary psychology is dissatisfied with the SSSM, the notion of the mind as blank slate, the nature-nurture paradigm, and the mind as a general purpose learning device. Two aspects of evolutionary theory are described, natural and sexual selection, in terms of their importance to evolutionary psychology. The main arguments of evolutionary psychology as a discipline are outlined, looking at its aims, and the ways in which it combines the disciplines of evolutionary biology and cognitive psychology toward a new integrative model for studying human behaviour. A case study demonstrates how evolutionary psychology offers a useful explanation of mate selection. This thesis then turns to the philosophy of science, setting out the differences between Karl Popper and Imre Lakatos' theories, and focusing on the latter's theory as a model of scientific philosophy which could be useful for evolutionary psychology, including discussing how this could be best achieved. This thesis then sets out various criticisms of evolutionary psychology, including the critique of domain-specific modularity, the focus on the Pleistocene period as problematic, the over-reliance on natural selection, just-so stories, the reductionism of evolutionary psychology, and that it is politically conservative. This thesis concludes that the attempt of evolutionary psychology to combine cognitive science and evolutionary theory has been successful in showing how the integration of psychology into the sciences is not only possible but inevitable.

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INTRODUCTION

Human beings have evolved over millions of years in varying ecological conditions. Through evolutionary forces, we have developed characteristics that have been favourable to our continual reproduction as a species. Along this evolutionary journey, humans have been interested in understanding themselves and others. However, the field of psychology, as an attempt to study the human mind and behaviour, is a relatively recent discipline in the history of human understanding. Psychology originated from its intellectual affiliation with the discipline of philosophy (Ettinger, Crooks, & Stein, 1994; Lykken, 1991), yet just as the other sciences (e.g., astronomy, physics, chemistry, physiology) slowly broke away from the field of philosophy, so did psychology. Before these sciences broke away, philosophers speculated and reasoned about man and the arrangement of the universe (Baum, 1994). In many cases they employed assumptions about God or some other privileged source as the basis for their reasoning. However, the predominant reason for the split of psychology from philosophy can be linked to the rise of evolutionary theory (Buss, 1995). With Darwin's 1859 publication of *The Origin of Species*, the existence and role of God (or other privileged sources) in the account and creation of life was left out, and it was suggested that there were more scientific ways of approaching the problem. Toward the end of the 19th century, psychologists were faced with the problem of defining the 'science of mind', because it was unclear how one should study the mind and its processes (Fodor, 1983). Some psychologists suggested that the philosophical technique of introspection ought to be used, however others were dissatisfied with the subjectivity of introspection, maintaining that as a scientific method it was unreliable and open to personal bias (Rosenberg, 2005). Other sciences, such as physics and chemistry, used objective methods and measurements which could be checked and replicated in laboratories. For example, experiments measured people's reaction times objectively and were thus seen as a great advance over introspection. Psychologists could now do laboratory experiments with the same objective methods as the more reputable sciences. As Plotkin (1998) mentions, “psychology, at least in its origins, was modelled upon physiology in terms of being a laboratory science that seeks explanations of a particular kind” (p. 23). From around this time, the early 1900’s, psychology turned away from evolutionary biology, and behaviourism then came to dominate the field of psychology until the 1970’s (Buss, 1995). Behaviourism was perceived as a more scientific endeavour and stressed that human instinct was not a factor in explaining behaviour and that humans had no innate qualities. Instead learning was said to be the guiding principle of behaviour, and the environment was thought to be all-powerful in shaping behaviour. As such, behaviour, and the environmental variables of which it is a function, constituted the proper subject matter of scientific study for psychologists.

However, after much research there was still dissatisfaction amongst many psychologists. This was especially in regard to the methods and theoretical justifications characteristic of mainstream psychology at the time. The main model in psychology was the Standard Social Science Model (SSSM) (Buss, 1995) which focused on culture and reason as the underlying causes of human behaviour. This model proposes that the mind is a blank slate (or tabula rasa) at birth, subsequently written on by experience, environment, and culture. Biological variables are minimised or ignored. It was clear, however, that all human behaviour could not be fully explained by nurture as maintained by the SSSM (Buss, 1995). This growing dissatisfaction led to a downgrading of behaviourism and a cognitive revolution in psychology. Various theorists found that Behaviourism had not been completely successful in banishing the mind from psychology (Thagard, 1992). For instance, in 1956 George Miller published the paper “The Magical Number Seven, Plus or Minus Two”, which provoked new ways of looking at the nature of information processing. Miller showed that the capacity for human thinking seemed to be limited, with short-term memory limited to seven items plus or minus two. A year after Miller’s foundation article, Noam Chomsky’s book, *Syntactic Structures* (1957) gave rise to linguistics and a psychology of language that was very different to that of the behaviourists. Chomsky argued that the knowledge of language that is acquired so quickly in children should be understood in terms of grammar, rather than as a collection of associations and habits (Thagard, 1992). At the same time Allan Newell and Herbert Simon announced that the development of the human brain was akin to the creation of a computer program that proved theorems in logic (Newell, Shaw, & Simon, 1957). This approach which was cognitive in that it likened the brain to a computer with neural networks, and cognitive processes being likened to various computer programs, which could account for all human cognition. This latter theory led to a focus on using cognitive processing models to study the human mind and behaviour. In this model, the brain awaits input in order to produce behavioural output; the computational ideas suggested how cognitive structures could produce behaviour (Thagard, 2002). The concept of information as something that could be processed by a person or a computer, and the concept of information processing as applied to the human mind, was a major innovation (Thagard, 1992). As Plotkin (2004) remarks,

> The cognitive revolution…allowed psychologists to develop a rich theory of the causes of behaviour in terms of central processes and mechanisms. …now, at last, people could theorise about the existence of different forms of memory, attentional mechanisms, or integrating executive processes, for example, which could lead to predictions and be cashed out into experiments, the results of which were fed back as adjustments to the theory. …it was only with the cognitive revolution that psychology became a science again (p. 130).

With psychology's integration with cognitive science, the conceptual heartland of behaviourism had weakened in force and with this the path opened for the new psychology of evolutionary psychology.

The emergence of evolutionary psychology, which was founded on the principles of cognitive science and evolutionary biology, had as its main line of thought that a person's nature is the primary cause of behaviour, followed by the influences of nurture. Evolutionary psychology maintained that the strict nature vs.

nurture dichotomy was not of value in explaining behaviour as these are not two separate causal processes. Instead the thinking was that nurture builds on nature. Using Darwin's theory, evolutionary psychologists assert that a person's nature has been determined through millions of years of evolution by the processes of natural and sexual selection. These two processes have established the mind's cognitive architecture in order to achieve adaptive survival. In other words, if our physical selves are explainable in terms of evolutionary processes, and if our behaviours are mediated by our physical selves, then evolutionary thinking should be able to explain why we think and behave in the ways that we do. If our ways of thinking and behaving have lead to the continual reproduction of our species, then the psychological phenomena and their underlying mechanisms should be explainable in terms of evolutionary processes.

However, the explanation of such psychological mechanisms continues to be elusive (Crawford, 1998) and the domain of psychology remains largely conceptually fragmented (Lykken, 1991; Tooby & Cosmides, 2005). Although evolutionary theory has recently been employed to explain various psychological phenomena (e.g., perception, consciousness, emotion, motivation, cognition, learning, personality, intelligence; see Gaulin & McBurney, 2004), mainstream psychology has largely resisted the use of evolutionary explanations to date (Buss, 1999; Cosmides & Tooby, 1998). The question of why evolutionary theory has failed to gain widespread acceptance in psychology has recently been addressed (e.g., Crawford, 1998). This question has prompted a renewed interest in evolutionary approaches within psychology, with the objective being to clarify the role and extent that evolutionary explanations can play in psychology. Some (e.g. Buss, 1995, 1999; Caporael, 2001; Sterelny, 1992) argue at one extreme that evolutionary theory is the only viable explanatory account for the diversity of biological phenomena, while at the other extreme, others (e.g. Fodor, 1998; Herrnstein-Smith, 2000; Rose, 2000) argue that evolutionary theory does not furnish convincing or useful explanations. A more recent line of argument is that evolutionary theory offers a unifying theoretical framework for psychology (Ketelaar & Ellis, 2000), and as such, it should play a more prominent role in explaining psychological phenomena. This line of argument maintains that if we better understand the relationship between the central tenets of evolutionary theory and theories in psychology, then such an endeavour will be beneficial for our understanding of psychological phenomena. In this way, evolutionary psychologists seek to provide the conceptual tools needed to emerge from the current fragmented state of psychological theory. For more than a hundred years, the theory of evolution by natural selection has provided a useful heuristic framework which unites the many different facets of the biological sciences. Psychology has no such theory to unite its disparate parts. However evolutionary psychologists claim that their approach may eventually achieve this. More recently, this relationship between evolutionary explanations and psychology has begun to be clarified by a consideration of various philosophies of science (e.g., see Caporael, 2001; Lakatos, 1970; Ketelaar & Ellis, 2000).

This thesis investigates whether evolutionary psychology offers a new paradigm for integrating psychology with science. In this regard, I argue that evolutionary theory offers a coherent, unifying, explanatory framework for psychology, and that evolutionary thinking should have more of a prominent role in psychology than it currently does. I contend that evolutionary psychology has an appropriate scientific method for studying the mind and behaviour, and that it offers a new fruitful paradigm for integrating psychology with science. I reach this conclusion by a more through consideration of a contemporary theory in the philosophy of science.

In order to support my position, I divide this thesis into seven chapters. In the first chapter I discuss the Standard Social Science Model as well as some of its common criticisms. This important model has been the intellectual basis for the social sciences throughout most of the 20th century. While the Standard Social Science Model appeals largely, or only, to environmental influences on an individual's behaviour, evolutionary psychology endorses the view that learned behaviour is the joint product of ‘innate’ equipment interacting with environmental inputs. It is also important to understand some of the criticisms that evolutionary psychologists have made of this predominant model of social science research. To fully understand evolutionary psychology, it is necessary to understand evolutionary theory, and so in the second chapter I give a brief account of evolutionary theory. I describe the main tenets of evolutionary theory; this chapter is sub-divided into two sections: natural selection and sexual selection. This discussion of evolutionary theory provides much of the theoretical basis for the later discussion on evolutionary psychology. Primed with knowledge of the fundamentals of evolutionary theory, chapter three turns to the question ‘What is evolutionary psychology?’. In this chapter, I outline the aims of evolutionary psychology along with its five core theses. Together, these communicate the full extent of the discipline of evolutionary psychology and make clear its structure, framework, and ultimate goals. Chapter four is a case study of mate-selection, included in order to demonstrate evolutionary psychology’s application. In the fifth chapter, I outline two very different theories in the philosophy of science; the first is that of Karl Popper (1959) and the second is that of Imre Lakatos (1970, 1978). Following this, I turn to the next question is whether of not evolutionary psychology can be fully integrated with the rest of science. The sixth chapter examines this question, and asks how this integration can be achieved. I demonstrate that evolutionary psychology can indeed be considered scientific by utilising a Lakatos’ philosophy of science. Although the possibility of integration is strongly supported, there are also some significant criticisms against evolutionary psychology which need to be considered in future research in the field. The seventh chapter addresses these criticisms, which are: the reliance on domain-specific modularity, the heavy weighting on the Environment of Evolutionary Adaptiveness, ignoring other possible causes of evolution, political conservatism, the reliance on “just so” stories, and reductionism.

1. THE STANDARD SOCIAL SCIENCE MODEL

The Standard Social Science Model (SSSM) (e.g; Gaulin & McBurny, 2004) has been the intellectual basis for the social sciences throughout most of the 20th century. It was developed during a period when the natural sciences (including biology, physics, and chemistry) were becoming more and more integrated. In the early 20th century, the social sciences were outside of the unified scientific knowledge system. This meant that they were somewhat unsuccessful as sciences, and they provided limited scientific knowledge about humanity. This situation came about largely because the social sciences failed to recognise the value of connecting to the working methods of the larger body of scientific thought. As Cosmides, Tooby and Barkow (1992) remark,

> The social sciences have largely kept themselves isolated from this crystallizing process of scientific integration. Although social scientists imitated many of the outward forms and practices of natural scientists (quantitative measurement, controlled observation, mathematical models, experimentation, etc.), they have tended to neglect or even reject the central principle that valid scientific knowledge… should be mutually consistent (pp. 21-22).

Nonetheless, the SSSM has a long history, reaching back before the incarnation of psychology to the early philosophers of the Enlightenment (Pinker, 2002). This model stretches back to philosophers such as Aristotle, Locke, Hobbes and Berkeley (Cosmides & Tooby, 1998), and is based on an empiricist line of thinking which emphasises the major importance of environmental influences on behaviour (Buss, 1995).

1.1 The Standard Social Science Model

The SSSM is founded on three interrelated assumptions. These are that the mind is a blank slate, that culture is more important than biology, and that general-purpose learning mechanisms filter experience and account for variations in behaviour.

1.1.1 The mind as a blank slate

The first assumption is that the human mind is a blank slate, or *tabula rasa*, from birth. It is assumed that the mind has no initial content, and is 'blank' until experience begins to shape it. On this view, the mind has no predetermined traits or tendencies, and is a neutral medium in which experiences make their mark. Locke (1690) stated that since ideas are grounded in experience, which varies from person-to-person, differences in opinion arise not because one mind is able to grasp the truth and another is defective, but rather because the two minds have different histories (Pinker, 2002). The behaviourists, for example, were of the view that there were no such things as an infant's talents or abilities (Pinker, 2002); talents and abilities would come later as a result of experience and cultural exposure. Gaulin and McBurny (2004) eloquently make this point: "just as you could scribble anything on the blackboard – a sonnet, your rendition of the Mona Lisa, the reaction pathway of a chemistry experiment – experience can supposedly carve any effect on human psychology" (p. 3). The assumption that the slate is initially blank means that there are no natural, inborn inclinations or tendencies. Those inclinations or tendencies that are seen in adults are assumed to be the result of their unique experiences. In other words, differences in people arise because of differences in their exposure to the environment, including culture which creates their subsequent experiences. Thus, human development is seen as a process whereby the mind is formed through its experience with the social world.

1.1.2 Culture versus biology

Consistent with the first assumption, culture is held to more important than biology in developing the mind. As Barkow, Cosmides and Tooby (1994) emphasise, “the SSSM denies that ‘human nature’ – the evolved architecture of the human mind – can play any notable role as a generator or significant organisation in human life (although it is acknowledged to be a necessary condition for it)” (p. 28). The assumption here is that culture plays a dominant role, with biological constraints on human behaviour seen as minor and unimportant (Gaulin & McBurny, 2004). According to the SSSM, humans have few, if any, instincts and only a few basic biological drives - such as hunger, thirst and sex. Instead, as Cosmides and Tooby (1998) note, the SSSM postulates that “all of the content of mind and behaviour is supplied by socialisation into one’s culture, and so utilises a ‘learning-plus-culture conceptual framework’” (p. 323). The behaviourist, John B. Watson (1925) also argued that instead of sharing a basis in biological humanity, people are greatly influenced by culture.

Given that behaviourism (and other social sciences) denied that the minds of individual people were important (Pinker, 2002), behaviourism banished mental entities such as beliefs and desires, and replaced them with stimuli and responses. The social sciences located beliefs and desires in culture and societies rather than the head of the individual person (Pinker, 2002). However, as George Murdock (1935) famously remarked “cultural phenomena…are in no respect hereditary but are characteristically and without exception acquired’ (Murdock, 1932, p. 200). According to Ashley Montagu (1973), with the exception of infantile reactions and withdrawals, the human being is instinctless. Humans have no instincts because everything they are and have become, has been learned and acquired from their culture. Although we have tendencies and capacities, our ideas, values, actions, and emotions are manufactured products.

SSSM followers took this idea further, they believed that behaviour could be understood independently of biology, without considering the genetic makeup or evolutionary history of the species (Pinker, 2002). This view was that behaviour is the response to external stimuli and environmental factors, not chemical reactions within the brain. Harmful behaviour was neither instinctive nor freely chosen but rather, inadvertently conditioned.

1.1.3 General-purpose learning

The SSSM postulates that experience leads to learning. Adherents claim that there is either only one, or at most a very few, learning mechanisms. To account for all the different types of experiences, these learning mechanisms are characterised as general-purpose in nature. A general-purpose learning mechanism is “one that can handle many different kinds of input information and that can generate many different kinds of output” (Gaulin & McBurny, 2004, p.4). Thus adherents to the SSSM strive to discover how culture and experience, operating by means of one or more general-purpose learning mechanisms, produce variation in human behaviour. General-purpose learning mechanisms are also said to account for all variation human behaviour. It was on this basis that Watson (1925) famously stated:

> Give me a dozen healthy infants, well-formed, and my own specified world to bring them up in and I’ll guarantee to take any one at random and train him to become any type of specialist I might select – doctor, lawyer, artist, merchant-chief, and yes, even beggar-man and thief, regardless of his talents, penchants, abilities, vocations and race of his ancestors (p. 104.).

Thus, general-purpose learning mechanisms are said to filter experience, and account for and generate variations in behaviour. In regard to the SSSM being embraced by psychology, Barkow, Cosmides and Tooby (1992) claim that “the role of psychology is clear. Psychology is the discipline that studies the process of socialisation and the set of mechanisms that comprise what anthropologists call ‘the capacity for culture’” (p. 29). In other words, the task of psychology is to utilise the

SSSM to study the process of the unformed individual's development within their culture, and in this regard, the central concept within psychology is learning.

1.2 Criticisms of the Standard Social Science Model from an evolutionary psychological perspective

Below I discuss five interrelated issues: that the SSSM misunderstands the nature of human development, draws a false dichotomy between nature and nurture, cannot explain environmental effects by general laws of learning, drives a wedge between the natural and social sciences, and lacks an overarching theory of design. My discussion here draws on the extensive critiques of the SSSM by Tooby and Cosmides (1992) and by Gaulin and McBurney (2004).

1.2.1 The Standard Social Science Model misunderstands the nature of human development

The first criticism of the SSSM is that it misunderstands the nature of human development and is based on outdated theories of human development. Human development is seen as a process whereby the mind is a blank slate which forms through its introduction to, and experience with, the social world and subsequent experiences (Tooby & Cosmides, 1992). The mind of the human infant is seen as a content-free mechanism which evolves when brought into contact with its environment. The very idea of a content-free mechanism is seen as inadequate when set alongside the vastly complex tasks the human mind must engage in from a young age, such as seeing, learning a language, and walking.

However, a truly blank slate could not respond to the environment, as it would have no rules for determining how to respond (Buss, 1999). As Gaulin and McBurny (2004) point out, “a blank slate could never learn language; nor could it do much of anything else. Responses are impossible without rules for responding” (p.5). In contrast, human infants learn spoken language easily because their minds are prepared for the experience of language (Hayes, 1951). It is obvious there is a human nature which is not a blank slate. The view of evolutionary psychologists is that the environment only has effects on organisms with certain inherent response tendencies. Tooby and Cosmides (1992) remark, “the claim that some phenomena are ‘socially constructed’ only means that the social environment provided some of the inputs used by the psychological mechanisms of the individuals involved” (p. 89-90). Thus, the social (and cultural) world plays only part of a causative role in the mental organisation of human development. Cultural differences are seen as real and important, however explanatory accounts of culture cannot ignore the underlying evolved psychological mechanisms. Evolved psychological mechanisms provide a necessary foundation for cultural analyses. Evolutionary psychology advocates integration and consistency of different levels of analysis, the cultural and the biological, not just the cultural (Tooby & Cosmides, 2005).

1.2.2 The Standard Social Science Model draws a false dichotomy between nature and nurture

The second issue is the false dichotomy that the SSSM draws between nature and nurture (similarly, genes vs. environment, innate vs. learned, biology vs. culture). The SSSM asserts that behaviour is produced by the immersion of the individual into a culture, with nurture determining human development. The question here is whether a trait is shaped by various experiences in the environment, or whether it is shaped by something deeper; such as person’s genes. The SSSM leans towards the former, however evolutionary psychologists see any attempt to compartmentalise the categories of ‘nature’ and ‘nurture’ as nonsensical, and regard it as mistaken to try and divide the causes of behaviour (Tooby & Cosmides, 1992). Instead, evolutionary psychologists claim that nature and nurture work together in the development of traits; genes work with the environment. For example, mice, dogs, and birds have a different genetic makeup from human beings, and thus their adaptive behaviours to particular environmental stimuli are different to the behaviours a human would exhibit given the same environmental input. However, behaviour cannot be explained fully by the SSSM model’s reliance on cultural input.

Instead evolutionary psychologists view the major causes of behaviour to be genetic. In this way, psychological mechanisms are a result of genetics working with the environment, and the two cannot be separated. Here, it can be seen that nature and nurture are working in tandem to produce behaviour. In essence, the evolutionary psychologist argues that without basic psychological mechanisms, no environmental response is possible: "evolved mechanisms do not prevent, constrain or limit the system from doing things it otherwise would do in their absence. The system could not respond to 'the environment' without the presence of mechanisms designed to create that connection" (Barkow, Cosmides, & Tooby, 1992, p. 38). Richard Dawkins (1982) provided the analogy of making bread. Bread is the result of ingredients and heat; without both ingredients and heat, there would be no bread. However, once the ingredients and heat have interacted, it is then impossible to disentangle their effect, either logically or physically. Similarly, when considering the cause of a trait or behaviour, it is a mistake to attempt separate out nature and nurture.

A similar claim to opposing nature and nurture is that nature sets the limits, but that experience shapes the traits within these boundaries. In other words, nurture builds on nature. For example, a fear of snakes can be observed in small children to exhibit an aversion based on threat. However, small children have not been taught that snakes are dangerous. Although supplemented by experience and learning that snakes are dangerous, the initial aversion is held to be a genetically coded response.

However, it has been said that this approach fails to address the problem of *how* experiences can shape traits (Gaulin & McBurney, 2004). Instead of asking 'is it nature or nurture?', evolutionary psychologists think it more appropriate to ask, 'why does the environment have this particular effect?'. Pinker (2002) has more recently expanded on the nature vs. nurture argument in light of new discoveries relating to brain plasticity, stating that "the brain somehow must change in response to its input; the only question is how" (p. 83). He goes on to explain that "it is not surprising that the discovery of plasticity has given the nature-nurture pendulum a push" (p.84),

1.2.3. Environmental effects cannot be explained by general laws of learning

The third issue arises in the SSSM claim that environmental effects can be explained by general laws of learning. Starting from the assumption that there are no innate structures in the mind, the SSSM sees behaviour as the result of learned responses to the environment. However, evolutionary psychologists believe that learned behaviour is the joint product of ‘innate’ equipment interacting with environmental inputs (Buss, 1995), and as such, no behaviour can be attributed solely to environmental effects. Instead, it is proposed that the brain has certain kinds of structures for learning. To learn, there must be some mechanism that causes this to occur, because learning cannot occur in the absence of a mechanism that causes it. Certain learning mechanisms must therefore be innate aspects of our evolved architecture that reliably developed across all the kinds of environmental variations that humans normally encountered during their evolutionary history. As Buss (2005) puts it, “to get your brain to learn, you would have to arrange the neurons in particular ways. You would have to create circuits that cause learning to occur. In short, you would have to equip your brain with programmes that cause it to learn. The same is true when natural selection is the engineer” (p. 31). Garcia (1981) has demonstrated that some things are extraordinarily difficult to learn, requiring thousands of trials while others can be learned in a single trial. More people learn fear of snakes, heights, spiders and darkness, for example, more easily than fear of cars or electrical outlets, which are currently more hazardous (Buss, 1995). That fear of snakes would have proposed a greater benefit to our ancestors, suggests that this fear is to some extent ‘programmed’ into our minds as a psychological mechanism. Thus, it seems that humans are predisposed to learn some things more easily than others, based on their innate propensity or ‘programming’.

Secondary to this general debate is whether learning mechanisms are ‘general-purpose’ (things like trial and error induction; Herrnstein-Smith, 2000) or ‘domain-specific’ (things like mate preference mechanisms; Herrnstein-Smith, 2000). Evolutionary psychologists argue that there are no general-purpose learning mechanisms because those kinds of mechanisms would not serve any useful purpose (Gaulin & McBurney, 2004). As Don Symons (1992) has eloquently elaborated, there is no such thing as a general solution because there is no such thing as a general problem. In contrast, learning mechanisms, which have themselves evolved, tend to be specialised for particular kinds of evolutionary problems. We should expect our brains to contain specialised modules that are finely tuned to the needs of the organism and that have evolved to solve each of the problems faced by our ancestors (Crawford, 1998). Evolutionary psychologists reason that each adaptive problem has its own solution, and that the human mind has evolved to be a highly complex system of mechanisms which enables the solution of a large variety of different adaptive problems. Because these evolved psychological mechanisms are likely to be large in number and complex in nature, one of the goals of evolutionary psychology is to specify and explain the rich diversity of learning mechanisms that organise the behaviour of humans.

1.2.4. The Standard Social Science Model drives a wedge between the natural and social sciences

The SSSM claims that psychology studies how experience and culture produces behavioural differences, and that there is therefore no room in psychology for the natural sciences, biology in particular. However, evolutionary psychologists argue that this overlooks the fact that biology makes our behaviour possible. Evolutionary psychologists claim that we think the way we do because of our evolved cognitive mechanisms. Their argument is that psychologists, in studying behaviour, are studying the behaviour of biological organisms which conform to the principles observed by biologists. Given that the most powerful principle in biology is the principle of evolution by natural selection (Sober, 1993), the correct conclusion is that a complete explanation of the behaviour of living organisms must involve evolution. This is succinctly put by Gaulin and McBurney (2004) who explain that trying to exempt the behaviour of organisms from the principles of biology is like “trying to exempt the behaviour of atoms from the principle of physics” (p. 13). Thus, the natural sciences, and biology in particular with its central principle of evolution, seem highly relevant to understanding the behaviour of living organisms. Evolutionary psychologists argue that the natural and social sciences are linked and that all of science is a single coherent enterprise based on common assumptions and methods. As Gaulin and McBurney (2004) remark, “science is a single endeavour linked by a coherent set of laws, principles and theories” (p. 13) and “there is no scientifically defensible division between the natural and social sciences. Science is demonstrably one enterprise, not two, and living things are products of evolution” (p. 14).

The SSSM claims that there is no room in the social sciences for the natural sciences has come about largely because of the failure of the social sciences to recognise the value of the working methods of the natural sciences. The social sciences have largely kept themselves isolated from the process of scientific integration (Tooby & Cosmides, 1992). As Cosmides, Tooby, and Barkow (1992) remark, “although social scientists imitated many of the outward forms and practices of natural scientists (quantitative measurement, controlled observation, mathematical models, experimentation, etc), they have tended to neglect or even reject the central principle that valid scientific knowledge… should be mutually consistent” (pp. 21-22). Thus, the social sciences are not conceptually integrated. Conceptual integration (also known as ‘vertical integration’) refers to the principle that the various disciplines within the behavioural and social sciences should make themselves mutually consistent, and consistent with what is known in the natural sciences as well (Cosmides, Tooby, & Barkow, 1992, p.4).

1.2.5 The Standard Social Science Model lacks an overarching theory of design

Traditional psychology is most concerned with mechanism, with *how* questions, while evolutionary psychology focuses on both mechanism and function, or *why* questions as well. Thus, evolutionary psychology provides an added perspective that enriches our current understanding of behaviour. As Gaulin and McBurney (2004) put it, “what is missing in the SSSM, and what evolutionary psychology adds to psychology, is an overarching theory that unifies these findings and allows one to predict them in advance" (p. 14). Rather than explaining behaviour solely in terms of culture and experience, evolutionary psychologists seek to explain why people respond to their environments in the way they do. To do this, they explain why such features have been designed in our species over the course of evolution. Traditional psychology, or the SSSM, is most concerned with mechanism (with *how* questions), while evolutionary psychology focuses on both mechanism and function, (or *why* questions) as well. In other words, rather than explaining behaviour solely by culture and experience, evolutionary psychologists seek to explain more broadly why people respond to their environments in the way they do, and to do this they explain why such features have been designed in our species over the course of evolution.

Thus, the SSSM is seen as an inadequate framework for the social sciences because it fails to take account of new developments in evolutionary biology, human development, and cognitive science. The broad conclusion is that neither 'biology', 'evolution', 'society', nor 'the environment' directly equate to behavioural outcomes "without an immensely long and intricate interleaving chain of causation involving interactions with an entire configuration of other causal elements" (Tooby & Cosmides, 1992, p. 49).

2. EVOLUTIONARY THEORY

Since Darwin's book, *On the Origin of Species* (1859), there has been a huge literature on evolutionary theory. Most of this literature has focused on the principle of natural selection itself, and its explanatory application across a range of domains. However, Darwin's theory of evolution and its application to humans still meets with resistance and misunderstanding (Buss, 1995).

The term 'evolution' refers to a process of change over time. In regard to evolutionary theory, evolution concerns changes in traits of living organisms over many generations, including the emergence of new species with new traits. Darwin played a leading role in rekindling the idea of evolution and applying it to species. For Darwin, evolution meant a slow gradual change from one entity to another. For example, he explained in a series of logical steps how evolutionary processes work by using the illustration of how finch's evolved around the Galapagos Islands. He observed that each island had its own distinct type of finch, each with its own discrete characteristics. He argued that while all the Galapagos finches descended from a common South American ancestor, as they migrated from one island to another in the Galapagos Islands, they encountered varying conditions. Mainland finches were land-dwelling, seed-eating birds that had relatively large strong bills. However on many islands the large seed-eating bill was no longer as advantageous as it was on the mainland. Darwin found that on some islands finches had slender pointed bills for extracting insects, on other islands some had shorter and broader bills for tearing buds and leaves, and on other islands again some used cactus spines in very long straight bills for getting insects out of trees. Darwin's conclusion was that over generations the finches on each island had adapted to the specific environmental conditions present. The finches that possessed traits that were most functional for exploiting resources on their particular island survived and passed on their traits to their offspring until each island had its own distinctly different type of finch. In other words, according to Darwin, the finches' genotypes were shaped by their environment and gradually evolved over time. Darwin's theory rests upon the phenomena of natural and sexual selection. I will briefly discuss these principles.

2.1 Natural selection

Darwin's significant contribution to our understanding of evolution was his account of the mechanism of natural selection as the causal mechanism for explaining evolutionary change. This mechanism enabled Darwin to explain why organisms appeared so well adapted to their local environments. The theory hinged around the idea that all organisms' physical and behavioural traits are the result of a slow adaptive process. In *The Origin of Species* (1859), Darwin laid out the evidence for evolution by natural selection as a rigorous scientific theory.

There are three main components of natural selection: variation, heritability, and selection. Variation refers to a state in which there exists a variety of biological traits within a population. For example, organisms vary in their wing length, bone mass, trunk structure, cell structure, fighting ability, and social cunning. Principal sources of this variation are mutation and recombination. Mutation refers to alterations to individual genes while recombination refers to the endless variety of particular gene combinations produced by sexual reproduction. Some of the ways individual organisms vary confer advantage, others confer disadvantage, and some have little, if any, effect at all. Advantageous and disadvantageous effects are defined by how they influence an individual's ability to survive and reproduce in their particular environments. Thus there are two ways in which organisms vary: they have traits that aid or hinder their survival, and they have traits that aid or hinder their ability to reproduce. For example, greater speed gives a cheetah greater success in pursuing prey in the African plains and a kea's greater social cunning helps it to compete with other birds for limited resources. A large and bright display of peacock feathers helps attract mates, whereas a small body mass hinders reproduction in a gorilla, because small gorillas are lower in the pecking order and have less access to females. The environmental context determines whether a particular trait is advantageous or not for reproductive survival. An organism with an especially short lifespan can dramatise the process of natural selection (Ridley 2002). For example, the HIV virus, an organism which exhibits both inheritance and variation, as well as a high degree of mutations within the overall population, takes two days to reproduce.

Heritability is closely linked with variation and refers to the ability of variations to be inherited through reproduction. Variation in this sense refers to the differences within a local population of the same species at any one time. The types of variants may mean that an individual is more or less suited to challenges within its environment. However natural selection only occurs when these variations are also linked to something which influences potential reproductive success, in something which biologists term “fitness”. The successful combination of attributes will likely be passed down at a genetic level, as individuals with this combination will produce more offspring. Individuals are more likely to resemble their genetic parents (i.e., vary less) than others in the same population. For example, with a strong family resemblance, a son may have his father’s nose or a daughter may have her mother’s eyes or cheekbones. These traits have been pasted down from generation to generation through the genetic material (i.e., DNA) that is transmitted from the parents. Heritable traits vary in regards to the fitness they confer; variations may predispose an individual to be more or less likely to survive and reproduce than those who do not possess those traits.

Natural selection is the process whereby variations that individuals possess make them more or less well adapted to their environment and therefore more or less likely to survive and pass on those variations. The process of natural selection, which created the delicate specializations of human physical structure, has been a very long, drawn out series of “accidental” appearances of certain genetic traits, which were advantageous for survival, and passed on through reproduction. As Write (1994) comments:

> The thing that is massively more probable than the charmed lineages that populate the world today – an uncharmed lineage, which reaches a dead end through an unlucky break – happened a massively larger number of times. The dustbin of genetic history overflows with failed experiments…. Their disposal is the price paid for design by trial and error. But so long as

> that price can be paid – so long as natural selection has enough generations to work on, and can cast aside scores of failed experiments for every one it preserves – its creations can be awesome. Natural selection is an inanimate process, devoid of consciousness, yet it is a tireless refiner, and ingeneous craftsman. (pp. 25-6).

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Thus, advantageous heritable traits are more likely to remain in, and spread through, a population because those traits help the organism to survive and reproduce. As Wright (1994) further remarks:

> If within a species there is variation among individuals in their hereditary traits, and some traits are more conductive to survival and reproduction than others, then those traits will (obviously) become more widespread within the population. The result (obviously) is that the species' arrogate pool of hereditary traits changes (p. 23).

2.2 Sexual selection

Sexual selection is a form of selection, which works together with natural selection. Sexual selection can be defined as the selection for traits that increase the ability to attract and mate with members of the opposite sex. Sexual selection can be seen to have an effect on genes in a species in which mating success has evolved to depend on the ability of one sex to attract the other with a display of dance and colour, such as some Birds of Paradise, or song, such as some species of frogs or the ‘booming’ of the New Zealand Kakapo. This form of selection also operates in species in which competition between the members of the same species eventually results in winning the right to choose a mate or mates.

It is advantageous to distinguish between factors that drive natural and sexual selection since this explains why, in some species, males have evolved highly specialized and often ornate traits which, while beneficial to mating, seem to hinder an organism’s survival. For example, peacocks have flamboyantly coloured tails which can be detrimental to survival because they are costly to produce, attract predators, and impair their ability to escape. However, their bright tails are also attractive to female mates, a factor which increase their reproductive success (Buss, 2005). Sexual selection over many generations drives such adaptations in the following ways. Inter-sexual selection refers to traits that one sex prefers in the opposite sex, and it is usually a result of females selecting for males of high genetic quality. This is the mechanism behind the Peacock’s tail, the Kakapo’s boom, and the frog’s call. It is also why being tall or having blond hair is valued in some human cultures, because having these preferential characteristics increases a person’s chance of being selected for reproduction by the opposite sex.

Intra-sexual selection, on the other hand, refers to competition among members of the same sex for mating access to the opposite sex. The existence of genetic size differences between sexes in a species could be seen as a fairly reliable indicator of this mechanism at work. In the elephant seal population, for example, males are much larger than females, and there is a distinct social hierarchy in the male population which is directly linked to the ability to breed (Zuk, 2002). Likewise, male gorillas compete by slapping water or banging their chests in order to demonstrate their dominance to other males, and thus gain preferential access to females (Zuk, 2002). Those species in which polygamy, rather than monogamous mating habits, are the norm, are more likely to display intra-sexual selection. This occurs because as there is direct competition among males for the right to mate, which sets conditions for advantageous traits to develop by sexual selection.

The traits in question are the manifest solutions to adaptive problems, and show the results of the mechanisms whereby sex-specific characteristics can evolve in a species under sexual selection (Buss, 2005). Both inter-sexual and intra-sexual selection amalgamate with reproductive success, which is defined as the ability of an individual to increase the representation of its genes in the population (Cartwright, 2000).

Darwin (1859) himself summarized natural selection concisely as “multiply, vary, let the strongest live and the weakest die” (p. 263). Thus, the bottom line of evolution by natural selection is survival and reproductive success relative to others. This mechanism of natural selection explains both how and why evolutionary changes happen over time; it explains why organisms have characteristics that serve them well in the context of their environments. The conclusion is that individuals best suited to their environment within a population will pass on more traits than those who are less suited, and the population's heritable makeup will adaptively change over time. Advantageous traits will become more common, while disadvantageous traits will become less common. Natural and sexual selection thus provide a causal account of the relationship between adaptive environmental challenges and the "design" features of various species, including humans.

3. WHAT IS EVOLUTIONARY PSYCHOLOGY?

Evolutionary psychology has derived largely out of dissatisfaction with the Standard Social Science Model and various challenges to more current psychological paradigms, in particular to that of behaviourism (Buss, 1995). Also important has been the impetus provided by Sociobiology (Wilson, 1975), a very similar discipline which has grown up within biological science. Evolutionary theory is important in understanding human behavior as it provides psychology with a means of explaining the nature and organization of the mind, just as it has provided explanations for other physical phenomena (e.g., Darwin's finches). Evolutionary psychologists view psychology as a branch of biology, and as such, it studies brains, their evolution, how brains process information, and how the brain's information-processing programmes generate behaviour (Cosmides & Tooby, 1987). Thus, the scientific tools and methods developed in biology are used in psychology to understand the human mind and behaviour.

The foundations of evolutionary psychology reach back to Darwin. Although Darwin barely alluded to the implications of natural selection for human psychology, in the final chapter of the *Origins of Species* (1859), he speculated that psychology "will be based on a new foundation, that of the necessary acquirement of each mental power and capacity by graduation. Light will be thrown on the origin of man and his history" (p. 458). By this Darwin meant that psychology will come to embrace the tenets of evolutionary theory and apply them to the bigger picture of human evolution. He further provided the logical foundations for the future development of evolutionary explanations of psychological phenomena in *The Decent of Man* (1871).

However, the tenets of evolutionary theory are not being upheld by many, and evolution psychology is often overlooked and rejected. The convenient use of the causal relationship between evolution and behavior is often made, while at the same time neglecting a crucial link – that of a psychological mechanism (Cosmides & Tooby, 1987). This is crucial because the casual link between evolution and behaviour is only made possible by a mediating factor, a psychological mechanism.

Cosmides and Tooby (1987) describe a psychological mechanism as the human's innate processing system which connects the evolutionary process to particular manifested behaviors. It is these psychological mechanisms that generate behaviours and have evolved over generations through interactions with the environment.

Past attempts at applying evolutionary theory directly at the level of behaviour, rather than using it as an heuristic guide for discovery of innate psychological mechanisms, has lead to limited effectiveness in adopting evolutionary theory (Buss, 1995). These attempts to find evolutionary invariants at the level of behaviour have created a series of difficulties, one of which includes the optimality of behavior. Contrary to the normal stream of scientific research, natural selection theory does not predict invariance in the behavior of different individuals. Rather it predicts that the behavior of different individuals will vary enormously (Cosmides & Tooby, 1998) and, in some, appear far from optimal.

Due to conflicts between the interests of individuals, each selected to promote its own inclusive fitness, an outcome cannot, in principle, produce results that will be optimal for both individuals. Hamilton (1964) proposed that the original definition of fitness did not encompass all possible ways of successfully passing on one's genes, and instead proposed that the term 'inclusive fitness' was a more fitting description. According to Hamilton, inclusive fitness is not a property of an individual or an organism, but rather a property of its actions or effects. It can be viewed as the sum of an individual's reproductive success plus the effects the individual's actions have on the reproductive success of his or her genetic relatives (Buss, 1999). For example, it is possible for a person to pass on their genes by helping brothers and sisters, nieces and nephews to survive and reproduce. Thus, the behaviors of individuals cannot be understood in isolation. Individuals adapt to their situation by using their best strategies; these may incorporate many factors such as size, health, aggression and the ability to accrue resources. Individuals with the same psychological programming may manifest different behaviors in response to different information they derive from the environment. However, for a behavioral mechanism to be selected, it need not be of advantage under every conceivable circumstance. It need only be of benefit on balance, and thus, must be advantageous more often than not. In other words, natural selection cannot be expected to produce behavioral responses that maximize fitness under every imaginable circumstance. It depends largely on how adapted the individual is to their particular situation. This is the result of species adapting to specific or similar situations in evolutionary history.

Without a focus on the psychological mechanism in natural selection, the application of evolutionary theory to human behavior was impoverished. As Cosmides and Tooby (1987) remark, “natural selection cannot select for behavior per se; it can only select for mechanisms that produce behavior” (p. 280). To illustrate this point, they use the analogy of the digestive system. Natural selection’s role here has been to rearrange tissues and molecules to form our digestive system. This rearrangement has had particular effects, and it is the presence of these effects that has determined whether each adaptation has been selected for use or not. In other words, natural selection has provided us with the food processing machinery (i.e., enzymes), however the operation of the food processing machinery which results in digestion is the effect of the functioning of mechanism *per se*. Analogously, behaviour is the effect of the functioning of psychological mechanisms. This effect cannot occur in the absence of a mechanism for producing it. However, researchers have been unwilling to explore psychological mechanisms, as exploration of the neurophysiologic aspects of behavior is a difficult area and one in which only a limited amount of research resources are available. Instead, Cosmides and Tooby (1987) have suggested that an alternative to the neurophysiological approach is the characterization of psychological mechanisms in terms of their ability to processing information. Behavior is elicited by both information we gain from the environment, and by how we process that information. Natural selection has provided this information processing machinery to produce behavior, just as it provided food processing machinery to produce digestion. Behavioural outputs differ from informational inputs, as the information processing machinery that maps informational input onto behavioral output involves a particular psychological mechanism.

Evolutionary theory can be consistently applied to tackle many of the problems that have appeared and which obstruct progress, in the social sciences. Behavioral sciences in particular have faced setbacks because they have based their investigation on finding systematic patterns which do not exist. As humans are the product of evolutionary processes, their characteristics are embedded in the evolutionary process. This is why evolutionary psychologists aim to study psychological mechanisms. This emphasis on psychological mechanism provides the fundamental difference between the approaches of sociobiology and evolutionary psychology.

3.1 The aims of evolutionary psychology

As evolutionary psychology utilizes the basic theoretical principles of evolutionary theory, it takes the view that the inherited architecture of the mind is the product of evolutionary process. In this regard, the principal focus of evolutionary psychology is to understand the cognitive mechanisms of the mind through understanding how such mechanisms evolved via the processes of natural and sexual selection. By appealing to cognitive mechanisms, as opposed to interpreting the outward signs of human behaviour as has been the traditional focus in psychology (e.g., behaviourism), the focus and aims are on explaining mental mechanisms rather than on behaviour.

In searching for what causes behaviour in an organism, evolutionary psychologists employ the notions of *proximate* and *distal* (or ultimate) explanations. A proximate analysis of behaviour is an attempt to explain *how* an organism comes to exhibit a pattern of behaviour, whereas a distal analysis is characterised as an attempt to explain *why* these behaviours occur from an evolutionary perspective (Mayr, 1961, 1982). In other words, proximal explanations explain *how* psychological mechanisms operate, and refer to the individuals' physiology, development and environmental stimuli in explaining the cause of behaviour. In contrast, distal (or ultimate) explanations explain *why* psychological mechanisms evolved, positing that these occurred through natural and sexual selection. These explanations refer to the function of the psychological mechanisms *per se*, and their role in solving particular adaptive problems. For example, proximate explanations include things such as a person's psychological mechanisms, their developmental history, learning, and environmental stimuli. Distal explanations, on the other hand, include things such as the ancestral environment, sexual, and natural selection (Siegert & Ward, 2002). A proximal analysis will look at an individual organism and its immediate environment without recourse to evolutionary theory, while a distal analysis will proceed on the assumption that the organism's behaviour results from selection in the populations from which the organism descended (i.e., the species history).

With evolutionary psychology's focus on the mechanisms underlying behaviour, instead of the behaviour itself, it has been interested in distal as well as proximate explanations. This aim is an important strength of evolutionary psychology in that it explains behaviour in terms of *both* proximate and distal causes (Siegert & Ward, 2002), whereas traditional psychology focuses on proximate causes (i.e., culture and experience as the cause of behaviour). However, as Durrant and Ellis (2003) point out, distal and proximate explanations are not independent, as they inform and influence each other. In this sense, "discerning the evolved function of a psychological mechanism, for example, should aid in discovering how the mechanism works – that is, understanding how evolved function can generate hypotheses about proximate mechanisms and causation" (Durrant & Ellis, 2003, p. 24). Thus, evolutionary psychology provides a more comprehensive explanation, as in addition to a proximal explanation, it also provides an ultimate explanation which offers an additional perspective for understanding human behaviour.

However, evolutionary psychology also has a broader aim. In addition to the scientific mapping of our evolved psychological mechanisms, evolutionary psychology also "includes the project of reformulating and expanding the social sciences in light of the progressive mapping of our species' evolved architecture" (Tooby & Cosmides, 2005, p.6). In this regard, the aim is to narrow the discrepancies between the behavioural and social sciences and to repair the situation where "evolutionary biology, psychology, psychiatry, anthropology, sociology, history, and economics largely live in inglorious isolation from one another. … (as) theories in the behavioural and social sciences are rarely evaluated on the grounds of conceptual integration and multidisciplinary, multilevel compatibility" (Cosmides, Tooby & Barkow, 1992, p.4)

3.2 Combining evolutionary biology and cognitive psychology

Evolutionary psychology has developed out of a fusion of the two disciplines of evolutionary biology and cognitive psychology. As such, some of the origins of evolutionary psychology are embedded in the sciences of evolutionary biology and cognitive psychology.

Evolutionary biology is the application of the theory of evolution by natural selection in order to explain the ways in which living things have evolved over time through adaptation to their environments (i.e., the process of natural selection explains biological evolution). For instance, evolutionary biologists maintain that humans are descended from apes and ultimately share a single common ancestor with all other living things. Evolutionary biology came about when the theories of natural selection, genetic drift and mutation were articulated by mathematicians in the early 20th century and brought about a unification of biology and evolutionary studies (Cosmides, Tooby & Barkow, 1992). Evolutionary biologists studied the physical structures of humans just as they studied the physical properties of animals and plants, assuming that such structures arise through the pressures of selection. However, the focus for biologists was not the human mind; they studied the physical aspects of humanity, with the discovery of the gene giving more support to the findings of evolutionary theory. Evolutionary psychologists on the other hand, were trying to unlock the links between physical and mental structures.

A second origin of evolutionary psychology was the science of cognitive psychology. Cognitive psychology explains thought and emotion in terms of information and computation (Buss, 1995; 1999). Cognitive psychology's main premise is that behaviour is caused by mental states (such as beliefs and desires) and that the mind is like a computer; it is seen as a series of modular information-processing mechanisms (Dennett, 1996). Cognitive psychology built on the advent of the computer and the application to the human mind of the language of information-processing (Dennett, 1996). As Tooby and Cosmides (2005) note, “a cognitive description specifies what kinds of information the mechanism takes as input, what procedures it uses to transform that information, what kinds of data structures (representations) those procedures operate on, and what kinds of representations or behaviours it generates as output” (p. 29). In other words, the metaphor of computation made the language of describing the mind as a series of programmes that process information possible, and thus cognitive psychology sees human mental processes as a series of information processing mechanisms. The “brain’s evolved function is computational – to use information to adaptively regulate the body and behaviour – so computational and informational formalisms are by their nature the most appropriate to capture the functional design of behaviour regulation” (Cosmides & Tooby, 1998, p. 14). Thus, psychology looked at the mind as a series of mechanisms or programmes, and psychologists sort behaviour to understand the information processing machinery in our brains in order to understand the casual underpinnings of human performance.

3.3 Evolutionary psychology is not human sociobiology

Evolutionary psychology is not the same as the discipline of sociobiology. Edward Wilson (1975) attempted to organise thinking about evolutionary biology by integrating cellular biology, investigative neurophysiology, ethnology, comparative psychology, population biology and behavioural ecology. Wilson was suggesting that the same principles of behaviour could be applied to all species, both humans and animals, and he utilised and synthesised theories developed in other sciences and the social sciences (e.g., inclusive fitness theory, theories of parental investment and sexual selection) in order to explain human nature. In this sense, both sociobiology and evolutionary psychology have a core focus on evolutionary theory. However, evolutionary psychologists differ from sociobiologists by suggesting that the emphasis of fitness maximisation in sociobiology is not an adequate explanation for behaviour (Buss, 1999). Evolutionary Psychology has a different perspective on the role of evolved psychological mechanisms and the ways in which they operate. Instead of explaining behaviour in terms of fitness maximisation, evolutionary psychologists suggest that we need to account for ways in which the ends (behaviour) sometimes do not follow simply from the means (psychological mechanisms). In essence, humans are adaptation executors, not fitness pursuers. Evolutionary psychologists hope that mapping the computational architecture of the mechanisms will give a better theory of behaviour, while relying on predictions derived for fitness maximisation will give a very impoverished and unreliable set of predictions about behavioural dynamics (Cosmides & Tooby, 1998).

3.4 The core theses of evolutionary psychology

Utilising the principles evolutionary theory, as well as evolutionary biology and cognitive psychology, and directed by the aims described above, evolutionary psychology is comprised of five main interconnecting components: computationalism, adaptationism, modularity, a unique methodology, and what is referred to as the Environment of Evolutionary Adaptedness (EEA). These five commitments support evolutionary psychology's central assumption that the human brain is comprised of a large number of specialized mechanisms that have been shaped by natural selection over vast periods of time to solve recurrent information-processing problems faced by our ancestors (Symons, 1995). It is from these core components that evolutionary psychology builds a theory of the human mind and behaviour.

3.4.1 Computationalism

Evolutionary psychologists utilise the language of cognitive psychologists in their efforts to understand the mind as a computational mechanism. In this regard, cognitive psychologists use the term 'mind' to refer to an information-processing account of the way the brain works. Evolutionary psychologists came to realise that they needed to comprehend the information-processing ability of the human brain in order to understand the causal underpinning of human performance. With this approach, it has become common for psychologists to describe the brain as “a system that processes information – a computer made out of organic compounds rather than silicon chips” (Barkow, Cosmides & Tooby, 1992, p. 8). A computer processes information by taking in information (input), processing that information, and providing an output. It is argued that this is an appropriate model for the human mind which takes input from the environment (sensory information), processes it (makes complex transformations of the information), and then generates an output (thought, behaviour). Thus, evolutionary psychologists posit that the human mind consists of a set of evolved information-processing mechanisms embedded in the human nervous system.

Based on the work of David Marr (1982), Cosmides and Tooby (2001) argued that cognitive psychology should be anchored in computational theories. In their words,

> A computational theory specifies what the problem is and why there is a device to solve it. In short, it specifies the function of an information processing device. As information processing devices are designed to solve problems, they solve problems by virtue of their structure and hence to explain the structure of a device, you need to know what problem it was designed to solve and why it was designed to solve the problem. This in other words means that Computational Theory is a theory specifying what functional characteristics a mechanism capable of solving that problem must have (p. 162).

Computational theory considers specific information processing problems, including the constraints of natural selection theory. These problems should be made explicit as they form the building blocks of psychological theories (Cosmides & Tooby, 1987). However, by itself computational theory is not enough to establish accurately how a mechanism solves a specific adaptive problem, because a particular problem may have many different solutions. For example, warm blooded animals must solve the problem of thermal regulation in order to survive. Dogs do this by evaporation from their protruding tongues, whereas humans achieve it with sweat glands distributed throughout the body. Computational theory itself does not provide a shortcut to conducting scientific experiments to test hypothesis about how organisms solve problems. It does, however, describe successful solutions to adaptive problems. Computational theories are able to exclude from consideration the thousands of possibilities that fail to solve an adaptive problem. For example, one such constraint in humans is that the relevant information for solving an adaptive problem must have been a recurrent feature of a human ancestral environment (Cosmides & Tooby, 1987). Natural selection rigidly constrains the patterns of behaviour that can evolve in such domains, and thus provides insights into the structure of the cognitive programmes that produce these patterns of behaviour.

Discovering the structure of complex cognitive programs requires a great deal of theoretical guidelines. Marr (1982) suggests, therefore, that the computational theories of each information processing problem must be developed before progress can be made in experimentally investigating the cognitive programmes that solve them. Computational theory specifies the nature of an informational processing problem by incorporating constraints on the way the world is structured. These constraints provide sufficient information to allow processing to succeed. The production of behaviour that respects constraints imposed by the evolutionary process is a cognitive programme’s adaptive function; and, it is the reason why it was selected, the reason it could supersede other cognitive programmes and spread through the population to become a species typical trait. It is important to note that the specificity of constraint imposed by the evolutionary process does not in itself constitute a complete computational theory. These constraints merely define what counts as adaptive behaviour. Cognitive programmes are the means by which behaviour, adaptive or otherwise, is produced, whereas computational theory addresses the question of what kind of cognitive programmes an organism must have if it is to behave adaptively. Although natural selection theorists often do not think of their theories as defining information processing problems, this is precisely what they do. For example, to benefit kin in accordance with the constraints of kin selection theory, an organism must have cognitive programmes that allow it to extract certain specific information from its environment. Knowing that an organism has some means of distinguishing kin from non kin may not enable us to identify the specific structure of the cognitive program, but it does help to narrow down the hypotheses. The cognitive program responsible must be sensitive to environmental cues that correlate with kin. Frequently, only a few sufficient cues from the environment will be available. Researchers can, therefore, easily pinpoint which cues are used by the organism. Discovering which cues will later illuminate other procedures in information processing. For example, early exposure suggests an imprinting process, whereas facial similarity suggests a phenotype matching procedure. Slowly but surely, the cognitive programme responsible for kin selection can be mapped. However, if the research is blind to function, there will be no means by which the program can be understood. The organism’s behaviour will be random with respect to the constraints unless it has some means of extracting relevant information from the environment.

A clearly specified computational theory is also needed as it provides a test of adequacy that any proposed psychological theory must be able to pass. In this instance, the computational theory allows one to test the cognitive program to discover whether it is strong enough to produce adaptive solutions. According to Cosmides and Tooby (1987), any proposed cognitive system must be powerful enough to produce adaptive behaviour while not simultaneously producing maladaptive behaviours. Therefore, our cognitive programmes must be constructed in such a way that they somehow lead to the adaptive results, specified by evolutionary theory on the basis of the information available. This test of accuracy allows researchers to eliminate many hypotheses such as the general purpose learning theories that were popular in psychology’s past. This is how natural selection theory can be used to develop computational theories of adaptive information processing problems.

3.4.2 Adaptationism

It was suggested above that computational theories of information processing problems must be developed before progress can be made in experimentally investigating the cognitive programs that solve them. However, cognitive programs still have to be selected by the process of adaptation, as the function of these programs is to assist the organism to adapt to the environment, that is, to solve adaptive problems.

Adaptationism is the process by which natural selection produces various designs, called ‘adaptations’, which aid in reproduction. Grace (2001) defines adaptations as “inherited characteristics that arise in a species through natural selection because they facilitate reproduction. They are genetically inherited and have the primary function of solving adaptive problems. The hallmarks of adaptations are qualities like complexity, economy and precision, that point to evidence of special design” (p. 3). Thus, an adaptation is an inherited, and reliably developed characteristic that came into existence through natural selection because it enhanced survival or reproductive fitness during the period of its evolution.

The function of an adaptation is to increase reproductive fitness. For reproductive function to be effective, an organism will have to solve many problems posed in the environment, for example, food choice, mate preference, and avoiding predators. Such information from the environment has to be processed through computational theory mechanisms, and guided by adaptation before the genes incorporate input from the environment into a neural design. In short, adaptation shapes the psychological mechanism of an organism.

Evolutionary psychologists (Samuels, 2000; Symons, 1995) have suggested that human psychological mechanisms may be likened to Darwin’s finches’ adapted beaks. Humans face different kinds of environmental problems for survival, which in turn has caused humans to develop specific psychological mechanisms, which are termed adaptations. In order to fully understand the function of adaptation, it is important to understand that selection is not a random process, and that adaptations are formed slowly and are costly.

Firstly, selection is not a random process. Adaptation according to Crawford (1998) is goal directed, and Williams (1966), in support of this idea, states that an adaptation is the effect of response to selection. Four natural processes are known to cause evolution or changes in gene occurrence in a population. However selection is the only one that can create an adaptation and the only one that is not a random process. The other three, mutation, drift and gene flow, are all random, and Buss (1999) describes these as lacking “the necessary creativity because their action is random relative to individuals’ environmental problems” (p. 278). As Thornhill (1998) mentions, “an adaptation is a phenotypic feature that is so precisely organized for some apparent purpose that chance cannot be the explanation for the feature’s existence” (p. 547). In a sense, each adaptation is the archive of data of the selection that made it. These data are in the functional design of the adaptation. To discover the purposeful design of an adaptation, then, is to discover the kind of selection that led to the adaptation. Saying that the selection of adaptation is not random means that adaptative problems select for adaptation. In other words, adaptive problems act as the selection agent of adaptation. Over evolutionary time, more and more design features accumulate to form an integrated structure or device that is well engineered to solve its particular adaptive problem.

Secondly, adaptations are formed slowly and are costly. The natural pace of evolution is measured in generations, and traits cannot spread any faster than an organism in the population can reproduce. Thus, the pace of evolution is governed by the pace of reproduction. For humans, the generation time from birth to reproduction is roughly 25 years (Buss, 1999). Compared to the generation time of bacteria, which can be as little as 20 minutes, humans evolve much slower than other organisms. The time it takes for reproductively successful mutations to arise and spread in the population, is often taken to be roughly 1000-10,000 generations; for humans, that equals about 20,000-200,000 years (Hagen, 2005). Adaptations also form slowly as natural selection can only choose naturally occurring alternatives; it cannot create entirely new variants. To select means to choose from existing possibilities. Adaptations are costly in that they have a variety of costs which are associated with assembling the trait during development and with its maintenance. The materials and energy used for the adaptation could have been put to some other use, however, traits give a reproductive benefit sufficient to justify its cost.

Thus, natural selection is constantly changing organisms as it shapes them for reproduction, and those that reproduce pass on their traits to the next generation. For instance, bat sonar, the human eye, and the cheetah's agility were all a product of natural selection because they solved an immediate environmental challenge, such as obtaining food, avoiding predation, or avoiding danger (Gaulin & McBurney, 2004). These designs, and naturally occurring variations among individuals, are consistently being tested against the environment. Thus individuals have adaptations because they enhance the fit between the individual and their environment, and such a fit increases their chances of reproduction. Cosmides, Tooby and Barkow (1992) explain this point:

> The more sensitive retina allows one to see predators faster, the new digestive enzyme allows one to extract more nutrients from one's food, the new learning mechanism allows one to find food more efficiently. Individuals who exhibit such design modifications will be likely to have more offspring, and their offspring will inherit these traits and pass them on by reproduction. Eventually, the entire species will exhibit this feature as part of its genetic makeup. This is Darwin's theory of natural selection, which selects the most adaptive solutions to environmental problems and incorporates them into the structure of the psychological mechanism (p. 9).

In other words, if a trait is helpful in solving a particular adaptive problem in the individual's environment, this trait will be passed down through the individual's offspring because it is adaptive. In this way the process of natural selection can be imagined, retrospectively, to design the organism's physical structure over time. Natural selection provides a causal account of the relationship between adaptive problems and the particular design features of organisms.

3.4.3 The environment of evolutionary adaptedness

If the brain is an information processing machine, in order to understand how the information is processed, we need to first understand what the input is. The input is in fact the adaptive problems that our brains evolved to solve in past environments; not those in the current environments. Thus, in order to understand the design of the mind, we are required to understand the environment of evolutionary adaptedness (EEA).

The EEA is the environment in which humans were hunters and gatherers of resources in the wild (Cosmides & Tooby, 1997). The EEA for humans is loosely characterized as the Pleistocene period - the two million year period that our ancestors spent as hunter-gathers in the African savannah (Buss, 1995). This was the environment in which humans evolved over millions of years. This being so, many of our current adaptations are geared to life in the EEA as they were designed to solve the problems that confronted our ancestors, rather than meet contemporary challenges. In present day society, we live in environments where many aspects are new compared to that of the EEA: rapid travel, artificial lighting, permanent settlements, etc, for example, these environmental changes and challenges are recent compared to the vast period of evolutionary time, and this time span is certainly not long enough to facilitate adaptive responses to these new conditions in human minds or bodies. As Tooby and Cosmides mention:

"The few thousand years since the scattered appearance of agriculture is only a small stretch in evolutionary terms, less than 1% of the two million years our ancestors our ancestors spent as Pleistocene hunter-gatherers. For this reason, it is unlikely that new complex designs – ones requiring the coordinated assembly of many novel, functionally integrated features – could evolve in so few generations" (Tooby and Cosmides, 1990)

Thus, as Hagen (2005) remarks, “the structure of an organism’s EEA can be a masterful guide to the structure of the organism, including its brain” (p. 156). This environment, and its conditions, defined the adaptive problems the mind was shaped to cope with; in the case of humans, hunter gather conditions, rather than modern conditions.

To demonstrate why evolutionary psychologists study the EEA, consider the popular example in evolutionary psychology of the widespread fear of snakes that humans hold. This fear is largely unjustified, as most of us spend our lives in industrialised, suburban areas, in which we are never exposed to snakes. Habitation in these areas is relatively recent in evolutionary terms. The vast majority of human evolution was spent in the Pleistocene environment where there would have been frequent encounters with venomous snakes. A fear of snakes, which would generate snake-avoidance behaviours, is well designed for those environments. Further, if there was a genotype that was selected during the Pleistocene, it would still be present in modern human populations, as there have been too few generations since the Pleistocene for genetic evolution to eradicate the genotype. Thus, the wide-spread fear of snakes is a product of a mind that is adapted to the conditions of human evolution during the Pleistocene. Pinker (2002) argues that there are similarities for many human fears, such as; heights, storms, carnivores, strangers, and blood. Pinker also argues that in modern society, the sight of a car or gun should evoke more fear than that of a snake. However, there have been too few generations since the inventions of either of these two items for selection to proliferate any genotype for a fear of either.

This is why evolutionary psychologists focus on hunter gatherer societies rather than on modern society; our psychological traits are those of the hunter gathers, because possessing these traits advanced reproductive success in ancestral environments. The explanatory power of evolutionary psychology emerges from the concept of the EEA, for the structure of the ancestral environment is the basis and content for evolutionary psychology.

3.4.4 Modularity

Evolutionary psychologists focus on studying the EEA and on developing and testing models of the psychological adaptations (mechanisms and behavioural strategies) that may have evolved as solutions to environmental challenges (Cosmides, Tooby & Barkow, 1992). By doing so, they hope to identify the selection pressures that might have shaped the evolution of certain traits in our ancestral past. Evolutionary psychologists do so because the mind is seen as a computational mechanism that consists of many domain-specific psychological modules. These evolved information-processing mechanisms embedded in the human nervous system are specialised for solving specific adaptive tasks. Because these mechanisms are helpful in solving particular adaptive problems in the organism's environment, they enhance reproductive fitness and are passed down through the organism's offspring. Thus, a central assumption of evolutionary psychology is that the human brain is comprised of many specialized psychological mechanisms that were shaped by natural selection over vast periods of time to solve the information processing problems faced by our ancestors (Ketelaar, 2002). The EEA was so rich and heterogeneous during the time of our ancestors that in order to sort and process the vast amount of input, our brains developed modularity. EP hypothesise that psychological mechanisms take the form of modules. The notion of modularity, draws on the work of Jerry Fodor (1983), whose book Modularity of Mind provided a basis for this research program (Scher & Rauscher, 2002). These modules are defined as specific-purpose mini-computers which are each dedicated to solving certain problems relating to particular aspects of survival and reproduction (Buller, 2005). Modularity can be defined as the proposition that the mind contains many, functionally isolatable sub-units, each specialised to process different kinds of information (Buss, 2005). Modules themselves can be further defined; they are domain-specific in that they solve particular related problems which differ between modules. They each develop without direct instruction in the problem domain, which is because modules embody innate knowledge; that is, they come to a problem already knowing a lot about it. Furthermore, the information within each module is isolated from cognitive processing occurring in other parts of the brain. This isolation in turn allows for relatively faster processing (Buller, 2005). The properties that modules contain, strongly resemble what were traditionally called instincts. Cosmides and Tooby describe these purpose-specific computational systems as learning and reasoning instincts (Buller, 2005).

The two most central properties of modules are the fact that they are domain specific and informationally encapsulated. These two properties will be further discussed in this next section. Firstly, domain specificity is an important part of many biological and physiological adaptations. EP argues that domain specificity is also a very important property of psychological adaptations as well. The human body is massively modular; the heart serves the specific function of pumping blood through the body, the kidney serves the specific function of extracting waste nitrogen and the lungs serve the function of providing the body with oxygen. As our body has adapted with domain-specific organs, so has our brain adapted with domain specific modules, each of which relates to specific aspects of survival and reproduction. The most important feature of the modules is the fact that they are domain specific as opposed to domain general structures. The domain is a subset of the environment in which the organism operates (Scher & Rauscher, 2002).

By saying that a cognitive structure is domain specific, one is stating that it has evolved to solve a specific class of problems. Just like a Swiss army knife, which has many parts specific for certain tasks, the brain has certain modules for solving specific problems (Badcock, 2003). Structures which are domain specific may have advantages over those which are domain general, such as the ability to process information at a faster rate in a more detailed fashion. Evolutionary psychologists believe that the flexibility of the mind does not stem from a flexible, domain-general mechanism, but rather from many specific modules (Scher & Rauscher, 2002). Some evolutionary psychologists claim that modules can be differentiated from one another because they require qualitatively different rules for the solution of their corresponding adaptive problem (Scher & Rauscher, 2002).

Just as there is no one computer program which can solve all of the computer problems, there is no one module which can solve all of the psychological problems – in order to solve specific problems, specific knowledge, and thus specific modules, are needed (Scher & Rauscher, 2002). Because many computer programs are required, so are many modules required. Transformations of information are just as complex as any physical transformation and require equally complex mechanisms to complete the task. Thus psychological adaptations are likely to be just as specific as any other adaptation.

Secondly, the modules are information capsules. Evolutionary psychologists believe that the problems faced by our ancestors in their environment led to the development of hundreds, if not thousands, of these domain-specific modules. Being so specific, the modules are seen as being informationally encapsulated (Fodor, 1983) This means that each module is specialised to process a specific kind of input, and thus has a functionality which is contained within the module and is specific to it. In order to solve problems, minds combine modules – for example, a friendship module, a grammar acquisition module, a sexual attraction module, a fear module and so on (Barkow, Cosmides & Tooby, 1992).

Thus, evolutionary psychology holds the perspective that "humans have a faculty of social cognition, consisting of a rich collection of recurrent adaptive problems posed by the social world" (Hagen, 2005, p. 162). Thus, each of the specific-task solving modules, work separately in order to produce a final goal or coordinated functional outcome such as phenome recognition, syntax acquisition, object recognition or colour constancy. Rather than the mind being seen as a mere learning device that is programmed by culture, the mind is viewed as a set of highly specialised, content-rich, domain-specific mental modules

3.4.5 The methodology of evolutionary psychology

Evolutionary psychologists discover evolved psychological mechanisms by engaging in a systematic process of reverse engineering, which is guided by evolutionary theory (Tooby & Cosmides, 2005). In comparison to forward engineering, which involves designing a particular thing for a particular purpose or to serve a particular function, reverse engineering involves starting with a final working design and taking it apart in order to discover how it works (Ketelaar, 2002). In this way, evolutionary psychologists are engineers working in reverse.

Reverse engineering, the general method of evolutionary psychologists, is the process whereby we attempt to figure out what a machine was designed to do and how it works by looking at the machine's structure and hypothesising that it was designed to fit a number of specific functions. As part of the process of reverse engineering, evolutionary psychologists attempt to identify the key environmental problems of our ancestors in the Pleistocene environment, which would have posed challenges to survival and that needed to be solved to ensure the continuation of the species. In order to produce evidence of a fit between a mechanisms design and its proposed function, an evolutionary psychologist needs to identify an aspect of the organism's development or behaviour as an adaptation based on the following three criteria (Tooby & Cosmides, 2005, p. 28). Firstly, an organism has many design features that are very well suited to solving a particular ancestral problem, secondly, that these are unlikely to have arisen by chance, and lastly that they are not better explained as having developed to solve another particular adaptive problem. From this position, a researcher then hypothesises the existence of a psychological mechanism/s which would be needed to deal with these problems. They then explain how these physical and cognitive processes would produce output in behaviour and in human social and physical development. For example, by utilising scientific techniques, evolutionary psychologists test for the presence of a particular cognitive process under analysis. A successful test would give a positive result for the existence of an adaptive cognitive mechanism based on the solution of a particular problem a human would have faced in the EEA. Tooby & Cosmides (2005) explain this as such:

> There is a systematic method which can be used in evolutionary psychology for trying to understand unknown properties of the mind

> using the concept of good design based on adaptive properties. This starts with the researcher isolating an adaptive problem which may have been encountered by our ancestors, and developing a model of the kinds of computations necessary for solving that problem, with an emphasis on good design. Based on this, hypotheses can be made around the kinds of programs which might have evolved in response to the problem. Then the hypotheses are tested using a range of experimental methods from cognitive, social and developmental psychology, and other disciplines (p. 28)

They elaborate on this process by suggesting that in order to investigate cognitive mechanisms, the first step is to identify and isolate the adaptive problems that our ancestors would have been required to solve in their environments (i.e., the hunter-gather environment in the Plesitocence period). The next step would be to construct a theory of the specific cognitive mechanism that would solve a particular adaptive problem. With this theory of the specific cognitive mechanism we can then hypothesise about the kinds of programmes which might have evolved in response to a particular adaptive problem, and then explain how the mechanisms would be manifest in our development and behaviour. On this basis, we then utilise a range of experimental methods from cognitive, social and developmental psychology to test the existence of these cognitive mechanisms.

To summarise the main components of evolutionary psychology, evolutionary psychologists focus on studying the environment of evolutionary adaptiveness and on developing and testing models of the psychological adaptations (mechanisms and behavioural strategies) that may have evolved as solutions to environmental challenges. By doing so, they hope to identify the selection pressures that might have shaped the evolution of certain traits in our ancestral past. Evolutionary psychologists do so because the mind is seen as a computational mechanism that consists of many domain-specific psychological modules. These evolved information-processing mechanisms embedded in the human nervous system are specialised for solving specific adaptive tasks. Because these mechanisms are helpful in solving particular adaptive problems in the organism's environment, they aid reproduction and are passed down through the organism's offspring. Thus, a central assumption of evolutionary psychology is that the human brain is comprised of many specialized psychological mechanisms that were shaped by natural selection over vast periods of time to solve the information processing problems faced by our ancestors. The example of human mating provides a good example of evolutionary psychology's components and methods.

4. CASE STUDY: HUMAN MATING STRATEGIES

To date, evolutionary psychologists have been very successful in mate-selection research. The following case study discusses one of their most prominent research projects in mate-selection and explains how their methodology is beneficial in gathering empirical evidence to support their theories.

Evolutionary psychologists look at how males and females undergo mate-selection in today's society. Studies have shown that males and females have different preferences when selecting a mate. However, when comparing females across cultures, their preferences are very similar. The same has been found for males. Evolutionary psychologists maintain that the preferences are 'universal', which means that they are observable, across all cultures, throughout social classes, religious groups, all ethnic groups, and all relevant ages of the life cycle (Buller, 2005). For example, across cultures, males "express a desire for females younger than they are" and place higher importance on beauty and youthfulness (Buss, 1999), whereas females express a desire for men older than they are, and desire a mate with "good financial prospects" (Buss, 1999). These findings indicate that the preferences for mate-selection are not learned, but rather have an evolutionary basis.

Evolutionary psychologists can use reverse engineering to identify the psychological mechanisms governing human mate-selection. They first need to identify the adaptations formed by the selection pressures generated by the EEA. The next step is to identify the various strategies used in mate-selection, and from there to identify the psychological mechanisms involved in these strategies. This example will be presented in three sections: firstly, the adaptations developed from the selection pressures of the EEA, secondly how parental investment can explain what causes males and females to use different strategies when selecting their mates, and finally a discussion of the importance of understanding psychological mechanisms in mate-selection in order to make predictions of various behaviours, such as jealousy.

4.1 Adaptations for mate-selection

First, evolutionary psychologist's use reverse engineering to look at the hunter-gather Pleistocene period in order to understand why humans have particular cognitive mechanisms for specific mating strategies. We have seen that all organisms have been naturally selected for their ability to successfully reproduce and pass on their genes (Buss, 1999). As there is no way to directly study the hunter-gatherer society, evolutionary psychologist's make the assumption that natural selection created adaptations that increased our ancestors' reproductive success. Further theories are developed and tested to provide support for this core theory of natural selection. This assumption of natural selection is the highest level of the evolutionary theory. Evolutionary psychology requires a middle-level theory in order to test the highest level theory for understanding human mate-selection. This middle-level theory is that of parental investment, and it has been used to support the mate-selection theory.

4.2 Parental investment

Evolutionary psychologists have used parental investment theory to understand how humans choose their mates. The theory focuses on the sex differences in parental investment which lead to sex differences in mating strategies (Buss, 1999). The theory posits that, because males and females invest differently in the production of offspring, they will employ different criteria when choosing a mate, which relate to their ability to be a parent. One such hypothesis builds on the sex differences in time and energy devoted to the production and care of individual offspring (Buss, 1995). Generally females invest more, and males less. According to Trivers (1971), "the greater parental investment of females makes them a valuable reproductive resource" and males will compete for access to this resource. Thus, the sex that invests more in offspring (typically females) will be more discriminating when choosing a mate, and the sex that invests less will be more competitive with other members of that sex for sexual access to the higher investing sex. As a consequence of their smaller investment, males are more aggressive and compete more vigorously for reproductive access to females (Buss, 1999). They are also less discriminating in mate choice, willing to mate more quickly, and with more partners (Buss, 1999). It is hypothesised that all these aspects occur so that males benefit reproductively from doing so. However, in our own species, a substantial investment in parenting is made by both sexes, because in order to successfully produce and raise a child in the long-term, both men and women invest heavily in the child, and so the theory of parental investment predicts that in humans both sexes should be choosy and discriminating when forming long term partnerships. It is only when a pair bond is formed, as in humans and birds, that we find a similar amount of parental investment from both the mother and father.

Another such hypothesis of the theory is that because women are strictly limited in the capacity to reproduce, men will prefer to form partnerships with more fertile females, and thus father more offspring. Because men have chosen more fertile females in the past, they have evolved a preference for fertility, and thus, psychological mechanisms that enable men to recognise certain characteristics of fertility in women. This includes women who are physically sexually attractive, and generally younger. Trivers (1972) maintains that the hypothesis that men prefer younger women is based on the assumptions that:

1. During the evolutionary past, the preference for certain physical properties of young women was a tendency which could be passed down from generation to generation.
2. Males who preferred younger women reproduced more than other males.
3. Natural selection evolved psychological mechanisms for the preference of younger women.
4. Genes for this preference became established in human gene-pools.

Thus, the criteria for choosing a mate centred on the woman’s capacity to have children. This was complicated, as there are no obvious outward signs of fertility in human females. The emphasis thus shifted to males learning to recognise the signs of fertility, which were based on the observable cues, such as youth and health. Evolutionary psychologists take the view that what men desire is not youth or health per se, but that these features are associated with reproductive value and fertility. The evolutionary psychological explanation is that men desire young women because over evolutionary time, youth has constantly been linked with fertility and reproduction. In other words, the adaptive problem of survival and reproduction for males has been met with the psychological mechanism that selects for youth and health. In contrast, females have evolved preferences for males high in social status who have an ability to contribute resources, and for men who show a willingness to invest in women and their offspring. Women of the hunter-gather period were faced with the vulnerability and stress of a nine-month pregnancy and much longer period of child rearing. Thus, they benefited from choosing a mate with greater access to resources, because this helped them to solve their adaptive problems of both survival and reproduction. Thus selection pressure led to the evolution of the adaptive psychological mechanisms for this preference. Therefore, given that the process of choosing a mate is based on different adaptive criteria for men and women, we can expect that different cognitive mechanisms have evolved in men and women.

4.3 Jealousy prediction

If these hypotheses about parental investment are supported, then evolutionary psychologists can predict the evolved psychological mechanism of human jealousy. Here evolutionary psychologists are interested in whether male sexual jealousy varies in intensity according to the magnitude of male parental investment, or whether female jealousy decreases as a function of decreases in a males resources. An evolutionary analysis shows that the sexes will differ in the weight they give to the cues that trigger sexual jealousy (Buss, 1999). As predicted, men give more weight to cues that signal sexual infidelity, whereas women give more weight to cues which signal emotional involvement with another person. Sexual infidelity matters more to men because they could be tricked into helping to raise the children of another man. On the other hand, emotional involvement is more important for women because it may lead to desertion by the man, abandoning them and their offspring.

Thus, by posing a more specific question about jealousy that focuses on the triggers for jealousy, the empirical findings of the evolutionary psychologists have isolated a sex-difference in jealousy which had previously gone unnoticed. This finding is an example that shows that humans have evolved cognitive mechanisms specific to the sex-linked adaptive problems they recurrently faced over evolutionary history. As a result, male jealousy appears to be more sensitive to sexual infidelity, whereas female jealousy is more sensitive to emotional infidelity.

However, questions still remain as to whether evolutionary psychology is scientific in its endeavour to study the human mind and behaviour. There is also the question as to whether evolutionary psychology can integrate with the rest of science and whether it provides an efficient strategy for doing so. These questions are addressed firstly, by a fuller consideration of the philosophy of science.

5. PHILOSOPHY OF SCIENCE

This chapter discusses two influential philosophies of science: those of Karl Popper (1959) and Imre Lakatos (1970, 1978). The purpose of discussing these two particular philosophies of science is that there has been a long history of an empiricist philosophy of science in psychology, and Popper's philosophy of science has often been cited by psychologists. I discuss Lakatos's philosophy of science because it is a more contemporary philosophy of science which is more applicable to psychology, especially evolutionary psychology, and has the potential to make psychology a more scientific enterprise.

This theoretical discussion is necessary as there are questions as to whether evolutionary psychology is scientific in its efforts to study the human mind and behaviour. A number of authors in fact consider evolutionary psychology not to be a scientific enterprise (e.g., Buller, 2005; Panksepp & Panksepp, 2000). These writers assert that the methods used by evolutionary psychology in order to generate and test evolutionary explanations are simply not good enough to be considered part of the science of evolutionary biology (Ketelaar & Ellis, 2000). The main claim is that evolutionary psychological theories are largely based and built upon assumptions which cannot be effectively tested, and thus the data cannot be considered as scientific. For example, evolutionary psychology has been accused of being 'untestable' (Gould, 2000), 'reductionist' (Rose, 1998), and that it relies on speculation about an EEA that we know little about (Siegert & Ward, 2002). In other words, evolutionary psychology uses hypothesised adaptationist scenarios that look into the past in order to explain evolution of a physical or behavioural feature (Siegart & Ward, 2002). In doing this, it is claimed that evolutionary psychology fails to achieve the goal of providing the conceptual tools for emerging from the current fragmented state of psychological theory.

However, I suggest that by embracing a Lakatosian philosophy of science evolutionary psychology can be considered scientific. Moreover, I maintain that evolutionary psychology can utilise this philosophy of science to integrate effectively with the rest of science. Thus, a fuller consideration of these two philosophies of science is warranted.

5.1 Popper's philosophy of science

Karl Popper (1959) rejected classical empiricism (Rosenberg, 2005). This is the view in philosophy of science that knowledge is derived from experience, in particular from experimentation (Rosenberg, 2005). According to this view, the scientific method requires that hypotheses be tested against the observations of the world, rather than from reasoning or intuition (Rosenberg, 2005). Instead, Popper demarcated science from pseudoscience by introducing the notion of falsificationism. Here scientific explanations consist of statements (or hypotheses) that are empirically tested to determine whether they "support" the data (are corroborated) or are inconsistent with the data (are falsified). As Popper (1959) has commented:

> We seek a decision as regards these (and other) derived statements by comparing them with the results of practical applications and experiments. If this decision is positive, that is, if the singular conclusions turn out to be acceptable, or verified, then the theory has, for the time being, passed its test: we have found no reason to discard it. But if the decision is negative, or in other words, if the conclusions have been falsified, then their falsification also falsifies the theory from which they were logically deduced (p. 33).

In other words, the method of falsification serves to evaluate the scientific status of particular hypotheses and predictions. According to Popper (1959), a theory should be considered scientific only if it is falsifiable because the truth content of theories cannot be verified by scientific testing; they can only be falsified.

The cognitive scientist Alan Newell (1973, 1990), has argued that psychology has largely utilised a Popperian philosophy of science in order to discover truths about the mind by way of revealing particular falsehoods. Newell argued that with such an approach the mind is revealed by accumulating negative knowledge about what the mind is not and does not do. From this base of negative knowledge, positive knowledge about how the mind is and what the mind does do (how it operates) is inferred by considering various explanations that are left unrefuted. Essentially Newell argued that Popper's strategy was not an efficient strategy for advancing positive knowledge about how complex mental processes operate. Null hypothesis testing was seen as a specific problem in that it merely allows the researcher to calculate the probablility of rejecting the null hypothesis when it is in fact true. Newell believed that the slow rate of progress, and a lack of cumulative progress, in psychology is directly due to the acceptance of an empiricist philosophy of science, in particular the strategy of null hypothesis testing. Therefore he suggested that psychology ought to replace the discriminating approach of a Popperian philiosophy of science with a different, more productive, philosophy of science.

Whilst the method of falsificationism was seen as useful for evaluating the scientific status of specific hypotheses and predictions, others also saw falsification as inappropriate for directly evaluating theories and the meta-theoretical assumptions that generate such predictions and hypotheses (e.g, see Ketelaar and Elis, 2000). In the words of Lloyd (1979), a meta-theory "provides a guide and prevents certain kinds of errors, raises suspicions of certain explanations or observations, suggests lines of research to be followed, and provides a sound criterion for recognising significant observations on natural phenomena" (p. 18). In this regard falsificationism has been challenged on both descriptive and normative grounds (see Ketelaar, 2002). As Newell (1990) remarks:

> Theories are approximate. Of course, we all know that technically they are approximate; the world can't be known with absolute certainty. But I mean more than that. Theories are deliberately approximate….They are defined and reformulated, corrected and expanded. Thus, we are not in the world of Popper, as far as I'm concerned... Working with theories is not like

> skeet shooting – where theories are lofted up and bang, they are shot down with a falsification bullet, and that's the end of the story. Theories are more like graduate students – once admitted you try hard to avoid flunking them out…Theories are things to be nurtured and changed and built up. One is happy to change them to make them more useful (p. 14).

Newell (1990) was critical of the lack of a coherent unifying meta-theory to guide the research endeavour in psychology. He argued that because researchers were operating without a larger meta-theoretical framework to guide the construction and evaluation of various alternative explanations, they had no explicit guidelines for separating the *a priori* plausible (alternative) explanations or the *a priori* implausible (null) explanations (Newell, 1973). Instead Newell contended that the more approximating approach proposed by Imre Lakatos (1970, 1978) was more advantageous as one of the endeavours of psychology is to increase our knowledge base by constructing better and better approximations of phenomena based on current theory. Lakatos' approach provided such a coherent unifying meta-theory.

5.2 Lakatos' philosophy of science

Imre Lakatos (1970, 1978), a former student of Popper, has proposed an approximating approach which is comprised of two central features. These features are that meta-theoretical research programmes are comprised of several levels of analysis, and that they adhere to a criterion of research progressiveness. The first feature of this philosophy of science is that meta-theoretical research programmes are comprised of several levels of analysis, which centre on basic hardcore assumptions. These basic hardcore assumptions comprise the meta-theory, and are the defining characteristic and guiding metaphors of a research programme. Lakatos contends that scientists rely on basic meta-theoretical assumptions when they construct and evaluate theories. Once these assumptions have been empirically established, they are often not directly tested thereafter (Ketelaar, 2002). Instead these assumptions are utilised as a starting point for further research. Examples are the principles of gradualism and plate tectonics which are the basic assumptions which provide a meta-theory for the discipline of geology.

Below the basic hardcore assumptions, is the protective belt which consists of middle-level theories, hypotheses, and predictions. The protective belt provides an empirically verifiable means of linking the hard core basic assumptions to observable data, and also provides indirect evidence in support of the meta-theoretical basic assumptions. Middle level theories themselves consist of applications of a particular set of meta-theoretical assumptions to a distinct content domain. From a single middle-level theory, a wide number of hypotheses can be derived. These hypotheses vary along a continuum of confidence. From these hypotheses, predictions are derived which correspond to specific statements about the state of the world that one would expect to observe if the hypotheses were verified. When the data fail to support a prediction, one goes back to the drawing board. The performance of the predictions provides the basis for evaluating the more general hypotheses from which they are drawn. In essence, predictions represent explicit, testable instantiations of the hypotheses. Ultimately, the value of the more general hypothesis and theoretical model is judged by the cumulative weight of the evidence.

Basic hardcore assumptions are also sometimes referred to as ‘negative heuristics’. An heuristic are rules of thumb that aid discovery or invention. In contrast to negative heuristics, positive heuristics provide guidance on how the hard core basic assumptions are to be supplemented by the protective belt, and how this protective belt is to be modified in order for a programme to produce explanations and predictions of observable phenomena. As Lakatos (1970) comments, “the positive heuristic consists of a partially articulated set of suggestions or hints on how to change, develop, the ‘refutable variants’ of the research program, how to modify, sophisticate, the ‘refutable’ protective belt” (p. 135).

The second feature of Lakatos’ philosophy of science is the criterion of research progressiveness. Here competing research programmes are judged as progressive or degenerative, rather than as false or ‘as yet not falsified’ (Lakatos, 1970, 1978). Research programmes are judged progressive or degenerative in regard to their explanatory and predictive power. For instance, when a research programme contributes only marginally to the advancement of knowledge, this explanatory system is viewed as degenerative rather than progressive. As Lakatos (1978) puts it:

> A research program is said to be progressing as long as its theoretical growth anticipates its empirical growth, that is as long as it keeps predicting novel facts with some success ('progressive problemshift'); it is stagnating if its theoretical growth lags behind its empirical growth, that is as long as it gives only post hoc explanations whether of chance discoveries or of facts anticipated by, and discovered in, a rival programme ('degenerative problemshift') (p.11).

In other words, instead of searching for confirmatory or disconfirmatory evidence as happens with orthadox hypothesis testing, Lakatos suggests evaluating explanations by sorting through a set of plausible alternative accounts which are then evaluated relative to each other rather than on their own. A theory should be retained if it is the best available explanation, even if the theory has experienced predictive failures, for a theory cannot be rejected on the basis of observation unless a superior alternative theory exists. A new theory is generated after a novel observation and should be theoretically consistent with known facts, predict new facts, and the prediction of new facts should turn out to be empirically verified. Thus, confirmations, rather than falsifications, are of predominant importance, and the worth and merit of a research programme is shown by the extent to which it provides novel predictions that are confirmed. As Galison (1988) remarks, "as long as the adding of auxiliary assumptions led to fruitful new discoveries and explanations, the program was progressive; when the auxiliary assumptions needed to protect the core began contributing only marginally to the advancement of learning, the program 'degenerated' and was discarded" (p. 204). This highlights the fact that the feedback process between the theory and obtained data is critical to acquiring knowledge and allowing the judgement of progress.

To summarise Lakatos's approach, the hard core basic assumptions are surrounded by a protective belt of middle level theories and auxiliary hypotheses, which in turn are connected to observable data. Lakatos's (1978) point is that the auxiliary hypotheses surround the basic assumptions and these hypotheses are empirically tested and "adjusted and readjusted, or even replaced, to defend the thus hardened-core" (Lakatos, p. 48). Thus it is not the basic assumptions themselves of the research programme that are adjusted or readjusted. Hence scientists are actually relying on the hard core basic assumptions as a starting point for constructing and evaluating theories, and they seek to solve problems by modifying the more peripheral assumptions of the protective belt rather than the hard core basic assumptions. As Ketelaar and Ellis (2000) note, "a scientist using an approximating approach begins with a set of first principles on which everyone in the field can agree and then structures scientific progress around the task of using these principles to construct theoretical models – approximations – of particular phenomena" (p.3).

Newtonian physics provides a good example of Lakatos's philosophy of science in operation. With Newtonian physics, the hard core is comprised of Newton's three laws of motion and his law of gravitational attraction (Rosenberg, 2005). These four laws form the meta-theory for the field of classical mechanics. Following a Lakatosian approach, one accepts these laws and seeks to modify the assumptions and theories in the protective belt. The assumptions are modified in an attempt to improve the match between the predictions of the programme (i.e., classical mechanics) and the results of observation and experiment in the world. In such a case there may be several competing middle-level theories, such as the competing wave and particle theories of light in quantum physics (Matthews, 1994), however neither of these theories contradict the hard core basic assumptions of Newtonian physics (i.e., Newton's laws of mechanics). These theories are derived from the hard core basic assumptions and are evaluated on their own merits, with the expectation that eventually one will prevail. If, on the other hand, there was no meta-theory to provide hard core basic assumptions, there would be no theories of light or even of quantum physics.

6. THE INTEGRATION OF EVOLUTIONARY PSYCHOLOGY AND SCIENCE

This chapter builds on the previous chapters and argues that the methods and strategies that evolutionary psychologists utilise to generate and test hypotheses are scientifically defensible. They are defensible because they are in line with a Lakatosian philosophy of science a more contemporary philosophy of science than that pf Popper. I also contend that the explanations of evolutionary psychologists are more useful than general psychological explanations which rely on a Popperian philosophy of science, and as such, these more useful explanations should be adopted. In order to justify this position, I review and expand on the principles of a Lakatosian philosophy of science. In doing so, I outline how these principles are used to construct and evaluate meta-theoretical research programmes, and how they are employed to evaluate the endeavours of evolutionary psychologists.

6.1 Evolutionary psychology and Lakatos' philosophy of science

Consistent with Lakatos's philosophy of science (Lakatos, 1970, 1978), evolutionary psychologists employ multiple levels of explanation (Ketelaar & Ellis, 2000) in explaining various psychological phenomena. In this regard, the basic assumptions and tenets of modern evolutionary theory are taken as bedrock and assumed correct. These are the core meta-theoretical assumptions from the adaptationist programme in evolutionary biology, and consist of the general principles of genetical evolution drawn from modern evolutionary theory (see Buss, 1995). Working from these basic hardcore assumptions, evolutionary psychologists generate mid-level theories and hypotheses in order to analyse how they can be applied to our understanding of human behaviour. Buss provides a nice visual representation of the multiple levels of explanations of psychological mechanisms (from Ketelaar & Ellis, 2000):

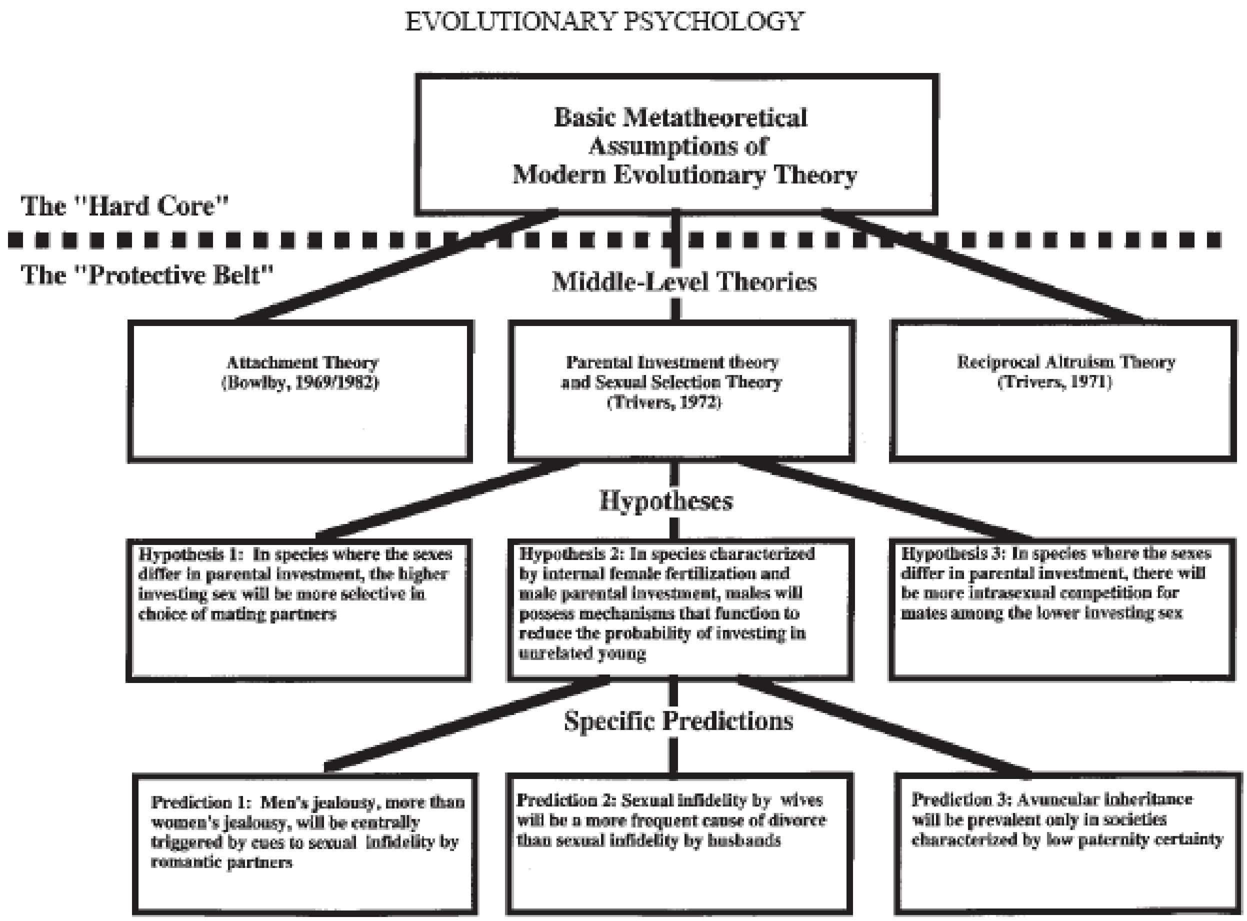

Figure 1. The hierarchical structure of evolutionary psychological mechanisms.

These levels of explanation begin at the meta-theoretical level with the assumptions of modern evolutionary theory. From here, evolutionary psychology organises the protective belt into three levels: middle-level theories, hypotheses, and predictions. As Buss (1995) remarks, “middle-level evolutionary theories are consistent with and subsumed by evolutionary meta-theory” (p. 10). The middle-level theories elaborate the basic assumptions of the meta-theory, in this case evolutionary theory, a particular psychological domain. Then hypotheses and predictions of that domain are generated (i.e., evolutionary psychologists utilise meta-theory to guide hypothesis generation). This is how evolutionary psychological explanations of phenomena involve multiple levels of explanation and analysis. As

Ketelaar (2002) remarks, “because the basic assumptions of one’s meta-theory can be combined with an array of auxiliary assumptions, several hypotheses can be derived from a single middle-level theory and these hypotheses might differ from those generated by competing theories, even if both theories share many of the same meta-theoretical assumptions” (p. 46). The finer points of these four levels of explanation (the meta-theory and the three levels in the protective belt) are further described by Ketelaar and Ellis (Ketelaar & Ellis, 2000; Ketelaar, 2002).

Consistent with Lakatos’ philosophy of science, evolutionary psychology meets the criterion of progressivity (Lakatos, 1970, 1978) based on its ability to account for apparent anomalies and generate novel predictions and explanations. As such, it has the properties of a currently progressive research programme (Ketelaar & Ellis, 2000). In comparison to other psychological paradigms, such as behaviourism, evolutionary psychology provides and utilises a meta-theory (i.e., evolutionary theory). Ketelaar (2002) notes that in doing so “it is a more reasonable (i.e., efficient and defensible) research strategy to put two competing evolutionary alternative explanations against each other rather than the more traditional approach of Popperian null hypothesis testing where plausible hypothesis against their logical opposites” (p. 47). For example, Buss (1995) pits attachment theory, parental investment theory, and reciprocal altruism theory against one other in order to explain the phenomena of mate selection (see Figure 1).

However, in some research the middle-level theories do not always provide verifiable predictions. In such situations researchers need to revise their predictions or the middle-level theories. This is in keeping with the criterion of progressivity as when the data do not support the hypotheses, rather than disregarding the meta-theory, a revision of the hypotheses is attempted or they are rejected, instead of disregarding the meta-theory. If these hypotheses fail, a re-evaluation of the mid-level theories is then required. For example, in the case of jealousy, if the predictions fail, evolutionary psychologists revised their hypotheses and devise better hypothesis. An example of predictions failing can be seen in sexual selection as this theory did not take into consideration the length of relationships. It is known that there is a difference in how people choose their mates depending on whether their coupling is expected to be short or long term (Buss, 1999). When looking for long term mates, females tend to prefer males with access to resources. However, when looking for a short-term mate, females prefer males who are more physically attractive (Buss, 1999). Thus, the predictions did not fit both short and long term coupling. In most cases, falsifying a specific prediction does not directly falsify the meta-theory (Ketelaar, 2002). In the above example, the limitation was that short and long-term relationships had not been distinguished; not that the theories were incorrect. The failure of predictions does not reflect on the core meta-theory, as these predictions are devised from the mid-level theories, not basic core assumptions.

The case study of human mating discussed above can usefully be conceptualised from a Lakatosian perspective. In this case, the meta-theory consists of the core principles of evolutionary theory; that is, the general principles of genetical evolution drawn from modern evolutionary theory (i.e., natural and sexual selection). Evolutionary psychologists are not attempting to prove these principles, they are assumed to be correct. The protective belt is composed of theories derived from natural and sexual selection. In this case, the middle-level theory consists of parental investment theory which discusses the different ways in which males and females choose their mate. From this theory the hypothesis is that the higher investing sex would be the more selective and the less investing the more aggressive. It is also predicted that males would prefer youth and health, and females would prefer males with resources, that male jealousy would be triggered by sexual infidelity, and woman's by emotional infidelity. By utilising this hierarchical structure, evolutionary psychologists are able to test and support their basic core assumptions, to develop and refine subsequent theories, and to better understand and predict human behaviour.

6.2 The benefit of evolutionary psychology adopting a Lakatosian philosophy of science

The explanations allowed by embracing a Lakatosian philosophy of science, and provided by evolutionary psychologists, are more useful than traditional psychological explanations (i.e., inferences derived from negative knowledge). In considering two competing alternative explanations, evolutionary psychology is both a more realistic view of how good science is practiced, and a more efficient research strategy than the alternative strategy of null hypothesis testing. As Lakatos (1970) remarks,

> …one theory may be judged as more useful than another because it possesses greater explanatory power, that is, it solves more of the existing puzzles and accounts for a wider range of known facts, including apparently anomalous findings. In addition to this ability to account (post hoc) for what is known, one middle-level theory may be judged as more useful than another because it possesses greater predictive power, that is, it better anticipates the data by specifying (a priori) previously unobserved phenomena (p. 80).

The Popperian method of falsification is still useful under a Lakatosian approach for evaluating the scientific status of specific statements (predictions and hypotheses), as it is these that generally bear the burden of empirical test. However, falsification is an inadequate strategy for evaluating middle-level theories and the meta-theoretical assumptions that generate these hypotheses and predictions; competing approaches within human evolutionary psychology can be evaluated at any level, including the middle-level and meta-theory levels. Thus, falsifying a specific evolutionary prediction does not directly threaten evolutionary meta-theory, unless that prediction directly tests a hard core meta-theoretical assumption. Nonetheless, at each level of analysis, evaluation is based on the cumulative weight of the evidence. These standards and procedures for evaluating evolutionary explanations are what Kuhn (1962) termed ‘normal paradigm science’.

Lakatos’ approximating model of science is also better suited to the task of constructing theories for psychology, because it accommodates the development and testing of alternative evolutionary explanations within the unifying framework of a single meta-theory (evolutionary theory). As such, evolutionary psychology is capable of providing us with consistent procedures for developing and testing evolutionary models, which in turn provide new knowledge and novel explanations of how the human mind works. In drawing on evolutionary theory, evolutionary psychology aims to place the discipline of psychology alongside the natural sciences, and presnt itself as a “conceptually integrated theory” (Cosmides, Tooby & Barkow, 1992, p. 11), with the goal of conceptual integration in mind, Lakatosian theory has been adopted whole heartedly by evolutionary psychologists (see Ketelaar and Ellis, 2000), for it provides them with a firm structure upon which to base their theories. Lakatos’ theory provides three main benefits. These are: not needing to directly test the hard core theory once it has been established, not disregarding theories on the basis of single inconsistent hypotheses, and the use of positive heuristics. Each of these benefits will be further discussed.

With Lakatosian theory, after the hard core theory has been established, it is not then necessary to continue to test and hypothesise on the theory. This hard core theory is set in stone and is not questioned further. For example, physicians do not question Newton’s gravitational theory, but rather treat it as fact. In evolutionary psychology, psychologists apply Darwin’s theory of natural selection to study the human mind and behaviour. Darwin’s theory has withstood time and tests, and is now established as fact in the scientific world. The meta-theory in evolutionary psychology is based on Darwin’s natural selection which has been well established. Thus it is not necessary to directly test these foundations again. The Lakatosian theory allows scientists to obtain a core theory which may not in itself be directly testable. Rather than testing the hard core theory, the middle-level theories are tested by numerous hypotheses. The middle-level theories are part of the protective belt, which has a primary function of providing empirically verifiable means of linking meta-theoretical assumptions with observable data (Ketelaar & Ellis, 2000). Thus, in such a research program, if one hypothesis turns up a discrepancy with a middle-level theory, the hard core theory is not affected. Rather, further hypotheses will be tested to see why the discrepancy occurred. Thus, evolutionary psychology has a concrete foundation set in Darwin's natural selection theory. Psychologists do not try to prove this foundation, but rather try to build upon it.

The Lakatosian theory has another crucial benefit over the Popperian theory. This is its ability to identify where the falsification lies. It is not logical to disregard a theory on the basis of one discrepancy. Without further analysis, where that falsification lies may not be identifiable. If the Popperian theory had been adopted when Newton was testing his theories, it is more than likely that his research would have been discarded. In the early years, Newton's gravitational theory was falsified by observations of the moon's orbit (Chalmers, 1999). It took almost fifty years to deflect this falsification onto factors other than Newton's theory. The theory again came to be inconsistent with the orbit of Mercury. Scientists did not abandon the theory on either of these two accounts (Chalmers, 1999). Rather, further tests and hypotheses were created to gain further insight and support for the theory. Thus, scientists cannot disregard a theory on the basis that a single test found inconsistencies. The Lakatosian theory accomodates this and directs where the falsification lies, i.e., it may lie in the hypothesis or in the testing, not in the hard core of the theory.

In the case of mate selection, evolutionary psychologists initially found discrepancies with the meta-theory. As was seen in previous chapters, the hypotheses were not consistent with short and long term relationships. Rather than disregard or throw out the hard core theory, further hypotheses were proposed and tested. These latter hypotheses provided data consistent with the hard core theory. When observations and experiments provide data which is inconsistent with the meta-theory, it might be the data which is at fault rather than the theory (Chalmers, 1999). To throw out the theory on the basis of a discrepancy is not sound scientific strategy.

A further benefit of the Lakatosian theory is its use of positive heuristics. The positive heuristic provides guidance on how the hard core theory is to be supplemented, and how the subsequent protective belt is to be modified in order to yield explanations and predictions of observable phenomena (Chalmers, 1999). This heuristic provides hints on how to modify and develop the protective belt. Lakatos provided an illustration of a positive heuristic with Newton's early development of his gravitational theory (Lakatos, 1978). The positive heuristic involved starting out with idealised situations and slowly progressing to more realistic situations (Chalmers, 1999). Starting with idealised cases allows theories to be proposed. Once these idealised cases are mastered, one can proceed to more complicated cases and make adjustments to the theory in order to make the transition to realistic situations.

7. CRITICISMS OF EVOLUTIONARY PSYCHOLOGY

We understand the goal of evolutionary psychology to be the discovery of the mental organs that constitute our universal human nature and how those mental organs function to solve evolutionary problems (Buller, 2005). Evolutionary psychology theory has a very strong structure which has been backed up by extensive research by psychologists. It has provided strong explanations for behaviour in several human situations, such as mate-selection and sexual-selection. As I have argued, Laktos' philosophy can successfully integrate evolutionary psychology with the rest of science. Thus, evolutionary psychology can provide a very powerful explanation for the human mind and behaviour.

However, there are aspects of the human mind and behaviour which other psychologists do not believe can be fully accounted for by an evolutionary psychology perspective. I will discuss the following criticisms of the evolutionary psychological perspective; including the argument against modularity, the reliance on the Pleistocene period, the elimination of other causes of evolution, and the reliance on what appears to be 'just so' stories.

7.1 The criticism of domain-specific modularity

The ultimate goal of evolutionary psychology is to discover the modularity of human psychological mechanisms in order to understand the human mind and behaviour. Evolutionary psychology emphasises that the brain is modular. The modern idea of modularity in evolutionary psychology was initiated by Jerry Fodor (1983) who claims the human brain is comprised of a discrete series of 'mental modules' or 'psychological mechanisms'. It is because of this concept of modularity (i.e., the evolved cognitive structure of the brain) that evolutionary psychologists argue that psychology should be considered a biological science. These mental modules are not mapped onto specific brain structures, nevertheless our brains are specialised like a Swiss Army knife or a computer (Grace, 2000, p.5). For example, evolutionary psychologists claim the brain embraces many modules, including, for example, modules for mate-selection, food selection, fear of snakes, and predator avoidance. The modules are so domain specific that they are considered informationally encapsulated and do not interact with each other.

However, there are psychologists who do not agree with the theory of modularity. An initial example which has been offered to negate modularity is the discovery of the brain's ability to ‘recover’ after the degeneration of certain regions or circuits (Buller, 2005). This has been termed neural plasticity, which refers to the ability of brain regions to perform different functions, so that a given brain region has the ability to take on the function of another region if required (Buller, 2005). The idea that the brain is able to do this negates the existence of domain specific modules. If domain-specific modules were to exist, there would be little or no room for reorganisation to occur following damage. However, it has been seen that the brain is able to create new or alternative pathways following damage to certain areas.

A further criticism of modularity is that it has overcompensated for earlier more “general purpose” theories of the human brain by postulating the existence of hundreds of discrete modules. Dan Sperber (2001) comments that modularity seems to conflict with the way in which the brain processes conceptual information (i.e., in integrating information from the different modalities of taste, sounds, touch, sight), and the recent appearance of cultural pursuits which are culturally specific, yet were not found in the EEA (e.g., TV viewing). Sperber argues it “would be absurd to assume there is an ad hoc genetically specified preparedness for these culturally developed conceptual domains” (p. 33).

These criticisms question the soundness of theoretical commitment of evolutionary psychology to modularity. Some also think that modularity might be more workable if it were supplemented with the idea of general purpose mechanisms working concurrently.

An example which supports the overlap in brain circuitry is that which can be observed when maintaining balance. The semi-circular canals within the middle ear are responsible for maintaining balance. However, if these are removed from an individual, the brain compensates for the vestibular disturbance (Buller, 2005). When the semi-circular canals are removed, the individual can recover their sense of balance very quickly. Some other sensory system must be feeding the brain with input about the environment. In such cases, the most likely explanation is that the visual system provides the brain with the required information (Buller, 2005). This degree of overlap within our brains shows that brain circuits are in fact not ‘domain-specific’ but rather, they are ‘domain dominant’. Thus, they are predominantly suited to certain tasks, however, they have the ability to undergo other tasks which are usually undertaken by another region. A further example, which cannot be explained by the existence of modules, is the mind’s capacity for an almost unlimited imagination (Siegert & Ward, 2002). It does not seem possible that something such as imagination can be confined to an informationally encapsulated module. Imagination consists of a wide variety of situations, which are often exaggerated. The modularity theory does not allow for many modules to interact with each other in the way which would be necessary for imagination to exist.

It has been shown that the brain has to incorporate many varying inputs at one time and produce a suitable response. If all modules work separately without knowledge flowing between them, it seems an impossible task to produce a combined outcome. Fodor (1998) raises a similar point:

> For, eventually the mind has to integrate the results of all those modular computations and I don’t see how there could be a module for doing that… Probably, modular computation doesn’t explain how minds are rational; it’s just a sort of precursor. It’s what you have to work through to get a view of how horribly hard our rationality is to understand (p. 12).

Thus, it is claimed that it is implausible to maintain that the brain has separate modules for every unique purpose which can arise.

7.2 Evolutionary psychology focuses too much on the Pleistocene period

An argument put forward by evolutionary psychologists is that the human brain evolved its specific structures in response to solving adaptive problems in a period of time known as the Pleistocene period. To focus specifically on this of period the EEA, is seen as too restrictive by some theorists because it fails to take into account developments occurring outside this particular time frame, such as human cultural achievements, writing, etc. The argument for mental structural development happening solely within the Pleistocene period suffers the major problem that it is difficult to explain, without empirical evidence, how a particular evolutionary period might have affected the brain. As Panksepp and Panksepp (2000) remark:

> Although all evolutionists recognise that existing organisms are living historical ‘texts’ that reflect past evolutionary passages, empirically we can only work effectively with the here and now brain/mind processes that are mixtures of evolutionary hand-me-downs and experiential blossoming. We can directly observe little more than strands of DNA, the proteins they help create, and the resulting developmental progression that takes place in certain environments. As is recognised by most, all historical/functional issues are largely hidden from direct analysis (p. 113).

Buller (2005) and Panksepp and Panksepp (200) raise strong criticisms of the heavy reliance on the EEA, which will be discussed below. Buller focuses on the brain’s ability to undergo modification since the EEA and the effect the changing environment has on the brain. Panksepp and Panksepp focus on changes to the brain’s mechanisms which could have occurred to the contemporary human.

Buller (2005) initially addresses the issue that evolutionary psychologists focus to heavily on the EEA. He raises three points which he believes puts the plausibility of evolutionary psychological theory in question. These include the heavy reliance on the EEA, the claim that the brain has not evolved due to natural selection since this period, and the issue that the brain has not evolved in response to the changing environment. The initial issue which Buller raised challenges the claim that the mechanisms in our brain have not had enough time over the last 400 generations since the EEA to develop new complex designs. It is true that selection could not have built new designs from scratch over this time span. However, the fact that a new complex design could not have evolved since the Pleistocene does not mean that the psychological mechanisms are the same in contemporary humans as they were in our ancestors in the EEA. The issue is whether old complex designs could have evolved and been modified since this period (Buller, 2005). Since evolutionary psychology does not address this question, it fails to show that our psychological adaptations have remained adapted to the Pleistocene environment. For Buller, evolutionary psychologists focus too much on the EEA and do not address the changes that may have occurred since. The idea that human psychological mechanisms cannot have evolved since the end of the EEA depends on a questionable assumption about the rate at which natural selection occurs (Buller, 2005).

Another issue relating to this is the fact that the environment has gone through some remarkable changes since the Pleistocene period. If our brain has evolved to respond to particular cues from a particular environment, then, if the environment has changed substantially over time, the cues and input will surely have also changed. Accordingly it would be expected that the psychological mechanisms which respond to these cues will have had to modify to accommodate the environmental changes. Substantial environmental change can be seen in populations that became agriculturalised and industrialised. Both of these two revolutions changed the human environment remarkably. Evolutionary psychologists argue that although the environments have changed, the problems raised by human social life have remained substantially the same. This is arguably false, as these two revolutions created huge changes in the group sizes and social structures of human populations, and these in turn changed the pressures placed on individuals (Buller, 2005). Buller believes evolutionary psychologists have failed to completely rule out these possibilities and have not fully addressed them in their writings.

An additional speculation in relation to the reliance on the EEA was raised by Panksepp and Panksepp (2000) who also focus on the change in the brain that could have occurred over the 400 generations since the end of the Pleistocene. Their argument takes a different perspective from that of Buller; they believe that much of the brain evolution during the Pleistocene was based on the rapid expansion of general-purpose cortico-computational space (which permitted the emergence of foresight, hindsight and language) rather than on any fine-grained moulding of special-purpose socio-affective mechanisms. (Panksepp & Panksepp, 2000). They suggest evolutionary psychologists should conduct research on species related to humans in order to gather more detailed information on how the brain evolved. Many animal husbandry practices and behavioural genetics experiments have indicated that it takes no more than half a dozen generations of selective breeding for robust temperamental differences to be induced into animal lines (Scott & Fuller, 1965; Segal, 1999). Thus we should not eliminate the possibility that a significant amount of phenotypic variability in humans may have been created by reproductive isolation or 'caste' selective mating (Panksepp & Panksepp, 2000).

7.3 There are other causes of evolutionary change other than natural selection

The focused emphasis of evolutionary psychology on natural selection as the sole or major cause of human cognitive development can be criticised by looking to other causes of evolutionary development which sit alongside natural selection, many of which were described since Darwin's time. There are factors other than natural selection which result in evolutionary change. I will discuss two of them here: genetic drift and the phenomenon of spandrels.

Genetic drift occurs in populations which break off from the main population and become isolated. In humans, the reasons for this can be both geographic and cultural. This is called "the founder effect", and it has the effect of modifying the genetic make-up of the population concerned. The phenomenon of genetic drift is more important in small populations. As Griffiths *et al* (2004) mention, "the process of genetic drift is, in fact, another way of looking at the inbreeding effect in small populations… Whether regarded as inbreeding or as random sampling of genes, the effect is the same. Populations do not exactly reproduce their genetic constitutions; there is a random component of gene-frequency change" (p. 704.).

Another cause of evolutionary change is the phenomenon of spandrels. The existence of specific mental modules moulded over time by adaptive changes through the process of natural selection is claimed by evolutionary psychologists to be the basis of the human cognitive structure. This has been challenged by the notion that there are a significant number of evolutionary features which do not arise as adaptations but rather are co-opted by the organism because they have useful benefits. These 'nonadaptive side effects', 'epiphenomena', or 'spandrels', which did not arise in the first place as adaptations, are believed to be much more common than genuinely specialised adaptive changes (Gould & Lewontin, 1979). According to Gould (1997), "natural selection made the human brain big, but most of our mental properties and potentials may be spandrels – that is, nonadaptive side consequences of building a device with such structural complexity… and therefore outside the compass of evolutionary psychology" (p. 21).

The theory of spandrels can be seen to explain many higher cognitive activities in humans, and in fact an understanding of how spandrels work may help us to understand more clearly how recent human cultural activity may fit into evolutionary psychology's focus on natural selection within the Pleistocene period.

7.4 The hypotheses of evolutionary psychology are little more than 'just so' stories

We have shown that from the vantage points of the philosophy of science advocated by Lakatos, the evolutionary psychological meta-theory of natural selection does not need to be tested. It is taken as true, as is Newton's law of relativity. However some theorists (e.g., Buller, 2005) claim that in order for evolutionary psychology to be considered science, it needs to provide testable theories and empirical evidence. Scientific studies rely on empirical evidential data to support their theories. Without such definitive information, the theories may be considered mere stories. Critics, such as Buller, cast doubt on the scientific status of evolutionary psychology; they claim, it is ‘untestable’ (Gould, 2000), that it is ‘reductionist’ (Rose, 1998), and that it relies on speculation about an environment of evolutionary adaptation about which we know very little. The heavy reliance on the EEA, which is largely untestable, leaves much room for criticism in relation to the ‘data’, which support evolutionary psychology theories. Gould states ‘it is always easy to concoct a plausible story about how a trait may have evolved’ (Gould, 2000). These stories, which do not contain empirical evidence, but rather, rely on assumptions, are often termed ‘just so stories’. Gould (2000) discusses how speculation cannot be considered science and Pinker (2002) explains that evolutionary psychology must offer testable theories in order for this paradigm to be considered science.

The palaeontologist Stephen J. Gould (2000) states that evolutionary psychology’s reverse-engineering hypotheses about the existence of mental modules are often on a level of speculation similar to storytelling, with some similarity to Rudyard Kipling’s highly fanciful, yet plausible explanations of natural phenomena. In other words, there is no way of empirically testing whether modules arose in response to specific environmental conditions within the period, of EEA, as such conditions are now inaccessible to study. Thus, it is concluded that evolutionary psychology is unscientific.

The task of evolutionary psychology then turns into a speculative search for reasons why a behaviour that may harm us now must once have originated for adaptive purposes. To take an illustration proposed seriously by Robert Wright in *The Moral Animal* (Wright, 1994), a sweet tooth leads to unhealthy obesity today, however it must have arisen as an adaptation. Wright therefore comments that the classic example of an adaptation that has outlived its logic is the sweet tooth, as our fondness for sweetness was designed for an environment in which fruit existed, but candy did not. This ranks as pure guesswork; Wright presents no neurological evidence of a brain module for sweetness, and no paleontological data about ancestral feeding. This "just-so story" therefore cannot stand as a "classic example of an adaptation" in any sense deserving the name of science.

Stephen Pinker (2002) on the other hand sets forth the idea that such hypotheses can be shown to have empirical rigor, and that there are ‘good and bad’ adaptationist explanations. As he notes: “evolutionary explanations should offer a rigorous engineering analysis of the phenomenon of interest and yield testable predictions that can be evaluated empirically, in the lab or in the world at large” (p. 95). Pinker’s model of research is the more clear-cut example of visual perception, where a reverse-engineering approach is obviously appropriate (we know the eye was designed for the purpose of sight). If evolutionary psychology is to be accepted into the mainstream of psychological research, it must offer testable theories that can be verified or disproven. As Grossman and Kaufman (2001) note, “evolutionary psychology’s storytelling must be joined with a commitment to empiricism” (p. 22).

In summary, because we cannot directly observe natural selection in operation, and therefore cannot gather empirical data concerning genetic variation and reproductive success, we cannot definitively demonstrate that any specified characteristic is actually an adaptation and thus open to an evolutionary explanation (Haig & Durrant, 2001). The suggestion from critics is that evolutionary explanations are untestable and therefore in the realm of storytelling. They claim that we cannot have assurance that a characteristic is really an adaptation (Haig and Durrant, 2001).

7.5 Evolutionary psychology is reductionist

Evolutionary psychology uses evolutionary theory to explain the human mind and behaviour. Some psychologists argue that because of its reliance on specific modules, evolutionary psychological theory cannot cover all aspects of the human mind and behaviour. This has led to accusations of reductionism, which involves breaking down systems into their smallest parts in order to explain phenomena.

Evolutionary psychology explains the complex nature of human behaviour in terms of specific mental modules, which arose as adaptations in our hunter-gatherer past. This is traditional reductionism – the breaking down of complex phenomena into components. Reductionism is regarded as essential in most areas of science, however critics of reductionism in psychology hold the belief that different levels of explanation are required for explaining different levels of human behaviour (Siegart & Ward, 2002). For instance, explaining the jealousy of a mate by talking about atoms and neurons would not make sense. The emotion involves complex integrations between various brain regions, and is dependent on the specific person and situation. Each complex level involves new interactions between component parts, which cannot be inferred by taking the system to pieces. For example, in social psychology, the focus may be on group dynamics and interactions, and on processes such as social categorisation. While these phenomena must reflect in some way the activity of the nervous system of each member, it is highly unlikely that meaningful explanations of such phenomena can be made at the micro level (Siegart & Ward, 2002) as it is at an inappropriate level of explanation. Even if we could detail the specific events that occurred in each individual's nervous system, it seems impossible that such descriptions could be combined to account for the phenomena of human social behaviour.

Scientists continue to believe that the science of human nature has to be understood at several levels of analysis, not just the lowest level (Pinker, 2002). Chomsky, Marr and Tinbergen have each marked out a set of levels of analysis for understanding the mind. These levels include: its function, its real-time operation, how it is implemented in neural tissue, how it develops in the individual, and how it evolved in the species. Its function includes what it accomplishes in an evolutionary sense and its real-time operation is concerned with how the mind works proximately from moment-to-moment (Pinker, 2002). An example is language, specifically how language is based on grammar designed to communicate limitless thoughts. It is used by people today via memory recall and rule adherence. Language is implemented in a network of regions which must coordinate memory, planning, word meaning, and grammar. If any of these factors is omitted, the result would be a linguistic mess. The English language was shaped by broad historical events that certainly did not take place in a single head and it is constantly changing every generation (Pinker, 2002). Wittgenstein (1958) has also pointed out the impossibility of a private language. Thus it is said that culture and society influence the language we know. For this to happen, the brain must also incorporate regions involved in culture when using language. Thus, it would be completely illogical to try to understand language at its lowest level because it has connections with social, cultural and linguistic factors.

It appears that evolutionary psychologists dumb down the complex richness of their subject matter into a genetic mess of neurons, genes and evolutionary urges (Pinker, 2002). It is not possible to explain the causes of such events as World War I through motions of atoms, electrons and quarks. An integrated level of explanation is required.

7.6 The political conservatism of evolutionary psychology

Evolutionary psychology's relationship to ethics is a continual topic of debate. It is argued by some critics (Holcomb, 2004) that, in its focus on the functional organisation of the brain, and on the existence of an innate, unchangeable 'human nature', evolutionary psychology is guilty of genetic determinism and of providing a moral justification for some innately conservative political ideas.

The immediate background to, and reason for, these concerns is the way in which, since Darwin, theories of evolution have been co-opted by conservative political governments to justify some of the twentieth century's most chilling atrocities, for example, the treatment of Jews by Nazi Germany, and lesser, although no less significant, attempts at social engineering such as the forced sterilization of the physically or intellectually disabled, and ideological assumptions around racial, gender or class-based differences in intellectual ability. There is no doubt that various misunderstandings of Darwinian theory have occurred in recent history, however this does not necessarily mean that *any* focus on the social aspects of evolution will fall into such traps. One of the main factors presented as evidence that evolutionary psychology is biased in such a way is that it falls into the trap of stating that certain human traits are justifiable because they are "naturally" occurring. That is, evolutionary psychology is committing the ‘naturalistic fallacy’ by deriving moral norms from evolutionary theory. The naturalistic fallacy occurs when one assumes that ‘what is’, is the same as ‘what ought’ to be (Rossano, 2003). Thus, one may think that if a phenomenon occurs in nature, then it is morally right. This is most avidly seen around issues of gender difference, which evolutionary psychology is often accused of rendering in a very narrow, conservative, and biologically deterministic manner, reflecting a hidden bias which reflects current cultural values. As Durrant (1988) states, “research directed at identifying and elucidating sex differences is not implicitly sexist in nature, nor do evolutionary scientists typically claim that current differences between men and women in society reflect *inevitable* patterns of diferentiation” (Durrant, 1998, p. 155). The constant interchange between environment and genetics is also seen to modify behaviours. For example, nepotism may be considered a human trait which evolved to increase inclusive fitness, however there is no reason to suppose that evolutionary psychology believes nepotism is morally good merely because it states its existence as an adaptive human trait. In fact, current research suggests a model in which the naturalistic fallacy is absent, and there is room to separate adaptive behaviour from moral imperatives:

> Recent cultural changes toward social equality are changing the opportunities that provide the range of options for evolved strategies to take. They are leading to men’s greater concern with their looks and women’s greater concern with work. These cultural changes are biological changes… Nepotism at work is an outcome of an evolutionary constant (caring for our family) that we want to change. We can enact policies that interact with out evolved psychological mechanisms to either increase or decrease nepotism (or other traits)… This is a real-life issue in states such as Kentucky, in which powerful county administrators suggest appointments of their kin to the few available high quality jobs. (Holcomb, 2004, p. 75)

CONCLUSION

Evolutionary psychology offers a new paradigm and novel conceptual tools to integrate psychology with the rest of science. The adaptationist explanations offered by evolutionary psychology are showing considerable promise in a number of areas (e.g., mate selection, social behaviour, emotion, abnormal behaviour; see Gaulin & McBurney, 2004). Moreover, evolutionary psychology can claim to be better science than the more problematic SSSM approach. With increased methodological rigor, and better scientific practices, evolutionary psychology has the potential to provide a more useful understanding of the human mind and behaviour than the SSSM. With other scholars (e.g., Bjorklund, 1997; Lykken, 1991; Richters, 1997) contending that the greatest obstacle to psychology's development as a science is the absence of a sound and agreed-upon meta-theory, a further consideration of evolutionary theory as the appropriate meta-theory for psychology is desirable. Evolutionary theory could become the unifying theoretical paradigm in the psychological sciences. This thesis endeavored to demonstrate how evolutionary psychology integrates with the rest of science in order to provide the most useful explanations of the human mind and behavior. In accordance with this aim, the primary tasks for this study were to set out the reasons why evolutionary psychology deems the SSSM an inadequate model of human behavior, to demonstrate the ways evolutionary psychology uses evolutionary theory to provide an ultimate explanation of human behavior, and to explain how evolutionary psychology integrates with the rest of science in order to provide more rigorous explanations of human behavior.

The thesis began by focusing on the first of these tasks, initially elaborating on the SSSM's main arguments: that the brain is a blank slate, that culture plays the major part in human behavior, and that learning mechanisms are general-purpose. The SSSM has dominated psychology for nearly a century, but it cannot fully explain human behaviour. For example, mate selection cannot be said to be culturally specific; rather, it is a cross-cultural phenomenon. Gradually evolutionary psychology developed a range of criticisms to address the inadequacy of the SSSM. This critique focused initially on the impossibility of a 'blank slate' view of human development, for instance that it is doubtful that human beings are not already set up for the experience of learning language. Secondly, evolutionary psychology analyzes the false-dichotomy put in place between nature and nurture by the SSSM, instead looking at the way that nature and nurture work together in the development of traits, specifically how genes work with the environment. Thirdly, it was argued that the claim by the SSSM that environmental effects can be explained by general laws of learning is inadequate, and that it is instead more likely that there are innate mechanisms interacting with environmental input to produce behaviour. The focus then moved to the division which the SSSM places between the natural and social sciences, arguing that an understanding of biology is crucial for any understanding of evolved cognitive mechanisms. The failure of the SSSM to place importance on scientific principles, particularly those of biology, leads to a lack of focus on natural selection, which evolutionary psychology attempts to address by placing natural selection at the centre of its inquiry. Lastly, the lack of an overarching theory of design is seen as a flaw of the SSSM. There are a range of disciplines, such as evolutionary biology, human development, and cognitive science, which the SSSM does not draw on in its quest to understand human behaviour. A more integrated theory is needed, one which takes into account how science's role in psychology might function.

Having set out the inadequacies of the SSSM model, and isolated the need for a more integrated approach which included science, this thesis then turned to evolutionary theory, and the ways in which evolutionary psychology applies this theory to achieve this aim. Overviews of natural selection and sexual selection are set out in order to clarify evolutionary biology's importance to evolutionary psychology. The causal mechanism of natural selection is seen as crucial to any understanding of how the brain has evolved over time to maximise individual survival and increase reproductive success. Sexual selection, as a factor within the process of natural selection, is additionally seen as important in the understanding of how organisms evolve traits which are not directly connected to individual survival, but serve to help reproductive success. With this established, the thesis then went on to introduce the major aims and principles of evolutionary psychology, beginning with an introduction which set out the increased disciplinary focus that evolutionary psychology brought to the field of psychology and the study of human behaviour by including principles and theories from biology and evolutionary theory. Past attempts to integrate psychology and evolutionary theory have not met with success, because the integration focused on the level of behaviour. Evolutionary psychology, on the other hand, shifts the emphasis from behaviour by focusing its inquiry on the existence of evolved psychological mechanisms, the development of which are seen as the key to understanding behaviour. As Toobey (1997) suggests, natural selection cannot select for behaviour, only for the mechanism which would produce that behaviour. The aims of evolutionary psychology were then specified: firstly that it employs the notion of both *proximate* and *distal* explanations, the former being concerned with *how* an organism's behaviour manifests, and the latter being concerned with *why* the psychological mechanism which caused the behaviour might have evolved through natural and sexual selection. This was then discussed in terms of how a better integration of the natural and social sciences might be achieved. Discussion then moved to the specific ways in which evolutionary psychology combines evolutionary biology and cognitive psychology. This is important, because without the insight which these disciplines provide, the functioning of evolved psychological mechanisms could not be understood. In particular, the physical functioning of these mechanisms was enhanced by insights into computational functioning in the brain, and the idea of human mental processes being akin to a series of information processing mechanisms. This is turn was discussed as being a crucial difference between evolutionary psychology and sociobiology, both of which have a core focus on evolutionary theory. The focus on fitness maximisation in sociobiology is seen, from an evolutionary psychology perspective, to account inadequately for the ways in which ends do not always follow from means; in other words, how behaviour functions not to merely maximise individual fitness, but how the existence of adaptive mechanisms function to produce that behaviour. The core theses of evolutionary psychology were then set out. Computationalism was discussed in greater detail, with the efforts of cognitive psychologists to understand the mind as an information processing machine considered as an important insight in the development of evolutionary psychology. In this model, the human mind, conceived as a set of evolved information-processing mechanisms, takes input from the environment, processes it, and generates output as behaviour. However, cognitive programs still need to be selected by the process of adaptation, which is the process through which natural selection produces various designs in order to increase reproductive fitness. This is a process which is deliberate, slow, and costly, and whose results can be seen as the sum total of the adaptations human beings exhibit. The relationship between the development of human cognitive structures and the need to find adaptative solutions for environmental problems was then discussed. In the evolutionary psychology model, we cannot understand mental functions without understanding the environmental inputs which created evolved traits as solutions to problems. The environment selects for survival, and it is the environment which has produced many of the adaptations now found in human beings. Human cognitive structures are seen as originating in the EEA, in particular the Pleistocene period. Discussion considered computational input-output, adaptationism and the role of the EEA, and the factors that evolutionary psychology can then understand the nature of human psychological mechanisms. The human cognitive mechanisms which have evolved are seen as modular. Compared to a ‘general purpose’ theory of human mental architecture, modularity suggests that there are specific and unique functions to various modules in the brain, which have evolved in response to specific problems to be solved. These modules are considered to be informationally incapsulated; the module for mate selection, for example, cannot be used for food choice or for the fear of snakes for example. Evolutionary psychology is faced with the challenge of how to understand the functionality of psychological mechanisms, which is not as straightforward as understanding the functionality of anatomical structures in the human body, such as the liver or the heart. These can be *seen* physically in surgical procedures. The mind’s functioning, however, has to be approached by different means. Evolutionary psychology employs the strategy of reverse engineering in order to solve this problem. This is the attempt to decipher a machine’s function by looking at its structure and hypothesising what functions this structure was designed to fit.

Building on this knowledge, a case study of human mate selection behaviour was utilised to illustrate the principles of evolutionary psychology, and the ways in which empirical evidence has been gathered by its methodologies. Reverse engineering is employed by evolutionary psychologists to identify the principles driving human mate selection. This procedure has shown how specific strategies for mate selection, which seem present across cultures, evolved via natural selection in hunter gatherer times to create adaptations that have increased the chances of reproduction. Mate selection is supplemented by the theory of parental investment to further explain these behaviours, creating a set of circumstances which adequately predicts the existence of human jealousy as an adaptive trait.

This thesis then argued that there is a need for empirical research as a core part of science. The inability to empirically test the EEA is problematic for evolutionary psychology. A discussion of philosophy of science was conducted in order to understand whether the discipline of evolutionary psychology can be seen as scientific. A comparison between Poppers' and Lakatos' theories was conducted in order to understand how evolutionary psychology can utilise philosophy of science in order to develop the conceptual tools to integrate psychology effectively with other relevant sciences. A reliance on Popper's theory, which emphasises falsification, was seen as not particularly useful for advancing knowledge about complex psychological processes which are the focus of evolutionary psychology. Lakatos' approximating approach, which is comprised of two central features was outlined, that meta-theoretical research programmes are comprised of several levels of analysis and that they adhere to a criterion of research progressiveness. Here it was explained that a hard core of basic assumptions surround a protective belt of middle level theories and auxiliary hypotheses, which are in turn connected to observable data. Auxiliary hypotheses surround the basic assumptions and these hypotheses are empirically tested and adjusted and readjusted in order to defend the hard core; thus, it is not the basic assumptions of the research programme that are adjusted and readjusted. Rather, scientists actually rely on the hard core basic assumptions as a starting point for constructing and evaluating theories, and they seek to solve problems by modifying the more peripheral assumptions of the protective belt rather than the hard core basic assumptions.

With this groundwork laid, the question as to how the integration of psychology and science could best be conducted, via an overriding integrative model, was considered. I argued that the mehods and strategies that evolutionary psychologists utilise to generate and test hypotheses are scientifically defensible. They are defensible because they are in line with a Lakatosian philosophy of science, a more contemporary philosophy of science than Popper's. I outlined how these explanations are more useful compared to general psychological explanations which rely on Popperian philosophy of science, and, as such, suggested they should be adopted. I further outlined how the specifics of Lakatos's approach (i.e., its multiple levels of explanation and its criterion of research progressiveness) applied to evolutionary psychology and how this approach was considered scientific.

The thesis then presented the major current criticisms of evolutionary psychology from various standpoints, and attempted to address these criticisms. The first of these was the criticism of domain-specific modularity, which is important to evolutionary psychology precisely because it is this feature which makes it a candidate for being integrated with the biological sciences. The criticism of modularity comes from neuroscientific insight into brain plasticity, where it is sometimes observed that the brain will regenerate after injury, with different regions of brain tissue taking on the function of tissues which have been lost. Further criticism comes from those who consider modularity to be an overcompensation for earlier conceptions of the brain as a general purpose mechanism. The second criticism of evolutionary psychology is that it focuses too much on the EEA. This was seen as limiting because human history has developed much since this time, and a backward-looking theory may not take into account developments since the Pleistocene period. The third critique of evolutionary psychology was that it puts sole emphasis on natural selection as the driving force of evolutionary change, and fails to take other forces into account, such as genetic drift and the existence of spandrels. A fourth criticism was that the inability to test hypotheses developed around adaptive traits evolving in the EEA renders evolutionary psychology unscientifically testable, with its theories being little more than ‘just so stories’. The fifth criticism of evolutionary psychology was that its theories reduce the complexity of mental functioning by treating the complex interaction of different levels of human behaviour as explainable purely by breaking them down into components. Lastly, the controversies which attend evolutionary psychology, in which it is seen from the perspective of a variety of disciplines as being politically conservative, were discussed, as was the difference between uses of evolutionary theory to support negative social stratification and evolutionary psychology’s quest to provide adequate explanations for evolved mental structures.

The goal of this study was to explain not just why evolutionary psychology remains merely a sub-discipline of psychology, but also to show why evolutionary theory provides a meta-theoretical framework within which to examine the whole field of psychology. As Buss remarks, “although psychologists assume that the mind is a whole and integrated unity, no metatheory subsumes, integrates, unites, or connects the disparate pieces that psychologists gauge with their different callipers…An important new theoretical paradigm called ‘evolutionary psychology’ is emerging that offers to provide this metatheory” (1995, p.1).

The emergence of evolutionary psychology is not surprising when we consider that the primary subject matter of psychology is the behaviour and mind of biological organisms. What is perhaps surprising is that this emergence has taken so long. Biological science has been unified by the theory of evolution since the 1930's (i.e., since the integration of Darwin's theory with that of population genetics). Curiously, this was about the time that the social sciences began seriously to reject biological determinism (e.g., Watson's Behaviourism) in favour of what became the SSSM. As the social science pendulum begins to swing once more in the direction of biological determinism, psychology is perhaps more ready to accept the unification and integration with biological science promised by evolutionary psychology.

As I have shown, the critics and criticisms of this new discipline are many, but if we accept Max Planck's (1949) caution that “a new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die, and a new generation grows up that is familiar with it” (p. 35.), then future generations of psychologists may yet begin their studies with Darwin's great unifying theory in mind.

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