PROFESSIONAL ARTICLE

EvoS Journal:
The Journal of the Evolutionary Studies Consortium

Misunderstandings in Applying Evolution to Human Mind and Behavior and its Causes: A Systematic Review

Marco Antonio Corrêa Varella
Isabella Bertelli Cabral dos Santos
José Henrique Benedetti Piccoli Ferreira
Vera Silvia Raad Bussab

Institute of psychology, University of São Paulo

ABSTRACT

In spite of the increasing influence and acceptance of the evolutionary approach in psychology, misunderstandings continue to occur and a systematized approach to cope with its diversity and causes is needed. We have analyzed content of evolutionary psychological literature published from 1992 to 2011, in which misunderstandings were explicitly mentioned. We identified 22 different misunderstandings, which we categorized into 3 dimensions (individual, social and evolutionary), and we identified 6 types of attributed causes. By discussing definitions and inter-relations of the identified misunderstandings, we hope to contribute to a more precise approach to teaching and scientific communication. The first step in overcoming misconceptions and decreasing the barriers between areas of knowledge is to comprehend their diversity and their causes. Advices on how to better address and combat misunderstandings in the classroom are given.

KEYWORDS

Misunderstandings, Evolutionary Psychology, Interdisciplinarity, Teaching Evolution

INTRODUCTION

Despite the increasing influence and acceptance of the evolutionary approach within psychology (Cornwell, Palmer, Guinther & Davis 2005), misunderstandings about basic concepts have been reported several times (Buss, 1999; Confer et al., 2010; Terleph, 2000). The very concepts of evolutionary biology as well as sociobiological concepts have been misunderstood repeatedly, as shown in publications aimed at identifying and clarifying them (Alters & Nelson, 2002;

AUTHOR NOTE: Please direct correspondence to Marco Antonio Corrêa Varella, Institute of Psychology, University of São Paulo, Av. Prof. Mello Moraes, 1721 São Paulo, BR, CEP 05508-030 E-mail: macvarella@gmail.com

Gregory, 2009; Dawkins, 1982; Dennett, 1995; Nettle, 2010; Smith & Sullivan, 2007; Sullivan & Smith, 2005). Within psychology, in general, there are also many mistaken or incorrect ideas, concepts, and theories about the nature of mind and the relationship to its neural substrate (Uttal, 2003). Thus, when applying evolutionary perspective to human mind and behavior, misunderstandings play an important role because both erroneous ideas about evolution and about psychology meet and can reinforce each other. This article is thus aimed at analysis of misinterpretations about the application of the evolutionary framework to human mind and behavior.

Misunderstandings might lead to unnecessary controversies (Holcomb, 2001), they give an erroneous first impression to those not familiar with the field, misinforming interested readers and might dissuade them from pursuing it further (Kurzban, 2002). Thus, they have fueled resistance by many scientific fields, in particular within social sciences, in accepting that the theory of evolution can contribute to the comprehension of human behavior, which in turn promotes isolation from the evolutionary approach (Barker, 2006; Buss, 1999; Pinker, 2004; Salmon & Crawford, 2008). This conceptual conflict is especially evident in psychology, which is a heterogeneous field of many approaches and theoretical frameworks (Hass et al., 2000). The hindrance of dialogue between different theoretical perspectives reinforces a conceptual fragmentation, increasing barriers between various disciplines. A science of human behavior could greatly benefit from evolutionary knowledge, which provides a broader viewpoint of the interplay between nature and nurture (Hass et al., 2000).

Our aim was to make a systematic review of the literature on misunderstandings regarding evolutionary implications of human mind and behavior, and to categorize the field in order to systematize the most relevant aspects of misunderstandings. This topic has already been touched by evolutionary psychologists, and we have categorized the material into types of misunderstandings and their possible causes. The organized elucidations of each misunderstanding including didactic examples will be presented in detail in a forthcoming paper (Varella et al, in preparation).

It is worth pointing out, that we have distinguished misunderstandings from criticisms. Sometimes, of course, misconceptions correspond to undue application or generalization of relevant criticisms. Our intention, however, was not to dispute or analyze these criticisms, but rather to examine erroneous conceptions that represent obstacles to the potential contribution of the evolutionary perspective and its criticism. Holcomb (2001) separates non-constructive criticism from a constructive one: the first argues against such research, and the latter points to alternative paths or more achievable goals. Constructive criticism is very important for the progress of science, so by identifying types of misunderstandings and their causes our intent is to encourage well-founded constructive criticisms. We hope our analysis will contribute to more careful teaching and better science communication within psychology.

MATERIALS AND METHODS

The survey was carried out using the database *Web of Science* and books in the field of evolutionary psychology. The selection of the bibliographic material was

made by using the following criteria: (a) We analyzed texts when the title, abstract, or text of publications on the application of the evolutionary approach to human behavior contained the words "misunderstandings", its synonyms, and "controversy", "correction", "disagreement", "criticisms", "friction", "misuse", "distorted conceptions" or "resistance", and when the author(s) mentioned two or more of these terms; (b) We did not analyze texts that only contained conceptual descriptions and corrections without explicitly approaching misunderstandings; (c) We chose texts since 1992, because in that year evolutionary psychology became a recognized field of study (Cosmides & Tooby, 1992; Webster, 2007), and only one text per first author to keep up with the diversity of views and approaches; (d) We did not analyze texts that explicitly compiled misunderstandings regarding only specific aspects and theories of the evolutionary approach to human behavior (e.g. kin selection, sexual selection). According to the criteria, we found and analyzed 14 books, 9 articles and 2 book reviews, which are specified in Table 1.

Table 1: Sources of the analyzed material, chronologically.

Chapter or topic analyzed	*Publication year and pages*	*Author(s)*
1 - On the use and misuse of Darwinism in the study of human behavior	1992 (In: *The adapted mind*, Barkow, Cosmides & Tooby, pp. 137-162)	Symons
2 – Why Darwinism has been ignored or worse	1995 (In: *Homo Aestheticus*, pp. 13-23)	Dissanayake
3 - Standard equipment – Psychological correctness	1998 (In: *How the mind works*, pp. 44-58)	Pinker
4 - Common misunderstandings about Evolutionary Theory	1999 (In: *Evolutionary Psychology*; Allyn, Bacon, pp. 18-22)	Buss
5 - Criticisms of Evolutionary Psychology, mistaken criticisms and misunderstandings	1999 (In: *Introducing Evolutionary Psychology*; pp.134-166)	Evans & Zarate
6 - The relationship between the theory of evolution and social sciences, particularly psychology	2000 (*Annals of the New York Academy of Sciences*; pp. 1-20)	Hass *et al.*
7 - Resisting Biology: the unpopularity of a gene's-eye view	2000 (*Annals of the New York Academy of Sciences*; pp. 212-217)	Terleph
8 - On the evolution of misunderstandings about Evolutionary	2000 (*Annals of the New York Academy of Sciences*; pp. 218-223)	Young & Persell

Psychology		
9 - The Sociobiology controversy	2001 (In: *Animal Behavior*, pp. 459-462)	Alcock
10 - Evaluating Evolutionary Psychology	2001 (In: *Conceptual challenges in Evolutionary Psychology*, pp. 386-391)	Holcomb
11 - Introduction: Fear and Loathing of Evolutionary Psychology in the Social Sciences	2001 (In: *Evolutionary Psychology and Motivation*, French, Kamil & Leger, pp. ix-xxiii)	Leger, Kamil & French
12 - Clarifying the foundations of Evolutionary Psychology: A reply to Lloyd and Feldman	2002 (*Psychological Inquiry*, 13(2), pp. 157-164)	Ellis & Ketelaar
13 - Alas Poor Evolutionary Psychology: Unfairly Accused, Unjustly Condemned	2002 (*The Human Nature Review,* 2, pp. 99-109)	Kurzban
14 - Criticisms of Evolutionary Psychology	2003 (In: *Evolutionary Psychology: The Science of Human Behavior and Evolution*, pp. 44-49)	Rossano
15 - Criticisms of Evolutionary Psychology	2003 (In: *Encyclopedia of Cognitive Science*, pp. 52-53)	Sell *et al.*
16 - Agreement and disagreement in Evolutionary Psychology	2004 (In: *Evolutionary Psychology-An introduction*; pp. 24-27)	Workman & Reader
17 - Controversial issues in Evolutionary Psychology	2005 (In: *The handbook of Evolutionary Psychology*, Buss; pp. 145-173)	Hagen
18 - Modern application of Evolutionary Theory to Psychology: Key concepts and clarifications	2006 (*American Journal of Psychology*, 119(4), pp. 567-584)	Goetz & Shackelford
19 - Evolutionary Psychology is not evil! (…and Here's Why…)	2006 (*Psychological Topics*, 15(2), pp. 181-202)	Geher
20 - Two errors in thinking that we must avoid	2007 (In: *Why beautiful people have more daughters?*, pp. 04-06)	Miller & Kanazawa
21 - Evolutionary Psychology: the historical context. Why the wariness?	2008 (In: *Foundations of Evolutionary Psychology*, Crawford & Krebs, pp. 16-	Salmon & Crawford

	17)	
22 - Book Review - Analyzing evolutionary social science and its popularization	2009 (*Evolution and Human Behavior*, 30, pp. 301-304)	Frederick *et al.*
23 - Examining the acceptance of and resistance to Evolutionary Psychology	2010 (*Evolutionary Psychology,* 8(2), pp. 284-296)	Fitzgerald & Whitaker
24 - Evolutionary Psychology: Controversies, questions, prospects, and limitations	2010 (*American Psychologists,* 65(2), pp. 110-126)	Confer *et al.*
25 – Controversies in Evolutionary Psychology	2011 (*Teaching of Psychology*, 38(2), pp. 103)	Liddle & Shackelford

Categorizing Misunderstandings

Since we did a compilation of misunderstandings already identified, we define the term 'misunderstanding' as all explicit meta-language about misleading, erroneous, or simplistic interpretation regarding the meaning, presuppositions, and implications of the evolutionary approach to human mind and behavior, even though the authors may not have used the same terminology. We grouped the misunderstandings into categories according to similarities in explanation, preserving the subtleties between each one and the level of detail presented. Although some of these were similar, we aimed to maintain their peculiarities. The categories of misunderstandings were named with a clear and direct expression; sometimes with the name the authors had already used (e.g. genetic determinism); in other occasions we created new labels (e.g. Confusion between individual intention and adaptation's design). We also offer a brief definition of each one, based on analyzed texts.

Causes

We present the causes of misunderstandings as assigned by the authors, that is, the reasons that the author believes account for the misunderstandings. We again grouped the causes into categories according to similarities of the different individual, cultural, and conceptual factors that facilitate and/or originate misunderstandings.

RESULTS

According to similarities between single cases of misunderstandings with respect to their definition and elucidation, three following dimensions were identified:

individual, social, and evolutionary. In general, one misunderstanding can be placed in more than one category, so we adopted a didactic division that would account for relatively homogeneous groups on the subject, the focus of misunderstanding. Individual dimensions include categories of confusions related to the manifestations of biological factors in human mind and behavior (e.g. “nature versus nurture”, “immutable and inevitable nature”). The social dimension aggregates confusions related to the social implications of the biological factor (e.g. “naturalistic fallacy”, “racism and sexism”). Finally, the evolutionary dimension includes misconceptions related to the theoretical underpinnings of the evolutionary approach and focus on the origins of biological factors to human mind and behavior (e.g. “confusion between proximate and ultimate causation”, “intentional maximization of fitness”).

IDENTIFIED CATEGORIES AND MISUNDERSTANDINGS

a) Individual dimension

The first four misunderstandings listed below in Table 2 are quite similar to one another and could be grouped into a single category, depending on the goal. They are all based on a misconception about the manifestation and effects of genes on the mind, as if they were stereotyped and completely incompatible with the effects of experience. The fifth misunderstanding listed, results from opposition to the concept of innate, and supposes that everything is learned from experience. All these misconceptions prevent us from having full comprehension of biological influences on human psychological processes.

Table 2: Number of authors that identified each misunderstanding in the individual dimension.

Misunderstanding	Authors	Total
Immutable and inevitable nature	Buss; Ellis & Ketelaar; Evan & Zarate; Frederick *et al.*; Geher; Hagen; Hass *et al.*; Holcomb; Leger, Kamil & French; Pinker; Rossano; Salmon & Crawford; Sell *et al.*; Terleph; Young & Persell	15
Genetic determinism	Confer *et al.*; Buss; Evans & Zarate; Fitzgerald & Whitaker; Geher; Hagen; Hass *et al*.; Kurzban; Liddle & Shackelford; Rossano; Salmon & Crawford; Sell *et al.*; Workman &	13

	Reader	
Nature versus nurture	Confer *et al.*; Dissanayake; Evan & Zarate; Hagen; Hass *et al.*; Holcomb; Liddle & Shackelford; Salmon & Crawford; Terleph; Young & Persell	10
Reductionism	Evans & Zarate; Dissanayake; Geher; Hass *et al.*; Workman & Reader	5
Blank Slate	Confer *et al.*; Dissanayake; Geher; Salmon & Crawford; Symons	5

1) *Immutable and inevitable nature:* This can be defined as the assumption of fixedness in the functioning and development of human nature, based on a supposition that the naturally selected behavior and/or psychological process must be, by definition, stereotyped, and thus inevitable and impossible to be changed.

2) *Genetic determinism:* Corresponds to an undue supposition that naturally selected human behavior would be controlled exclusively by genes, with little or no contribution from the environment. All our actions would be genetically pre-programmed, without interference from education, culture, or any wish for change.

3) *Nature versus nurture:* Nature and nurture are considered incompatible, exclusive, or inversely proportional to one another; it follows that any time effects of nurture are identified, nature is discarded and vice versa.

4) *Reductionism:* The evolutionary approach would intend to explain all human psychology as a function of genes or neurons, ignoring the complexity and singularity of psychosocial and cultural phenomena, which would be, itself, a contradiction to the approach.

5) *Blank Slate:* The misunderstanding here is to consider the human mind as a blank slate, i.e., our behavior is completely the result of environmental influences. We would have no genetic predispositions, hence biology is totally discarded from explanations of human psychology, and the evolutionary approach would be irrelevant.

b) Social dimension

In this dimension, misunderstandings were assembled in Table 3 according to all social implications of the biological factor to human behavior: the fear that the evolutionary approach, by showing natural determinants of the human behavior, would justify social practices of domination, economic exploration, promotion of inequality, and would exempt individuals from responsibility for their own actions.

Table 3: Number of authors that identified each misunderstanding in the social dimension.

Misunderstanding	*Authors*	*Total*
Naturalistic fallacy	Alcock; Dissanayake; Evans & Zarate; Geher; Hagen; Kurzban; Leger, Kamil & French; Miller & Kanazawa; Pinker; Rossano; Salmon & Crawford; Terleph; Workman & Reader; Young & Persell	14
Racism and sexism	Frederick *et al.*; Geher; Hagen; Hass *et al.*; Kurzban; Leger, Kamil & French; Liddle & Shackelford; Pinker; Rossano	9
Political agenda	Confer et al.; Fitzgerald & Whitaker; Geher; Kurzban; Liddle & Shackelford; Terleph; Young & Persell	7
Status-quo justification	Evans & Zarate; Geher; Hagen; Pinker; Sell *et al.*	5
Moralistic fallacy	Holcomb; Miller & Kanazawa; Terleph	3
If it is genetic, I am not responsible	Hagen; Pinker	2

1) *Naturalistic fallacy:* Direct relation between what “is” and what “ought to be”. It is the naive idea that we can obtain moral lessons directly from

evolutionary studies. Innate behaviors are natural and therefore are desirable and the way it ought to be.

2) *Racism and sexism:* If the human mind has an innate structure, as postulated by the evolutionary perspective, people of different sex or ethnicity would have different innate structures, and this in turn could be used to justify inequality and oppression.

3) *Political agenda:* Evolutionists promote and defend certain behaviors as part of an implicit political sometimes even eugenicist agenda, simply because they believe these behaviors could have been adaptive during our evolutionary past.

4) *Status-quo justification:* If behaviors are fixed biologically, social change would be impossible to achieve, thereby justifying the status-quo.

5) *Moralistic fallacy:* Direct relation between "ought to be" and "is". If the society ought to be a certain way, then it can only be so. It is also known as the reverse naturalistic fallacy.

6) *If it is genetic, I am not responsible:* If behavior is caused or influenced by genes, individuals cannot be held responsible for their actions especially morally unaccepted behaviours, such as rape, sexual assault, murder, torturing, cheating, stealing and so on.

c) Evolutionary dimension

Misunderstandings classified into this dimension shown in Table 4 have in common some theoretical and methodological misconceptions about the evolutionary origins of the biological factor in human mind and behavior. The main misconceptions are related to selectionism and adaptationism, which include confusions between the proximate and ultimate explanations, the fitness concept, and adaptations.

Table 4: Number of authors that identified each misunderstanding in the evolutionary dimension.

Misunderstanding	*Authors*	*Total*
Just so stories	Confer et al.; Dissanayake; Ellis & Ketelaar; Evans & Zarate; Frederick et al.; Fitzgerald & Whitaker; Kurzban; Rossano; Salmon & Crawford; Sell *et al.*	10

Pan-adaptationism	Alcock; Evans & Zarate; Goetz & Shackelford; Kurzban; Leger, Kamil & French; Rossano; Sell *et al.*; Workman & Reader	8
Intentional maximization of fitness	Alcock; Buss; Ellis & Ketelaar; Hass *et al.*; Leger, Kamil & French; Terleph	6
Confusion between individual intention and adaptation's design	Buss; Goetz & Shackelford; Hagen; Symons; Terleph	5
Adaptation equals gene	Alcock; Confer *et al.*; Hagen; Hass et al.	4
Excessive modularity	Ellis & Ketelaar; Hagen; Leger, Kamil & French	3
Evolution as perfectionist	Buss; Terleph	2
A totally different Environment of Evolutionary Adaptation	Hagen	1
Selfish gene, selfish person	Hagen	1
If a trait is not an adaptation, it is not evolved	Leger, Kamil & French	1
Natural selection is too weak for originating complex adaptations	Sell *et al.*	1

1) *Just so stories:* Evolutionists accepted adaptive hypothesis just because they are good stories, constructed to fit the facts perfectly, according to the researcher's desire, thus unfalsifiable.

2) *Pan-adaptationism:* All human behaviors and psychological traits would be adaptive, and for all people.

3) *Intentional maximization of fitness:* Confusion between the evolutionary gene's point of view and personal intentions, also sometimes taking them as incompatible. The intentional motivation of the individual is treated as if it were the cause for which the genes have been evolutionarily selected, thus excluding the pleasurable and painful individual motivations. Then, individuals would have an active motivation to spread their genes, maximizing fitness.

4) *Confusion between individual intention and adaptation's design:* Confusion between the functional design of mental adaptations and personal intentions, sometimes taking them as incompatible. People would act aware of the internal logic of the functioning of mental adaptations and would have to be conscious of it in order for the mental adaptations to function well.

5) *Adaptation equals genes:* The main target of evolutionists in describing adaptations would be the search for genes specific to each behavior, e.g. gene for aggression, gene for homosexuality.

6) *Excessive modularity:* Evolutionists have exaggerated on the expected modularity of human mind, as if the human mind should have a specific module for each task imposed by the environment, a not very parsimonious position since it would be difficult to produce different and complex abstract thoughts from modules specific. Cognitive modules that process abstractions would then be less specific and less modular than those operating in more concrete representations about things, places and people.

7) *Evolution as perfectionist:* Evolution would have a progressive and optimizing goal, thus our traits would be the most perfect ones.

8) *A totally different Environment of Evolutionary Adaptation:* The modern human being would be living in a totally different environment from the ancestral one, so researchers should not adopt the Environment of Evolutionary Adaptability (EEA) as a model for the evolution of human behavior.

9) *Selfish gene, selfish person:* If there are selfish genes underlying the human behavior, then people would themselves be selfish.

10) *If a trait is not an adaptation, it has not evolved:* recent behaviors and maladaptive ones wouldn't have any related evolved aspect.

11) *Natural selection is too weak for originating complex adaptations:* natural selection is seen as being such a weak force in evolution, making adaptations poor and rendering functional predictions irrelevant.

CAUSES

Below in Table 5 we summarize the authors and the types of causes for misunderstandings they mentioned in their writings.

Table 5: Identified attributed causes for misunderstandings

Causes	Science communication	Historical	Cognitive	Ignorance	Theoretical	Philosophical
Authors	Frederick *et al.*; Holcomb; Terleph; Rossano	Dissanayake; Evans & Zarate; Hass *et al.*; Leger, Kamil & French	Leger, Kamil & French; Pinker; Young & Persell	Dissanayake; Holcomb; Pinker	Buss; Terleph	Terleph; Hagen
Total	4	4	3	3	2	2

a) Science communication

The causes of misunderstandings can partly be attributed to a lax didactic transposition made by popular press. Terleph (2000) states that the media can promote misunderstandings by simplifying the theory for popular consumption. Holcomb (2001) highlighted the oversimplification made by media coverage. Interestingly this media tendency fits right into the cognitive bias pointed out by Young and Persell (2000) and can contribute to originate misunderstandings related to cognitive and theoretical causes. Frederick et al. (2009) points out that some evolutionary researchers are sometimes careless and sensational when communicating with the lay public. Rossano (2003) also state that mistakes happen when "scientists communicate their ideas and theories to the general public. (...) One important challenge for evolutionary psychologists will be to communicate this message clearly to students and the public" (Rossano, 2003, pp. 49).

b) Historical causes

Some misunderstandings might have originated from the past misuses of evolution to justify political actions that occurred throughout history. The fear of new misuses has in many cases ruled out evolution completely. Misguided Social

Darwinism and Eugenics are the most cited misuses of evolutionary reasoning. For example, Evans and Zarate (1999) state that

> Darwin's ideas about evolution have been distorted by many people in an attempt to justify various political projects, some of which have been truly evil. (…) in Victorian times, Herbert Spencer (1820-1903) and other "social Darwinists" (…) thought they could find support in Darwin's ideas for their ruthless *laissez-faire* economic policies.(…) The critics of Evolutionary Psychology may be wrong in accusing it of genetic determinism, but their fears become more understandable in the light of history (Evans & Zarate, 1999, pp. 165-166).

Similarly, it is recognized that some "(…) Attempts to biologize human behavior led earlier in the 20th century to the now discredited eugenics movement, and to recurring attempts to explain differences between races in genetic terms. (…). For some the fear of biologizing psychology arises from the mistaken equating of evolutionary theory with genetic explanations" (Hass et al., 2000, p. 8).

Leger, Kamil and French (2001) also point out that "The antievolutionary sentiments of many social scientists stem from misunderstanding whose origins reach back to the centuries-old nature/nurture debate" (Leger, Kamil & French, 2001, p. xi). Dissanayake (1995) stated that "With this long history of perceiving Darwinist ideas to be irrelevant or perverse, and the phalanxes of influential contemporary philosophers and social scientist either actively opposed to or blithely unaware of contemporary Darwinian Theory and its implication (…)" (p. 22).

The historical causes, when combined with misunderstandings from both the individual dimension, such as genetic determinism (as put forth by Evans & Zarate, 1999), and the evolutionary dimension, such as adaptation equals genes (suggested by Hass et al. 2000) can lead to the misunderstandings from the social dimension, such as "If it is genetic, I am not responsible" or Status-quo justification.

c) Cognitive causes

For some authors the cause of these misunderstandings would be more related to the information processing patterns we use when reasoning about scientific theories. They would produce cognitive biases in understanding, giving rise to undue extrapolations. "(...) a large part of the controversy surrounding evolutionary explanations of behavior may come from our cognitive reasoning styles, which themselves are likely to have an evolutionary basis. (...) Two such patterns are (1) the tendency to oversimplify information so as to reduce demand on cognitive resources and (2) our strong desire to generate predictability and stability from perceptions of the external world" (Young & Persell, 2000, p. 218).

The solution proposed by the authors is developing a simple model of how genes and environment interact. "(...) but scientists have not yet developed a model to describe the genetic influence on behavior that has anything like the compelling logic of Mendelian genetics. As a result, controversy and confusion will inevitably accompany any discussion of the relationship between genetics and behavior." (Young & Persell, 2000, p. 221). On this subject, Pinker (1998) states that "The

debate over human nature has been muddied by an intellectual laziness, an unwillingness to make moral argument when moral issue comes up. The solution could be "To expose them [misunderstandings], one need only examine the logic of the theories and separate the scientific form the moral issues" (p.47).

Leger, Kamil, and French (2001) add that "All (...) [misunderstandings] persist because some psychologists seem threatened by this 'new' way of thinking. (...) Studies of development and of proximate mechanisms (...) will not and should not go away." (Leger, Kamil & French, 2001, p. xi).

These causes are more related to the individual and evolutionary dimension because we can find oversimplification in some misunderstandings such as "Immutable and inevitable nature" and "Nature versus nurture", but also "Confusion between proximate and ultimate causation", "Intentional maximization of fitness" and "Adaptation equals gene".

d) Ignorance

To Holcomb (2001), another source of misunderstanding is the ignorance made by people not educated in the area, concerning various aspects of this approach, such as its multidisciplinary nature, its vast specific literature, its objectives and methodologies, its explanatory theoretical reasoning and the context of the researches in each study. The solution proposed by the author is to continuously apply self-criticism to our interpretation and judgment. Dissanayake (1995) also pointed out ignorance: "…social and political philosophers and social scientists are seen to join hands with New Agers and creationists in their inherent prejudice against, ignorance of, and intrinsic lack of sympathy with Darwinism" (p.21). Pinker (1998) stated that "(…) they [misunderstandings] are thought to be extrapolations that the untutored masses might draw, so the dangerous ideas must themselves be suppressed" (p. 47).

Although the intellectual laziness for doing moral arguments is related to misunderstandings of the social dimension, these causes are related to misunderstanding regarding the three dimensions and can also contribute to a superficial science communication, since journalists usually lack a proper background on the topic.

e) Theoretical causes

Some features of the theory of evolution itself complicate the understanding of even its basic principles and its update subsequent to the new synthesis. According to Buss (1999), "The theory of evolution by selection, although elegant in its simplicity, generates a number of common misunderstandings. Perhaps its very simplicity leads people to think that they can understand it completely after only brief exposure to it - after reading an article or two in the popular press, for example" (p. 18).

For other authors, like Terleph (2000), "(…) misconceptions [about evolution and natural selection] which arises in part from an overemphasis on the individual, rather than the gene (…), our own proclivity towards overemphasizing the role of individuals in evolution is seen as a common impediment to a more complete

understanding of both natural selection, as well as the philosophical implications arising from a gene's eye view of evolutionary theory" (p.212). The solution proposed by the author is making the genes the protagonists of natural selection, and not the individual. We believe that this emphasis can generate other misunderstandings, because intention could be attributed to genes, or generating the assumption that selfish gene originates a selfish person, and so on. Even if the focus is on the gene, it is necessary to consider misunderstandings that might appear, like what happened to Dawkins (1982) after criticism of his book *The Selfish Gene*.

These causes are more related to the evolutionary dimension, however as Terleph (2000) pointed out, they can originate some misunderstandings from the individual dimension as well, such as Reductionism.

f) Philosophical causes

This category groups causes related to the fundamentals of the concept of man, associated with philosophical positions. Terleph (2000) highlights that the evolutionary perspective is commonly considered to be incompatible with our sense of self and this acts as an obstacle to the full comprehension and acceptance of the evolutionary theory. "People do not like perceiving themselves as what is described in *The Selfish Gene* by Dawkins (later much maligned by his critics) as "lumbering robots", whose ultimate job is merely to pass on the replicators. We similarly dislike views that splinter our sense of self. We feel like individuals (...)" (p. 215).

Hagen (2005) states that the causes of some misconceptions can be found in philosophical postures that are divergent and incompatible with evolutionary monism. This is because much of the scientific criticism surrounding these misunderstandings derives from a dualism between body and mind, rejected by evolutionary psychology. The previous impediment is based on a philosophical position somewhat independent from other theoretical questions, because even if one is properly exposed to evolutionary concepts, belief in dualism would make understanding difficult. These causes are more related to some of the misunderstandings from the individual dimension, such as "Reductionism" and "Nature versus nurture".

DISCUSSION

We categorized twenty-two types of misunderstandings concerning evolutionary psychology, five in the individual dimension, six in the social dimension and eleven in the evolutionary dimension. By far the most cited misunderstandings were three: "Immutable and inevitable nature" within individual dimension with fifteen references, "Naturalistic fallacy" within social dimension with fourteen references, and the two within evolutionary dimension related with adaptationism: "Just so stories" and "Pan-adaptationism", together with eighteen references. Most authors are explicitly referring to at least one misunderstanding of each dimension.

The current analysis presents a systematic review of the literature on misunderstandings regarding the evolution of human mind and behavior, in particular evolutionary psychology. We categorized misunderstandings already

highlighted by evolutionary psychologists and their attribution on possible causes of its occurrences. Our approach might be understood as a continuum to a perspective of Deaner et al (2010), who identified misleading statements about evolutionary psychology, specifically regarding sex differences done by authors of sociology books, and of Wilson, Dietrich, and Clark (2003), who identified inappropriate solutions to the misunderstanding of naturalistic fallacy done by evolutionary psychologists.

The texts analyzed in this article referred to misunderstandings in a broad sense pointed out by evolutionary psychologists regarding the evolutionary approach applied to human mind and behavior in general. Thus, we have not been focusing on specific behavioral questions. In specific areas of the evolutionary approach to human mind and behavior, authors have already identified and clarified misunderstandings. As an example, Pinker in *The Blank Slate* (2002) addressed three misunderstandings of the modern denial of human nature: the blank slate, the noble savage (related to naturalistic fallacy), and the ghost in the machine (dualism). Miller (2003) identified and clarified six misunderstandings about the theory of fitness indicators, in order to decrease the ideological fears that hinder the understanding of the modern theory of sexual selection. Park (2007) identified and clarified three misunderstandings about inclusive fitness and kin selection found in social psychology textbooks. West, El Mouden and Gardner (2011) approached and elucidated sixteen misconceptions regarding the evolution of cooperation and altruism in humans. Henrich, Boyd and Richerson (2008) addressed and solved five misunderstandings about memetics and cultural evolution. It is important to keep in mind the importance and complementarity of both, our general approach and those specific ones.

In our study, we have shown more than 20 different types of misunderstandings, stemming from three different dimensions. However, various approaches might be adopted to analyze in more detail specific misunderstandings. For example, Curry (2006) has identified 8 types of misunderstandings which we label under naturalistic fallacy: (1) moving from ‘is’ to ‘ought’ (Hume’s fallacy), (2) moving from facts to values, (3) identifying good with its object (Moore’s fallacy), (4) claiming that good is a natural property, (5) going ‘in the direction of evolution’, (6) assuming that what is natural is good, (7) assuming that what currently exists ought to exist, and (8) substituting explanation for justification. In contrary, our approach is aimed at showing more general patterns of misunderstandings, in the average level of detail that evolutionary psychologist have been focusing. For instance, in more specific approach, we might have separated racism from sexism, or separated attributing inevitability to the development from attributing it to the functioning of mind and also separated them form the inevitability as uncontrolled actions. Nevertheless, here we have focused on showing broad categories of all types of misunderstandings identified previously.

Due to the heterogeneity of views and approaches we have analyzed, misunderstandings present the mistake in different positions. Some misunderstandings start off as misconceptions, such as "Immutable and inevitable nature" and "Naturalistic Fallacy". These misconceptions, when assigned to the evolutionary studies, distort the understanding of concepts in the area. Others start from misconceptions, not attributed to evolutionary approach, but to Social

Sciences. They are shown in this review because they are common contrary reactions to specific misunderstandings applied to evolutionary psychology. For example, "Blank Slate" stands in opposition to "Genetic determinism", and "Moralistic fallacy" as opposed to "Naturalistic fallacy". By including these misconceptions here we gain a broader view of the dynamics of misunderstandings and the relations of opposition between them. These oppositions probably have originated by evolutionary psychology critics using the straw-man strategy, mischaracterizing the field, to easily appear the winner of the discussion.

Some misunderstandings arise from correct notions and pertinent criticism, but are assigned to evolutionary approach as if it was inherent to it. In "Just so stories", for example, the notion that scientists should not only invent good stories without proper verification is a constructive criticism, however, this problem should not be considered as an inherent attribute of evolutionary psychology in general.

Attention should be brought to the close connection between the misunderstandings, in which one leads to other, forming cohesive and stable aggregates of misconceptions. This idea has already been noted by Pinker in *The Blank Slate* (2002) and earlier by Dawkins in *The Extended Phenotype* (1982). For Dawkins, the "genetic determinism" misconception originates from the association between the gene myth (genes go through the generations without environmental influences, so their phenotype cannot be influenced either) and the computer myth (if something is programmed, it is immutable and inevitable). Considering human nature as immutable and inevitable is related to the notion that genes control our behavior, which in turn is related to the impression that genes exclude culture and nurture, a notion related to the reductionism that is attributed to the field. Therefore, inter-relations are not restricted to one dimension, and can create cross-dimensional aggregations. For instance, a misunderstanding can begin as "Adaptation equals gene" (evolutionary dimension), pass through "Genetic determinism" (individual dimension) and end with the notion that "If it is genetic, I am not responsible" (social dimension).

Further, our analysis allows offers a taxonomical approach, and thus, giving us a big picture of the subject. The categorization we propose separates misunderstanding related to the origins (evolutionary dimension), from the ones related to manifestations (individual dimension), from the ones related to the social implications (social dimension) of the biological factor of human mind and behavior. This categorization can help us understanding the underline logic and lines of reasoning, and thus helps us to create more appropriate teaching approach, and wide elucidations strategies.

Our proposed categorization creates a bridge between the categorizations done in the field of misunderstandings about psychology and misinterpretations about evolution. Uttal (2003) in reviewing what he called the psychomyths (mistaken ideas, concepts, and theories about the nature of mind), identified ten main driving forces behind them: (1) confusion of the endogenous with the exogenous, (2) inevitable natural laws, (3) superpowerful mathematics, (4) self-organizing systems, (5) misconceptions about measurement, (6) miraculous graphs, (7) misleading statistics, (8) erroneous assumptions and conceptual errors, (9) nonillusions, and (10) persistent mysteries. Inside our individual dimension we have “Nature versus nurture” which is more or less related to (1) confusion of the endogenous with the

exogenous, and “Immutable and inevitable nature” which is related to (2) inevitable natural laws. Most of the other misunderstandings we gathered are related to (8) erroneous assumptions and conceptual errors.

In the “Understanding Evolution” webpage of Berkeley University (http://evolution.berkeley.edu/evolibrary/misconceptions_faq.php) there are 37 misconceptions about evolution and each respective correction. There, the misunderstandings about evolution are categorized into misconceptions about: (1) evolutionary theory and processes, (2) natural selection and adaptation, (3) evolutionary trees, (4) population genetics, (5) evolution and the nature of science, (6) the acceptance of evolution, (7) the implications of evolution, (8) evolution and religion, and (9) teaching evolution. Most of the misunderstanding we gathered in the evolutionary dimension is strongly related to (2) misconceptions about natural selection and adaptation, and most of the erroneous concepts we complied in the social dimension is strongly related to (7) the implications of evolution. Hence, we can basically say that misunderstandings about evolutionary psychology are composed of one third misconceptions stemming from psychology mostly in the individual dimension and two thirds misrepresentations about Evolution mostly related to the social and evolutionary dimensions.

Our next aim was to gather the attributed causes to misunderstandings. We have analyzed six different types of causes given by the authors: (1) science communication, (2) historical, (3) cognitive, (4) ignorance, (5) theoretical, and (6) philosophical. It is important to note that in spite of their differences, they are not mutually exclusive. Importance of all of them should be considered in order to adopt more effective measures for elucidating and reducing misunderstandings. As Holcomb (2001) points out, the synergistic effect between the causes provides the perfect recipe for an inaccurate and unfair view of the field.

One of the most cited causes of misunderstandings was the science communication for the lay public about evolutionary studies. Terleph (2000) and Holcomb (2001) claim that communication to general public about evolutionary psychology is done in a loose and simplified manner, fit for popular consumption. To this, we can add the sensationalism that often revolves around the approach, with eye-catching headlines, inappropriate from a theoretical point of view, as Frederick et al. (2009) pointed out. Examples of inaccurate and inappropriate news headlines can be: “When men go to war, blame their sex drive: Males evolved to be 'aggressive to outsiders', says psychology study”, or “Why suicide bombers are Muslim (lack of sex) and liberals are more intelligent: A controversial psychologist's VERY politically incorrect 'truths' about human nature”. Hence, scientists should be both cautious and aware of misunderstandings that can be generated and propagated in science communication when writing and/or giving interviews to journalists. Moreover, the very causes pointed out, such as cognitive biases and theoretical difficulties can be part of the causes generating the mistakes made by science communicators.

The historical and theoretical causes are important. We cannot change history, but we can use history in our favor, showing what not to do or interpret from the evolutionary approach, as suggested by Buss (Barker, 2006). Terleph (2000) states that theoretical causes importantly contribute to misunderstandings by

emphasizing inadequate conceptual framing or by the apparent simplicity in the theory of evolution, as Buss (1999) pointed out.

Cognitive causes can point to the fact that human pattern of processing information has biases that possibly lead to misunderstandings. An example given by Young and Persell (2000) is the misconception about "nature and nurture", which are viewed as opposite and incompatible, as a result of cognitive simplification due to the complexity of the problem. Buss in a recent lecture (2012) mentioned that we have evolved cognitive bias actively interfering with understanding evolutionary processes. He pinpointed two evolved cognitive bias: essentialism and teleology. During our lifetime, animal forms are perceived as very stable to us, this enables us to categorize them in an essentialist ethnozoology, but it presents obstacles for the understanding of the process of evolution which is populational (see Nettle, 2010 for an empirical substantiation of this point). According to Buss, our capacity to teleology enables us to guess desires and motives of other humans, but we also misattribute desires, motives and intentions to inanimate objects, other organisms and to the process of natural selection itself. A thorough understanding of the human information processing patterns could help the elaboration of teaching strategies that make use of the cognitive bias for a more effective learning, thus avoiding misunderstandings.

Emotional causes of misunderstandings have been underestimated so far. Pinker (2002) already pointed out that at least four fears could be negatively modulating the interpretation and acceptance of evolution: (1) the fear of inequality, indicating that if people are innately different, oppression and discrimination would be justified, (2) the fear of imperfectability meaning that if people are innately immoral, hopes to improve the human condition would be futile, (3) the fear of determinism indicating that if people are the products of biology, free will would be a myth and we could no longer hold people responsible for their actions, and (4) the fear of nihilism stating that if people are products of biology, life would have no higher meaning and purpose. Also, factual ideas about the rejection of dualism by scientific monism, genetic basis of human behavior, mental adaptations for murder, genetic differences in cultures concerning talents, average temperaments, and the existence of some psychological mechanisms with automatic functioning are considered dangerous ideas nowadays, just as Copernican heliocentric model was a dangerous idea in the past (Brockman, 2007).

Some authors claimed that philosophical causes, such as mind and brain dualism, prevent a real understanding of the approach, which is monistic (Geher, 2006; Hagen, 2005). For Dennett (1995), the gene point-of-view seems threatening because we do not want our interests to come in 'second' place. Moreover, the sum of dualistic and anthropocentric postures, which oppose the monist and gene-centered-view of evolution, motivate not only misunderstandings, but also resistance to the idea of evolution in the form of creationism, intelligent design, and the Standard Social Science Model. Making explicit the philosophical basis and conceptions underlying the evolutionary approach is an important strategy to overcome some misunderstandings.

The lack of adequate knowledge about the area is also a frequent cause of misunderstandings, as stated by Holcomb (2001). Cornwell et al. (2005) have found many inaccuracies in introductory psychology textbooks regarding sociobiology and

evolutionary psychology. Park (2007) also found three persistent mistakes on social psychology textbooks. Deaner et al (2010), by systematically analysing the most popular sociology and psychology textbooks, not only found fourteen misunderstandings regarding explanations for the evolutionary approach about sex/gender differences, but also empirically investigated one possible cause for it, and found evidence supporting the cycle of ignorance and resistance in academy, especially in Sociology textbooks. Therefore, it should be required that textbooks and classes in psychology and related areas explicitly address misunderstandings trying to improve the awareness about inaccuracies. In addition, Buss (in Barker, 2006) comments on the role of other disciplines in psychology, whose teachers make theoretical confusions themselves and propagate misunderstandings to the students.

It is noteworthy that most authors did not address the possible causes of misunderstandings, limiting themselves to identify them. This pattern is also found when dealing with misunderstandings in other areas. Smith and Sullivan (2007) wrote a book on identifying and elucidating ten misunderstandings about the Theory of Evolution, but dedicated only one paragraph to the causes. The causes listed were: (1) ignorance, (2) inadequate teaching in schools, (3) mistakes, (4) limitation of popular press, and (5) religious issues that hinders the acquisition of scientific knowledge. Two of these causes of misunderstandings about Evolution are similar to the ones we have presented in this study.

Understanding the causes of misconceptions and simplistic interpretations helps us to effectively overcome them. Full comprehension of the problem of misunderstandings is not complete if their causes are not investigated and presented together with their descriptions and corrections. The effective raise of awareness regarding misunderstandings and their proper clarification are 'proximate' interventions, almost palliative measures if they are not connected with the 'ultimate' interventions on its causes. A wide and integrated approach to misunderstandings enables more inclusive and effective teaching interventions, increasing conceptual integration and decreasing unfounded criticism.

HOW INSTRUCTORS MIGHT TRY TO COMBAT MISUNDERSTANDINGS IN THE CLASSROOM

There have not been many initiatives that exclusively target misunderstandings and although many of those initiatives are more concerned with combating critics than with improving teaching, all of the few papers focused on teaching evolutionary psychology deal explicitly with misunderstandings (see Barker, 2006, Buss, 2010, Liddle & Shackelford, 2011). The majority of authors we have analyzed dedicated a small part at the beginning of their books to address this issue. This shows that without addressing misunderstandings in the beginning, one cannot proceed successfully on teaching the basic concepts of this field. Hence, the first implication for teachers from our systematic review is to start the course already approaching explicitly the common misunderstandings of the field. We also provide

a rich source of the literature in this area that can be used in class and recommended for students.

The importance of approaching misunderstandings explicitly can be found in Barker (2006), who interviewed Buss about his experience in teaching evolutionary psychology. When he asked Buss about how might psychology teachers counter sorts of misunderstandings, Buss said: “In my experience, it helps greatly to devote a reasonable amount of time to explaining the logic of the enterprise, working through a number of concrete examples, and then dealing with the misunderstandings head on” (p. 72).

Buss (Baker, 2006, Buss, 2010) elaborated a conceptual toolkit for teaching evolutionary psychology and many of his teaching advices deal directly with combating misunderstandings in the classroom. In the lecture “Why students love evolutionary psychology… and how to teach it” from November 5th of 2012 in the American Psychological Association YouTube channel (http://www.youtube.com/watch?v=Y7fMzMgpFFU), he talked about 20 teaching conceptual tools to improve classes of evolutionary psychology, they are: (1) Convey sense of ‘deep time’ by providing a table of ‘milestones in human evolutionary history’ from emergence of life on earth to recent historical events, and by conveying a spatial metaphor of an American football field; (2) Stress the multiple levels of explanations in behavioral, psychological, neurological, physiological, etc.; (3) Explain the three theories of the origins of complex adaptive mechanisms (creationism, seeding theory, evolution by natural selection), by stressing the scientific utility of each theory heuristic value, ability to generate new predictions, it is possible to avoid issues with creationists; (4) Explain natural selection in great detail (variation, inheritance and differential reproduction); (5) Explain the importance of the theory of sexual selection and that the final arbiter of which characteristic evolve is the reproductive success, not only survival; (6) Explain the core tenets of evolutionary psychology (a. All behavior is an interaction between psychological mechanism and environmental input, b. All psychological mechanism, at some basic level, originate from evolutionary process, c. Natural and sexual selection are the most important evolutionary processes responsible for creating psychological mechanisms, d. Evolved psychological mechanism can be described as information processing devices, e. Evolved psychological mechanisms are instantiated in the brain, f. Evolved psychological mechanism are functionally designed to solve statistically recurrent adaptive problems), (7) Teach the critical distinction between ultimate and proximate causation; (8) Explain that humans were not “designed” to understand the causal processes that created their own psychology; (9) Show that we have evolved cognitive bias actively interfere with understanding evolutionary process (e.g. essentialism and teleology); (10) Draw analogies to the human body talking about the functions of liver and heart as well as mate selection and cooperation; a good body example is the callus-producing adaptation; (11) Use lots of animal examples, especially mating behavior, to help students to decenter a bit and see our species through a more objective scientific lens; (12) Use examples that relate to what is important in the lives of students: mating, cooperation, aggression, common clinical problems like depression and eating disorders, social and parental and offspring conflict; (13) Use thought

experiments, e.g. 'what would you do if you were a gene and your mission is replicate more successfully that other genes?' thus present inclusive fitness revolution (ensure the survival of your 'vehicle'(body), influence your 'vehicle' to reproduce, and aid in the survival and reproduction of other 'vehicles' that contain copies of you, help genetic relatives); 'list all the qualities females and males want in their partners', or 'list the things the men do that irritate, anger, annoy or upset women'; (14) Deal explicitly with controversial topics (warning #1: there are dark sides of human nature; warning #2 sexual conflict is prevalent; warning #3 there are evolved sex differences); (15) Emphasize that well constructed evolutionary psychological hypotheses are testable and hence falsifiable, mention theories that have been confirmed (sex differences in mating strategies) and that have been falsified by empirical experiments (kin altruism theory of homosexuality, evolved mate preference for virginity, "loser male" design feature of rape hypothesis). The cumulative and self-correcting nature of evolutionary psychology is precisely what should be taught in introductory psychology classes; (16) Lighten up, show a sense of humor using cartoons; (17) Explain heuristic value of evolutionary psychology which guides research to important domains; (18) Show that evolutionary psychology is consilient, promotes unity of knowledge (a. organizes known facts parsimoniously, b. provides guidance to important domains, c. leads to new predictions, d. unifies psychology with the life sciences); (19) Show humility and honesty, (20) Show excitement, awe and appreciation to be living during one of the most important scientific revolution in the history of psychology.

According to Liddle and Shackelford (2011), teaching evolutionary psychology presents several unique challenges. "Arguably the greatest challenge to teaching evolutionary psychology is that students must understand and accept as true the theory of evolution by natural selection" (p. 130). Buss (Baker, 2006) agrees with that when mentioning that "(…) it's sometimes tough because students usually have no prior exposure to the principles of evolutionary biology and so come into class with many misconceptions (…)" (p. 72). We have shown that, indeed, most of the misunderstandings compiled are in the evolutionary dimension. For this reason, Liddle and Shackelford (2011) stated that approaching the topic of evolutionary psychology requires teachers to engage in substantial preparatory work. For them, providing students with the information they need to accept evolution as established fact, such as giving concrete examples of the evolutionary process (e.g. the evolution of the eye) is prerequisite to teaching evolutionary psychology successfully. Furthermore, teaching evolution is not part of curriculums of most undergraduate and graduate courses (Glass, Wilson & Geher, 2012) which shows how important is to increase the number of place where evolution is taught.

Therefore a second implication of this review to evolutionary psychology teachers is to devote some time first to address the common misunderstandings about evolution. For that matter the "Understanding Evolution" webpage of Berkeley University and the following literature might be of a good start (Alters & Nelson, 2002; Dawkins, 1982; Dennett, 1995; Gregory, 2009; Nettle, 2010; Smith & Sullivan, 2007; Sullivan & Smith, 2005). The literature on misunderstandings about evolution is more advanced than the one on evolutionary psychology. There are several questionnaires already validated aiming on measuring the level of understanding,

literacy and acceptance of evolution, for instance, the “Measure of Acceptance of the Theory of Evolution - MATE” a 20-item Likert scale (see Rutledge & Sadler, 2007 for a recent reliability test), the “Evolutionary Attitudes and Literacy Survey - EALS” a 104-item measure (see Short & Hawley, 2012 for a development of a short form), the “Inventory of Student Evolution Acceptance - ISEA” a 24-item Likert scale encompassing microevolution, macroevolution, and human evolution (Nadelson & Southerland, 2012). Evolutionary psychologists could use some of those questionnaires to do an initial scanning of previous misconceptions and prejudice against evolution on students, and also be inspired by them on creating new scales more focused on misconceptions about evolutionary psychology.

Alters and Nelson (2002) discuss the teaching of evolution in higher education and stress the importance of considering the prior conceptions that students have. They have presented five groups of prior misconceptions: (1) From-experience misconceptions, (2) Self-constructed misconceptions, (3) Taught-and-learned misconceptions, (4) Vernacular misconceptions, (5) Religious and myth-based misconceptions. Not surprisingly, traditional pedagogy considers the student as a passive blank slate. Evolutionary psychologists know that students, as human beings, bring not only phylogenetic, but ontogenetic, and cultural prior bias to the classroom. Alters and Nelson (2002) suggest the use of a constructivist approach for dealing with prior misconceptions and resistance to evolution, emphasizing critical thinking, student-student discussion, creation by students of concept maps and promotions of historically rich presentations. Nelson (2008) note that three fundamental changes need to occur for teaching evolution more effectively: use structured active learning extensively, focus on scientific and critical thinking, and directly address misconceptions and student resistance.

Wilson (2005) uses many of those advices to successfully teach “Evolution for Everyone”, including human evolution and evolutionary psychology. For him, the best strategy to teach evolution overcoming prior misconceptions is to focus first on the presumed implications. This requires acknowledging and challenging all the past threatening associations with immorality, determinism, and social policies ranging from eugenics to genocide and uses of the theory to justify racism and sexism. “When these issues are discussed at the beginning of the course, students put their own threatening associations with evolution on hold and become curious (…)” (p.1002). After overcoming the threatening ideas regarding implications, Wilson presents natural selection and adaptationism, and only later explains that culture and learning are products of evolution, not contradictory. Thus, the third and last implication of our paper to professors is to start covering misunderstandings from the social dimension which deals with the implications of evolution, then the evolutionary dimension and later the ones from the individual dimension.

CONCLUDING REMARKS

We consider misunderstandings a topic of a great theoretical, educational, and communicational importance, because misunderstandings are barriers to the dialogue between fields, and also prevent students, scientists and lay people from

attaining a proper understanding of the concepts and their implications. Furthermore, the scientific study of misconceptions in evolutionary approach applied to human mind and behavior is an interdisciplinary area that involves the study of logic and structure of argumentation, cognitive psychology, pedagogy, history of science, philosophy of science, and science communication to general public. This is a large and complex area, because it raises questions about how several misunderstandings relate to each other and then to the diversity of causes, and, in turn, how the diversity of causes is related to its means of propagation. Future studies should use the scientific method to explore the chain of connections between misunderstandings and their causes in order to improve elucidations strategies and remove these barriers to the interdisciplinary and consilient endeavor of Darwinian revolution.

REFERENCES

Alcock, J. (2001). *Animal behavior: An evolutionary approach* (7ª ed.). Sunderland: Sinauer.

Alters, B. J., & Nelson, C. E. (2002). Perspective: Teaching Evolution in Higher Education. *Evolution: International Journal of Organic Evolution*, 56(10), 1891-1901.

Barker, L. (2006). Teaching Evolutionary Psychology: An interview with David M. Buss. *Teaching of Psychology*, 33(1), 69-76.

Barrett, L., Dunbar, R., & Lycett, J. (2002). *Human Evolutionary Psychology*. Princeton: Princeton University Press.

Brockman, J. (Ed.) (2007). *What is your dangerous idea? Today's leading thinkers on the unthinkable.* New York: Harper Perennial.

Buss, D. M. (1999). *Evolutionary Psychology: The new science of mind*. Austin: Allin & Bacon.

Confer, J. C., Easton, J. A., Fleischman, D. S., Goetz, C. D., Lewis, D. M. G., Perilloux, C. & Buss, D. M. (2010). Evolutionary Psychology: Controversies, questions, prospects, and limitations. *American Psychologist*, 65(2), pp. 110-126.

Cornwell, R.E.; Palmer, R.; Guinther, P.M., & Davis, H.P. (2005). Introductory Psychology texts as a view of sociobiology/evolutionary psychology´s role in psychology. *Evolutionary Psychology*, 3, 355-374.

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

Crawford, C., & Krebs, D. (Eds.) (2008). *Foundations of Evolutionary Psychology*. New York: Lawrence Erlbaum Associates.

Curry, O. (2006). Who's afraid of the Naturalistic Fallacy? *Evolutionary Psychology,* 4, 234-247.

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

Deaner, R. O., Winegard, B. M., & Winegard, B. M. (2010). Misrepresentations of evolutionary theory in social science textbooks. *Annals of the 22nd Annual Conference of the Human Behavior and Evolution Society*, Eugene, Oregon.

Dennett, D. (1995). *Darwin's dangerous idea*. New York: Simon & Schuster.

Dissanayake, E. (1995). Homo Aestheticus. Where art comes from and why. Seatle: University of Washington Press.

Ellis, B. J., & Ketelaar, T. (2002). Clarifying the foundations of Evolutionary Psychology: A reply to Lloyd and Feldman. *Psychological Inquiry*, 13(2), pp. 157-164.

Evans, D., & Zarate, O. (1999). *Introducing evolutionary psychology.* Cambridge: Incon Books.

Fitzgerald, C. J., & Whitaker, M. B. (2010). Examining the acceptance of and resistance to Evolutionary Psychology. *Evolutionary Psychology*, 8(2), pp. 284-296.

Frederick, D.A., Pillsworth, E. G., Galperin, A., Gildersleeve, K. A., Filossof, Y. R., Fales, M. R., Lopez, C. R., Luyere, F. S., Phuphanich. M. E., & Snider, J. B. (2009). Analyzing evolutionary social science and its popularization - Book Review. *Evolution and Human Behavior*, 30, pp. 301-304.

Gangestad, S. W., & Simpson, J. A. (Eds.). (2007). *The evolution of mind: Fundamental questions and controversies.* New York: Guilford.

Geher, G. (2006). Evolutionary Psychology is not evil! (…and here's why…). *Psychological Topics*, 15(2), 181-202.

Glass, D.J., Wilson, D.S., & Geher, G. (2012). Evolutionary training in relation to human affairs is sorely lacking in higher education. *EvoS Journal: The Journal of the Evolutionary Studies Consortium, 4*(2), 16-22.

Goetz, A. T., & Shackelford, T. K. (2006). Modern application of Evolutionary Theory to Psychology: Key concept and clarifications. *American Journal of Psychology,* 119(4), 567-584.

Gregory, T. R. (2009). Understanding natural selection: essential concepts and common misconceptions. *Evolution, Education & Outreach*, 2(2), 156-175.

Hagen, E. H. (2005). Controversial issues in Evolutionary Psychology. In M. D. Buss (Ed.) *The Handbook of Evolutionary Psychology* (pp. 145-173). Hoboken: John Wiley & Sons.

Hass, R. G., Chaudhary, N., Kleyman, E., Nussbaum, A., Pulizz, A., & Tison, J. (2000). The relationship between the theory of evolution and the social sciences, particularly psychology. *Annals of the New York Academy of Sciences*, 207, 1-20.

Henrich, J., Boyd, R., & Richerson, P. J. (2008). Five misunderstandings about cultural evolution. *Human Nature*, 19(2), 119-137.

Holcomb III, H.R. (2001). Evaluating evolutionary psychology: check your lens. In H. R. Holcomb III (Ed.) *Conceptual challenges in evolutionary psychology: innovative research strategies* (pp. 375- 392). Dordrecht: Springer.

Kurzban, R. (2002). Alas poor evolutionary psychology: Unfairly accused, unjustly condemned. *Human Nature Review*, 2, 99-109.

Leger, D. W., Kamil, A. C., & French, J. A. (2001). Introduction: Fear and Loathing of Evolutionary Psychology in the Social Sciences. In: J. A. French, A. C.

Kamil, D. W. Leger (Ed.) *Evolutionary Psychology and Motivation* (pp. ix-xxiii). Lincoln, University of Nebrasca Press.

Liddle, J. R. & Shackelford, T. K. (2011) Teaching the Evolution of the Mind: Current Findings, Trends, and Controversies in Evolutionary Psychology. *Teaching of Psychology*, 38(2) 128-132.

Miller, A. S., & Kanazawa, S. (2007). *Why beautiful people have more daughters.* New York: Penguin Group.

Miller, G. F. (2003). Fear of fitness indicators: How to deal with our ideological anxieties about the role of sexual selection in the origins of human culture. In *Being human: Proceedings of a conference sponsored by the Royal Society of New Zealand* (pp. 65-79). Wellington, NZ: Royal Society of New Zealand, Miscellaneous series 63.

Nadelson, L. S. & Southerland, S. (2012). A More Fine-Grained Measure of Students' Acceptance of Evolution: Development of the Inventory of Student Evolution Acceptance - I-SEA. *International Journal of Science Education,* 34(11), 1637-1666.

Nettle, D. (2010). Understanding of evolution may be improved by thinking about people. *Evolutionary Psychology*, 8(2), 205-228.

Park, J.H. (2007). Persistent misunderstandings of inclusive fitness and kin selection: their ubiquitous appearance in social psychology textbooks. *Evolutionary Psychology*, 5(4), 860-873.

Pinker S. (1998). *How the mind works*. London: Penguin Books.

Pinker, S. (2002). *The blank slate*. London: Penguin Books.

Rossano, M. J. (2003). *Evolutionary Psychology: The Science of Human Behavior and Evolution*. Hoboken, NJ: Wiley & Sons.

Rutledge, M. L. & Sadler, K. C. (2007). Reliability of the Measure of Acceptance of the Theory of Evolution (MATE) Instrument with University Students. *The American Biology Teacher,* 69(6), 332-335.

Salmon, C., & Crawford, C. (2008). Evolutionary Psychology: The Historical Context. In C. Crawford; D. Krebs (Eds.). *Foundations of Evolutionary Psychology* (pp. 1-21). New York: Lawrence Erlbaum Associates.

Sell, A., Hagen, E., Cosmides, L., & Tooby, J. (2003). Evolutionary psychology: Applications and criticisms. In *Encyclopedia of Cognitive Science* (pp. 47-53). London: Macmillan.

Short, S. D. & Hawley, P. H. (2012). Evolutionary Attitudes and Literacy Survey (EALS): Development and Validation of a Short Form. *Evolution, Education & Outreach*, 5, 419-428.

Smith, C. M., & Sullivan, C. (2007). *The top 10 myths about evolution*. New York: Prometheus Books.

Sullivan, C., & Smith, C. M. (2005). Getting the Monkey off Darwin's Back: Four common Myths about Evolution. *Skeptical Inquirer,* 43-48.

Symons, D. (1992). On the use and misuse of Darwinism in the Study of human Behavior. In J.H. Barkow, L. Cosmides, and J. Tooby *The adapted mind: Evolutionary psychology and the generation of culture* (pp. 137-162). New York: Oxford University Press.

Terleph, T.A. (2000). Resisting Biology: The unpopularity of a gene´s-eye view. *Annals of the New York Academy of Sciences* 907, 212-217.

Uttal, W. R. (2003). Psychomythics: sources of artifacts and misconceptualizations in scientific psychology. Mahwah: Lawrence Erlbaum Associates, Inc.

Varella, M. A. C., Santos, I. B. C., Ferreira, J. H. B. P., & Bussab, V. S. R (in preparation). Compiled clarifications and corrections about misunderstanding of Evolutionary Psychology.

Webster, G. D. (2007). What's in a name: Is "Evolutionary Psychology" eclipsing "Sociobiology" in the scientific literature? *Evolutionary Psychology*, 5(4), 683-695.

West, S. A., El Mouden, C., & Gardner, A. (2011). Sixteen common misconceptions about the evolution of cooperation in humans. *Evolution and Human Behavior,* 32(4), 231-262.

Wilson, D. S., Dietrich, E., & Clark, A. B. (2003). On the inappropriate use of the naturalistic fallacy in evolutionary psychology. *Biology and Philosophy*, 18, 669-682.

Workman, L., & Reader, W. (2004). *Evolutionary Psychology: An introduction*. Cambridge: Cambridge University Press.

Young, J., & Persell, R. (2000). On the evolution about misunderstandings of Evolutionary Psychology. *Annals of the New York Academy of Science*, 907, p. 218-223.

Received 7/22/12; Revision received 1/7/13; Accepted 1/16/13