



The interdisciplinarity of evolutionary approaches to human behavior: A key to survival in the Ivory Archipelago

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ARTICLE INFO

Article history:

Available online 25 May 2011

ABSTRACT

This paper explores the degree of interdisciplinarity of evolutionary approaches to the study of human behavior, and the implications that any such interdisciplinarity may have for the future of evolutionary psychology (EP) as a field of scholarship. To gauge the extent of interdisciplinarity of EP, the departmental affiliation of first-authors from 1000 journal articles evenly distributed across ten leading peer-reviewed psychology journals was assessed. Findings show that journals that are evolutionary-based have more first-authors from outside of psychology, and also include a wider variety of represented disciplines. These findings are discussed in terms of their influence on the future of EP, as a model for interdisciplinary research. EP's future will be successful if it continues to promote interdisciplinarity as well as recognize the epistemological worth of multiple evolutionary paradigms and frameworks. Evolutionary principles have been successfully applied to a broad range of topics, suggesting there is great utility in evolution serving as a common language for interdisciplinary pursuits within the behavioral and social sciences. As such, academic programs such as Evolutionary Studies (EvoS) programs, whose presence continues to increase across academic institutions worldwide, epitomize the future of successful interdisciplinary scholarly training.

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1. Introduction

Evolution provides a unifying framework by which to tackle an extraordinarily broad range of topics. This fact is evidenced by the success of published books on varied topics where evolutionary principles guide the primary thesis: love [1,2], the arts [3], music [4], disease [5,6], intelligence [7,8], consumer behavior [9], economics [10], religion [11,12], homicide [13], war [14], parenting [15,16], literature [17], morality [18], skin color [19], language [20], culture [21], politics [22], mate-choice [8,23], family studies [24], sociology [25], archaeology [26], architecture [27], computer science [28], and perhaps most popularly, sex [29–32], just to name a few. This list demonstrates that diverse applications of evolutionary thinking have come to typify modern academia – and we expect that such applications will characterize scholarship in the future.

On its own, the world of academia may be as suggested by David Sloan Wilson [33] more aptly called the *Ivory Archipelago* as opposed to the traditional term *Ivory Tower*. From this perspective, academia consists of isolated disciplinary islands that

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are too often disconnected from one another. Consistent with Wilson's take on the current state of academia, we proclaim that evolutionary theory has the consilient power to build interdisciplinary bridges between these islands. In particular, we consider the application of evolution to human behavior as "evolutionary psychology" (EP) which is inherently interdisciplinary and which naturally connects widely to intellectual domains outside psychology proper. We use the term "evolutionary psychology" in the broadest sense here, encompassing the various evolutionary perspectives on human behavior (e.g., evolutionary psychology, human sociobiology, human behavioral ecology, memetics, gene-culture coevolution, ethology). We recognize the subtle variations and do not align here with any particular narrow view, as we later advocate that "EP" should, and in the future will, include all these subtle variations. We additionally address what being *interdisciplinary* means for the epistemological and academic development of a discipline. Further, we contend – and empirically demonstrate – that EP is currently much more interdisciplinary than other fields, yet it still needs to continue to branch out and integrate with other academic fields to ensure its continued future success. Otherwise, EP may face the same fate as its early predecessor, *sociobiology* [34], which due to a tumultuous political history is now unjustly considered taboo in some academic circles [35,36].

A telling example of the interdisciplinary nature of evolutionary approaches to human behavior is revealed via the various home departments that house the authors of the current article: biology, anthropology, psychology, and marketing. This fact demonstrates what is at the core of our discussion – that researchers working within an evolutionary framework can cover a broad range of academic disciplines, united by a common metatheoretical thread. Further, such collaborative interdisciplinarity allows each contributor to bring discipline-specific knowledge to bear while sharing a common scientific lexicon. We agree that an evolutionary approach is not *necessarily* reductive [37,38], but rather that it is able to address questions at the ultimate level of explanation – an intended antithesis of a reductive approach. Ultimate explanations seek to explore *why* questions of causation (i.e., why in the adaptive sense), whereas proximate explanations seek to explore mechanistic *how* questions of causation. EP approaches are often focused on ultimate questions, which is why evolution's application to other fields has been beneficial in building a holistic perspective to include *both* levels of causation. Platek, Keenan, and Shackelford demonstrated this perspective in their outlining of evolutionary cognitive neuroscience [39], as did Garcia and Saad [40] in their integration of the neuromarketing literature using an evolutionary lens. To best contribute to future scholarship, EP should capitalize on its interdisciplinarity – not by imposing itself on other disciplines as has somewhat been the case when EP has ventured into the humanities (e.g., Literary Darwinism), but rather by offering a truly *integrative* and conciliatory dialogue for research on various phenomena [41].

The evolutionary framework finds its origins and most of its mainstream applications in the biological sciences. However, its expansion in guiding varied fields of inquiry has contributed to a wealth of new knowledge. Toward this end, we suggest that the recent housing of cross-disciplinary evolution programs within an interdisciplinary context in terms of college and university curricula – as has been successfully implemented via the Evolutionary Studies (EvoS) programs at Binghamton University and SUNY New Paltz – provides a blueprint for evolutionary behavioral scientists to work within a vibrant and supportive intellectual atmosphere [33,42,43]. Such an initiative is pivotal to the future success of EP.

In 2008, the National Science Foundation awarded nearly a half million US dollars to Binghamton University and SUNY New Paltz in their efforts to expand interdisciplinary EvoS programs like theirs throughout the United States [43]. The initial consortium of schools that expressed an interest in developing such a program includes no less than thirty colleges and universities – covering a broad spectrum from community colleges (e.g., Broome County Community College) to major research universities (e.g., University of Pennsylvania). Whereas we show here that EP has thus far been driven by a substantial interdisciplinarian ethos, we contend that the future of EP lies in the continued building of epistemological bridges and stronger attempts at integration between fields of inquiry – EvoS programs provide a platform for such pursuits.

2. Hurdles to the expansion of EP

It is undeniable that EP's future is laced with hurdles of many varieties. For evolution to realize its potential as a unifying paradigm across the behavioral and social sciences, these hurdles must be overcome. First, evolutionists must address the staunch resistance found on both ends of the political spectrum [42]. Strongly aligned with fundamentalist Christian doctrines, many conservatives reject evolution outright – as such, they necessarily reject EP [37]. However, it is important for all evolutionists to address this conflict in a clear and methodical manner. As Heywood, Garcia, and Wilson [41] discuss, this includes understanding and respectfully answering the qualms of their critics in accessible forms of communication, not by flippantly marginalizing the claims and accordingly failing to resolve any disagreements. Evolutionists themselves, Heywood, Garcia, and Wilson [41, p. 2] write:

"Evolutionists don't always communicate in ways that best serve our cause. In the humorous documentary *Flock of Dodos* (2006), biologist turned filmmaker Randy Olson examines the evolution/intelligent design debate, and finds that although he agrees with their ideas, scientists by and large suffer from a failure to communicate the principles of evolution effectively to the public."

In the case where religious doctrine is incongruent with evolutionary principles, it is particularly important that those working within the EP paradigm effectively explain the meaning of evolution as applied to human behavior (rather than creation). Most EP scholars can, in this view, take a non-frontal approach to navigating this hurdle. The macroevolution-

design debate has been complex, contentious, and charged [44], but in many cases, EP need not be pitted against religious narratives. For example, natural theology is a movement that accepts natural laws including evolution as the works of a Divine creator. In other instances, scientists have sought to steer clear from the evolution-religion conflict by arguing that each operates in a separate sphere (e.g., Stephen Jay Gould's non-overlapping magisteria principle). Whereas the current authors do not necessarily endorse such approaches, they recognize their pragmatic utility in navigating through the science-religion divide. EP is interested in how evolutionary biology has shaped the human mind and not how the world and life on it came to be, questions more appropriately investigated by physicists, geologists, and macroevolutionists. Of note, religion has itself been investigated within the EP paradigm [11,12,45]. In this regard, *some* work by evolutionists as relating to a possible adaptive nature to religiosity may actually serve a conciliatory function between evolutionists and religious individuals.

Ironically, within the confines of academia, the primary resistance to evolution stems from the far liberal left. Some social scientists who abdicate evolutionary theory tend to view EP as a conservative conspiracy, designed among other things, to keep men in powerful positions in society and to justify inequitable social outcomes. Such misguided and uninformed perceptions cause schisms within academic areas, such as frequently demonstrated in anthropology departments, where staunch disagreements on the validity of applying evolution to human behavior are palpable [46]. Scholars who represent the far left's resistance to EP often frame evolutionary-based findings, such as Buss, Larsen, Westen, and Semmelroth's [47] classic research showing that men are more distressed by sexual infidelity than are women, as making a comment about how things *ought* to be. Thus, in this case, they might interpret these findings as suggesting that men *should* be highly distressed by their partners engaging in sexual infidelity and that behaviors designed to reduce the likelihood of such infidelity, including violence toward women [48], are justifiable. This tendency of some scholars to conceptualize findings regarding human nature in a prescriptive light has been termed *the naturalistic fallacy* [49] – and it stands as a major epistemological hurdle to the greater acceptance of EP.

Incidentally, it is worth noting that evolutionary psychologists are not any more politically conservative than their non-evolutionist counterparts within academic psychology [50] – and a careful inspection of the works of the large majority of evolutionary psychologists should make it abundantly clear that these scholars seek to *understand* and *explain* behavior and not *justify* or *prescribe* it. A more scientific way in which one might challenge research claims such as Buss, Larsen, Westen, and Semmelroth's findings would be to empirically show that the jealousy sex-differences with respect to infidelity dissipates as a function of important situational and measurement-based (i.e., forced-choice questionnaire) variables. This point, demonstrated by Lishner and colleagues [51] and published in the journal *Evolutionary Psychology*, explicates an example of alternative evolutionary explanations of findings within EP itself, a sign of a healthy field of scholarship. Wilson, Dietrich, and Clark [52] provide a thorough discussion of how evolutionary psychologists should interpret and consider the naturalistic fallacy, and the propensity of those within EP to be led astray by it in their work, and the tendency of critics to use it against EP.

In any case, the dogged anti-EP sentiments from the far political left thrive in the Ivory Archipelago (see McCaughey [53] for a critique of EP from a feminist perspective). Whereas evolutionists have repeatedly provided trenchant rebuttals to such critiques [37,38,54], their persistent ubiquity serves as a significant obstacle to EP's future growth. The continued presence of these fundamental debates is a clear sign that the epistemological issues at hand have thus far not been sufficiently settled. Therefore it is imperative for EP researchers to be aware of such critiques, and of the implications of their research, both for intellectual triumph in these debates, and as a matter of social responsibility. A particularly striking example of this issue occurred when Randy Thornhill and Craig Palmer published their book titled *A Natural History of Rape* [55]. Most critics focused on the moral implications of arguing that rape might be adaptive, rather than critiquing the scientific validity of the postulated arguments. Interestingly, it is the latter that would have identified exiguous scholarship more effectively, such as the scientifically rooted claim that Thornhill and Palmer's book contained nine logically fallacious applications of the naturalistic fallacy [52]. This example highlights the fact that EP researchers must do two things in response to hurdles posed by the naturalistic fallacy: (1) they must be prepared to acknowledge and address criticisms beyond their own community of scholarship in a sophisticated and systematically rigorous manner and (2) they must be aware of the sociopolitical implications of their research. Otherwise, EP runs the risk of being viewed as lacking internal checks, to be dismissively cast as a misfit among the behavioral sciences, lacking in compassion and out of tune with contemporary human struggles. While we argue that this portrait does not and need not characterize EP, such concerns characterize the major humanistic hurdles to the study of human nature.

Another important obstacle to EP's increased acceptance in the future is the *knowledge* hurdle. Misconceptions about evolution abound both inside and outside of academia [49]. People often misunderstand the basic premises of natural selection, hold a species-centric perspective on evolution [56], or conflate evolutionary theory with a eugenicist agenda – mistakenly thinking that evolution has some planned direction and that a super-human species is somehow its *goal* [37]. Ultimately, the knowledge hurdle coupled with the aforementioned political hurdles need to be addressed by our educational systems [42]. One of the primary benefits of EvoS programs is to teach the fundamental principles of evolution in a thematic and cross-disciplinary fashion, and to provide students (and faculty) within an entire academic community the opportunity to see how those principles are then applied to disparate areas. As such, the EvoS platform not only serves as an education tool but also becomes a powerful outlet for facilitating interdisciplinary collaborations among researchers [33,42,43]. Such a pedagogical approach goes a long way toward addressing the numerous hurdles faced by EP today.

Currently, EP stands at the proverbial crossroads. On the one hand, work done under the banner of EP is growing enormously – both in volume and in impact [57]. In fact, a recent analysis of the impact of *Evolution and Human Behavior*, EP's most elite scholarly outlet, found that this journal has roughly as large a scholarly impact as other leading perspective-based journals in the behavioral sciences [58]. As such, perhaps the influence of EP is set to grow exponentially in the next several decades. On the other hand, as mentioned previously, the resistance to EP is flagrant, and it seems to be growing at about the same pace as EP itself [37], suggesting that the future of EP is potentially uncertain. As evolutionary behavioral scientists, we hope to provide insights to facilitate the steady growth of the evolutionary perspective within academia. To reiterate, we believe that the development of EvoS programs at institutions of higher education will help both the ideological and knowledge-based hurdles described here. We hope to highlight here the manner by which EP may capitalize on this interdisciplinary initiative as a means of securing its future success.

3. Where EP needs to expand

Notwithstanding its current plurality, in the future, EP will need to expand its topical foci while staying abreast of the methodological advances in the natural sciences (e.g., neurosciences, genetics, and endocrinology). Geher and Miller [7, p. xxi–xxii] proclaimed:

“Evolutionary psychology needs a rejuvenating tonic. It needs to crossbreed with new fields before it suffers from inbreeding depression and intellectual stagnation. Granted, it has succeeded brilliantly in developing research programs on sexual strategies, reciprocity, kinship, and other core aspects of human nature that were too long neglected in mainstream psychology. These research programs have become Kuhnian normal science – not exactly treading water, but no longer suffering the big waves of a radical paradigm shift. A sense of premature complacency can sometimes be discerned in the leading evolutionary psychology conference (the Human Behavior and Evolution Society meeting) and journals (*Evolution and Human Behavior*, *Human Nature*, *Evolutionary Psychology*).”

We posit that the rejuvenating tonic alluded to in this passage will stem partly from an openness toward other evolutionary-based approaches. For instance, not all researchers working within the evolutionary behavioral sciences identify themselves as evolutionary psychologists. Such scholars include human behavioral ecologists, human sociobiologists, gene-culture coevolution modelers, and memeticists [59]. A synthesis between these evolutionary-based scholars will permit for a broader range of methodological and theoretical plurality [60]. One of the critiques levied against EP is that it focuses too staunchly on adaptationism in identifying human universals. On the other hand, other evolutionary behavioral approaches, such as cultural group selection, eloquently tackle culture-specific phenomena by recognizing the importance of adaptive plasticity in various ecological niches [61]. The adaptationist regime will no doubt benefit from infusion of these culturally informed concepts [21]. Examples of tools that might be further adopted by EP include mathematical modeling, population genetics to map patterns of ancestral migration, hormonal analyses to test reactions to evolutionarily relevant social situations and cognitive tasks, and increased use of neuroscientific/neuroimaging techniques to determine what an adaptive ‘module’ may truly mean in terms of how the brain differentially responds to stimuli (e.g., mate-choice, kin detection, altruism, risk-avoidance). In so doing, EP can draw on the rich tapestry that exists for studying human behavior.

As suggested earlier, it is also important for EP to position itself in terms of integrating with other areas of study, not simply applying evolution to existing frameworks. The only way the natural and behavioral sciences can be merged with disciplines within the humanities, for instance, is to take an integrative approach. Heywood, Garcia, and Wilson [41, p. 1] discuss the benefit of an evolutionary approach that is integrative rather than intellectually imperialistic:

“Although Darwinism has gained a foothold in the social sciences, in the humanities, with a few exceptions, it is still largely rejected – not, as some would claim, because humanists are all radical poststructuralists who deny that material reality exists. . . as part of a humanistic approach to literature and art, a more productive truly “two way” approach is necessary, and must do more than impose the scientific method on the humanities. When this kind of imposition occurs, the humanities are treated *only* as subject matter, thereby discounting historical and interpretive research that is invaluable to scientists and claims they might make in these areas.”

Although evolution has been applied to a broad range of topics, to be a maximally interdisciplinary endeavor, EP must continue to draw both concepts and methodological advancements from other disciplinary foci. By infusing EP with tools from other disciplines such as the neurosciences – which possess an eclectic toolset to assist in understanding physiological responses – EP can continue to grow and demonstrate the consistency of research findings across methodologies (e.g., survey, interview, endocrinological, genetic, neuroimaging), eventually overcoming its greatest epistemological critique, namely of being accused of being a post hoc science. Wilson [33, p. 6–7] notes the extent to which evolution has been applied across wildly different fields:

“Indeed, evolution is increasingly being used to study all things human in addition to the rest of life. I recently conducted an analysis of the highly respected scientific journal *Behavioral and Brain Sciences (BBS)*. . . *BBS* is ranked first among 40 behavioral sciences journals. . . My analysis shows that during the period 2000–2004, 31.5% of the *BBS* target articles used the word “evolution” in the title or as a key word, for topics as diverse as religion, schizophrenia, infant

crying, language, food transfer in hunter-gatherer societies, facial expression, empathy, vision, brain evolution, decision making, phobias, mating, cultural evolution, and dreams. In other words, *using evolution to study our own species is not a future event or fringe science. It has already arrived.*"

As previously mentioned, we argue that interdisciplinarity is key to the continued success and growth of EP. With that in mind, we provide next a brief discussion of the importance of interdisciplinarity to science in general, as well as alternate ways by which one might measure it.

4. Scientometrics of interdisciplinarity

A growing number of universities and funding institutions recognize the value of interdisciplinary research in solving complex scientific problems. As such, there has been increased attention in identifying institutional-level mechanisms for facilitating such research [62,63]. Nissani [64] provided ten reasons for the importance of interdisciplinarity, one of which proposed that creative approaches oftentimes necessitate interdisciplinary expertise beyond the scope of any one particular discipline. Case in point: physicist Albert-László Barabási recently collaborated with geneticist Marc Vidal (along with several other colleagues, including physicians) to map the human disease network [65]. This is further evidenced by the following representative quotes lauding the value of interdisciplinarity:

"The complexity of today's research problems increasingly demands that scientists move beyond the confines of their discipline. ... important discoveries are being made at the intersection of disciplines."

- Tappeiner, Tappeiner, and Walde [66, p. 253]

"Interdisciplinarity is considered the best way to face practical research topics since synergy between traditional disciplines has proved very fruitful."

- Morillo, Bordons, and Gómez [67, p. 1237]

"In recent years, interdisciplinarity has become synonymous with all things modern, creative and progressive about scientific research. The interdisciplinarity imperative has arisen not from a simple philosophic belief in 'interdisciplinarity' or 'heterogeneity' but from the character of problems currently under study, many of which require the combined efforts of scholars trained in different disciplines."

- Rhoten [68, p. 2]

"Progress in scientific research is especially likely to appear at contact points between scientific fields, giving rise to 'hyphenated sciences'."

- Balaban & Klein [69, p. 627]

There are many ways by which to document the interdisciplinarity of a field. One can gauge whether scholars in one field cite works from other disciplines (importing from other disciplines). Alternatively, one can explore the extent to which scholars in various disciplines cite works in a particular discipline (exporting to other disciplines). A third way of capturing interdisciplinarity is to identify patterns of author collaborations – namely the extent to which scholars in one field collaborate with those from other disciplines. Fourthly, one can determine how often scholars in a particular field publish in journals outside their core disciplinary bounds. Finally, one can calculate the frequency with which scholars of various fields publish in a specific discipline other than their own core (the data presented in the subsequent section fit this conception of interdisciplinarity).

Typically these types of questions are tackled by scientometricians, these being scholars who study the structural networks of science. Scientometric analyses of interdisciplinarity have been conducted using a wide range of tools including concept mapping [70], cluster analysis using citation data [71], and social network analysis to calculate a betweenness centrality metric [72]. Of relevance to the current paper, Qin, Lancaster, and Allen [73] found that of the fields they investigated, biology and the medical sciences were the most interdisciplinary. We report here a scientometric analysis to examine the degree of interdisciplinarity of EP relative to other metatheoretical perspectives in the behavioral sciences.

5. Hypotheses and method

Ten behavioral science academic journals were analyzed to examine the relative interdisciplinarity of EP-based research as compared to other thematic areas of psychology. We differentiate between "perspective-based" as opposed to "content-based" sub-disciplines. By "perspective-based," we mean theoretical approaches (e.g., psychodynamic psychology) as opposed to a particular content area (e.g., personality psychology). We restricted our analyses to perspective-based areas, as EP itself is best construed as a theoretical framework rather than a specific content area. We predict that journal articles in evolution-themed journals are more likely to (a) include first-authors from outside psychology proper and (b) include first authors from a wider variety of academic departments compared to the other fields of psychology. Our analysis recorded the departmental affiliations of the first authors of articles – thus allowing us to gauge whether authors in the field of evolutionary psychology are more likely to originate from a broader range of disciplines. Five thematic topic areas of

psychology were included, with two journals within each topic area – for a total of ten individual journals. Decisions to include topic areas (e.g., psychodynamic psychology) were based on key theoretical perspectives that were consistently identified in General Psychology textbooks. The five perspectives that we ultimately chose were evolutionary psychology, behavioral neuroscience, cognitive psychology, learning/behaviorism, and psychodynamic psychology. We included two journals per area to mitigate the effects of journal-specific idiosyncrasies. Based on data from www.eigenfactor.org, which ranks academic journals for quality and impact, we included journals that were generally among the premier journals in each area. The chosen journals were the following:

Evolutionary psychology

Evolutionary Psychology

Evolution and Human Behavior

Neuroscience

Annual Review of Neuroscience

Neuron

Cognitive Psychology

Cognition

Cognitive Psychology

Learning/Behaviorism

Journal of Experimental Psychology: Learning, Memory, and Cognition

Learning and Memory

Psychodynamic Psychology

Journal of the American Psychoanalytic Association

American Journal of Psychoanalysis

5.1. Procedure

For each journal, the departmental affiliation of the first author of each article was recorded, starting with the most recent issue as of the beginning of the year 2009 and proceeding backwards until 100 articles were included. In instances where an affiliation was framed in terms of a sub-specialization, the author's home academic department was utilized (e.g., a cognitive psychologist who studies serial visual search tasks would be considered a psychologist). Further, repeat first authors were omitted. Specifically, if someone were a first author on two or more occasions and had already been counted as such, subsequent articles by that author were not counted. When the departmental affiliation was ambiguous or difficult to gauge from the article itself, we conducted individual Internet searches to obtain the necessary information. For each of the five perspectives areas, 200 data points were collected (100 articles for each of two journals), thus totaling one thousand (1000) data points. We concluded that 100 articles per journal would provide us with a representative sample in gauging the interdisciplinary status of the different fields, while concurrently providing us with sufficient data for the statistical tests.

6. Results

To examine whether the evolutionary psychology journals are more interdisciplinary than the other four fields, two chi-square goodness-of-fit tests were conducted. Each chi-square test, addressing a particular issue, examined if the frequency of first authors from outside psychology in the evolution-themed journals differed significantly from the frequency across the journals. The first addressed if evolutionary psychology journals differ from other journals in terms of the presence of first-authors from outside the discipline of psychology. The second addressed if the total number of non-psychology disciplines varied significantly across the different journals (also based on an analysis of the departmental affiliations of first authors). Table 1 shows the frequencies of first-authorship by academic departmental affiliation for all 10 journals examined.

6.1. Examining if the frequency of non-psychologist first-authors differs across fields

A chi-square goodness-of-fit test for the journals was computed by examining if the frequency of non-psychology first-authors differed significantly across the ten journals (with two journals representing EP and eight representing fields outside EP). The null hypothesis for this test is essentially that the journals do not differ significantly from one another in the extent to which they have first-authors from outside psychology proper. Thus, the *expected* values in this analysis reflect the average

Table 1
Frequencies of first authorships by academic department.

<i>Evolution and Human Behavior</i>		<i>Annual Review of Neuroscience</i>		<i>Cognitive Psychology</i>		<i>Learning and Memory</i>		<i>American Journal of Psychoanalysis</i>	
Psychology	63	Psychology	76	Psychology	95	Psychology	92	Psychology	92
Anthropology:	15	Biology:	18	Anthropology:	1	Anthropology	1	Art	1
Biology	5	Medicine	5	Business	1	Medicine	6	Linguistics	4
Economics	5	Physics	1	Linguistics	1	Public Policy	1	Medicine	3
Epidemiology	3			Medicine	2				
Law	1								
Medicine	2								
Musicology	1								
Public Policy	3								
Sociology	2								

<i>Evolutionary Psychology</i>		<i>Neuron</i>		<i>Cognition</i>		<i>Journal of Experimental Psychology: Learning, Memory, and Cognition</i>		<i>Journal of the American Psychoanalytic Association</i>	
Psychology	69	Psychology	75	Psychology	92	Psychology	95	Psychology	96
Anthropology	9	Biology	19	Linguistics	6	Business	1	Anthropology	1
Biology	7	Medicine	6	Philosophy	2	Education	2	Literature	1
Economics	1					Public Policy	1	Philosophy	1
Education	3					Speech Science	1	Political Science	1
English	1								
Epidemiology	2								
IT	1								
Linguistics	1								
Philosophy	4								
Poli. Science	1								
Zoology	1								

frequency of non-psychology first-authors across the ten journals – this came to 15.5. If the *observed* frequencies, representing the actual frequency of non-psychology first-author for each journal deviates significantly from this expected frequency, the chi-square should increase. This analysis was marginally significant ($\chi^2(9) = 16.41, p < .10$; see Table 2). Consistent with the hypothesis, the two evolutionary psychology journals included a greater number of first-authors who were not housed in psychology departments (37 of 100 for *Evolution and Human Behavior* and 31 of 100 for *Evolutionary Psychology*) as compared to the other, non-EP journals. The fact that this analysis was marginally significant suggests a strong trend for EP journals to include non-psychology contributors relative to other journals.

To examine the specific issue of whether the two evolutionary psychology journals differed significantly from the other journals in the proportion of non-psychology affiliated first authors, a z-test of equal proportions was conducted. This z (8.28) was found to be highly significant ($p < .01$), indicating that the proportion of non-psychology first-authors in the evolutionary psychology journals (68/200) is significantly greater than the proportion found in non-evolutionary psychology journals (87/800).

6.2. Examining if the number of non-psychology disciplines differs across fields

A chi-square analysis was computed to determine if the number of fields outside psychology differed across the ten journals. This analysis specifically examined how many different fields were reflected in the affiliations of the first-authors of

Table 2
 χ^2 Goodness of fit results; observed frequencies represent the number of first-authors from non-psychology departments for each journal.^a

Journal	Expected	Observed
<i>Evolutionary Psychology</i>	15.5	31
<i>Evolution and Human Behavior</i>	15.5	37
<i>Annual Review of Neuroscience</i>	15.5	24
<i>Neuron</i>	15.5	25
<i>Cognition</i>	15.5	8
<i>Cognitive Psychology</i>	15.5	5
<i>American Journal of Psychoanalysis</i>	15.5	8
<i>Journal of the American Psychoanalytic Association</i>	15.5	4
<i>Journal of Experimental Psychology: Learning, Memory, and Cognition</i>	15.5	5
<i>Learning and Memory</i>	15.5	8

$\chi^2 = 16.41; p < 0.10.$

^a The “expected” frequency, 15.5, is the average number of non-psychology first-authors across the ten journals; First authors from 100 articles per journal were included in this analysis.

Table 3 χ^2 Goodness of Fit Results Examining if the Journals Differ in the Number of Different Areas Outside Psychology Represented by First-Authors.^a

Journal	Average number of academic departments outside psychology being represented by first authors across journals	Observed number of academic departments outside psychology represented
<i>Evolutionary Psychology</i>	4.5	11
<i>Evolution and Human Behavior</i>	4.5	9
<i>Annual Review of Neuroscience</i>	4.5	3
<i>Neuron</i>	4.5	2
<i>Cognition</i>	4.5	2
<i>Cognitive Psychology</i>	4.5	4
<i>American Journal of Psychoanalysis</i>	4.5	3
<i>Journal of the American Psychoanalytic Association</i>	4.5	4
<i>Journal of Experimental Psychology: Learning, Memory, and Cognition</i>	4.5	4
<i>Learning and Memory</i>	4.5	3

 $\chi^2 = 18.33; p < .05.$

^a The “expected” frequency, 4.5, is the average number of fields outside psychology represented by first-authors across the ten journals; First-authors from 100 articles per journal were included in this analysis.

the articles. Thus, while the prior analysis examined if the frequency of non-psychology first-authors differed across the journals, this analysis addresses if the number of non-psychology fields differed across the journals. Thus, if a journal included articles first-authored only by psychologists, sociologists, and anthropologists, the frequency of non-psychology fields would be two. This analysis was conducted to gauge *the number of different fields* represented across the journals.

Again, a chi-square goodness-of-fit test was implemented. This test had a null hypothesis that the frequency of number of academic fields outside psychology would not differ significantly across the journals. As such, the *expected* number, *vis à vis* this null hypothesis, was the number of non-psychology fields represented by each journal, summed and divided by 10 – this came to 4.5. To the extent that some journals have actual (observed) frequencies that are considerably lower or greater than this expected number, the chi-square statistics will increase. The analysis was significant ($\chi^2(9) = 18.33, p < .05$), offering additional support for the general hypothesis regarding the greater interdisciplinarity of EP. A greater number of academic disciplines were represented within evolution-themed journals compared to the non-evolution-themed journals (see Table 3).

As with the prior chi-square analysis, this test was followed up with a z-test of equal proportions to see, in this case, if the proportion of fields outside psychology differed between the evolutionary psychology and other journals. In this particular case, importantly, the *proportions* are not fully interpretable in a literal sense, as the variables they are derived from do not represent binomial probabilities (yes/no) situations. For instance, if the field of biology was represented 20 times in the 200 evolutionary psychology articles, the field of biology would only be counted once given the nature of our metric here. Thus, our metric does not provide data that fully adhere to the assumptions of the z-test for equal proportions. However, to address the issue of statistical significance, we computed – notwithstanding the latter violation – a z-test, to at least provide us with a rough sense of whether these effects are statistically significant. The 200 evolutionary psychology articles contain first authors from 16 distinct disciplines outside of psychology, while the 800 non-evolutionary psychology articles contain first authors from 14 distinct disciplines outside psychology. The z-test ($z = 4.44$) is highly significant ($p < .01$).

7. Implications for EP

Our analysis demonstrates that authors of articles in evolutionary-themed journals call on far more departmental affiliations outside of psychology compared to their non-evolutionary-based counterparts. Not only do evolutionary-themed journals have a more disciplinarily diverse authorship in terms of number of departments represented, but they also have a greater overall percentage of articles written by those in departments outside of psychology proper. Of note, the field that came in second in terms of interdisciplinarity is neuroscience. This is perhaps not surprising considering that the neurosciences are not strictly restricted to behavioral neuroscience, but also include molecular, anatomical, and biomedical explorations of the brain.

The primary implication of these findings is that EP is already a full-fledged interdisciplinary field. Given the epistemological benefits of cross-disciplinary scholarship, this fact warrants optimism regarding EP's future. However, given the numerous sources of resistance to EP, some of which were addressed earlier, evolutionists should not rest on their laurels. Instead, they must continually seek to expand their disciplinary boundaries. Such interdisciplinarity is at the core of initiatives such as EvoS, which brings together individuals from all academic levels and backgrounds under one evolutionary rubric. In the future, EvoS programs are poised to become the structural catalyst to support true interdisciplinarity, integration, and project development.

As with any paradigm, EP's future rests in its ability to satisfactorily address its staunchest critics (e.g., David Buller's [74] critique of EP). Such critiques should not be taken lightly, and as we suggested earlier, they should not be too readily dismissed. Rather, criticisms of the field should be addressed with well-articulated methodical and conceptual rebuttals.

Buller and others point to a number of theoretical and logical claims which evolutionary psychologists must be prepared to tackle. It is worth noting that Buller's claims are clearly not intended to destroy the evolutionary behavioral sciences, but point to how evolutionary psychology can and should rectify some of its problems. An education steeped in evolutionary principles and broad in scope across academic areas, as offered by EvoS programs, lies at the core of the defense of EP from its staunchest critics in the future.

The future of scientific investigations across and between academic disciplines deserves so much thought that the current journal *Futures* had an entire special issue on the future studies of transdisciplinarity [75]. Exploring the possible futures of EP is particularly interesting given the marked interdisciplinarity discussed here. The empirical evidence presented is promising for the future of EP, as the future of the behavioral and social sciences more generally may suffer from disciplinary fragmentation and decision uncertainty as specialization remains more the norm within academic disciplines [76]. As such, EP in particular may be able to weather a tumultuous academic storm that is brewing on the horizon, by having a common theme connecting its various sub-specialty areas. A successful future for the social sciences, for instance, requires novel scientific developments [77], which are well achieved via an approach that is highly generative and based on a common set of integrating principles that are not tied to a particular disciplinary approach. However, interdisciplinarity in itself does not necessarily point to a bright and prosperous future (see [78]).

Due to EP's interdisciplinarity, many scholars who conduct research within EP are likely to not be fully – and even partly – formally trained in evolutionary theory, mechanisms of biological evolution, and/or mechanisms of cultural evolution. This is not a problem per se, as evolutionary principles are rather attainable to scholars in various fields and can be integrated into existing research streams [33] – in fact, part of the allure of evolution is that its application, such as with EP, does not necessarily demand such formal training. However, as new programs develop and new students become trained to work within this domain, it is advisable that students receive an appropriate interdisciplinary formal education. A cross-disciplinary program infrastructure such as that provided by EvoS raises an important issue about curricular needs at the level of course work – students of evolutionary studies (e.g., evolutionary psychology, behavioral ecology, physical anthropology, biocultural studies) should be taking courses in a variety of departments if they wish to understand (and fully engage) the epistemological, theoretical, and empirical bases of the work they plan to conduct. Cross-disciplinary training allows for actual evolutionary-themed research to go beyond the typical adaptationist approach favored by the EP discipline. Such a deep and broad education related to evolution will provide a new generation of scholars with a rich and multi-faceted understanding of the evolution and human behavior interface.

8. Evolutionary psychology's possible futures

The proverbial crystal ball is cloudy regarding the future of EP. Will this field's coherent framework and empirical generativity allow it to permeate across the behavioral sciences – and beyond? Or will intellectual and ideological walls of resistance lead to its premature demise? Here, we outline several possible futures.

8.1. EP is defeated by the far right

Notwithstanding the fact that EP has a stronghold at several major American universities (e.g., UC-Santa Barbara, the University of New Mexico, the University of Michigan), belief in evolution by natural selection as the force underlying the nature of life is actually relatively uncommon among non-scientists [79,80]. Foot soldiers of the fundamentalist right, steeped in a creationist account of life, have little tolerance for anything related to evolution. If the United States moves toward becoming a more conservative nation in the future (implicitly or explicitly), EP may become outlawed (implicitly or explicitly) from universities in the States, paving the way for its demise worldwide. While this future may strike some as sensationalist hyperbole, events in the not-too-distant past, such as the infamous efforts of the Dover (Pennsylvania) school district to force *intelligent design* into their *science* curriculum [81], speak to the influence that creationists currently have in the United States. Thus far, science and reason have prevailed. Yet, the existing tensions leave no reason to believe that the current triumph of science in this ongoing battle is a stable victory.

8.2. EP is defeated by the far left

Whereas the scenario portrayed above seems unlikely as religious ideology has minimal influence in American academic milieus, the academic left's resistance to EP is perhaps more palpable. After all, universities are strongholds of the ideological Left – and resistance from the Left has been a major hurdle for EP since its inception. We have already mentioned how EP is no more politically conservative than other academic areas. Hence, the far Left's resistance stems from EP's core thesis of biological predispositions to human nature, which is inconsistent with the far Left's notions of agency. Interestingly, it is only a narrow view of EP that would lead one to believe that developmental and environmental context are unimportant to human adaptation (behavioral and physiological), just as only a narrow social constructivist view can deny that humans are biological creatures shaped by evolutionary forces. A telling example of the tension between EP and the far Left is evidenced by the strained relationship between feminism and evolutionary theory [82]. Given how EP's intellectual predecessor, sociobiology, was effectively rendered untenable in intellectual circles in light of political resistance from the Left [36,49], that EP might become a similarly taboo area of inquiry – unfairly framed as sexist, racist, and politically conservative – seems

plausible. If the journal *Evolutionary Psychology* were to change its name within the next 20 years – as occurred when *Ethology & Sociobiology* was restructured and renamed *Evolution and Human Behavior* in 1997 – it will most likely be due to the resistance from the Far Left. This renaming reflected what became a necessary rebranding of human “sociobiology” in order to maintain core evolutionary principles but navigate the politicized dissent.

8.3. Evolutionary psychologists help dig their own graves

Whereas we are strongly supportive of EP’s theoretical framework and epistemological goals, we have lingering concerns regarding EP’s future. We have shown that whereas EP is already highly interdisciplinary, it is important to maintain that ethos in the face of a changing scientific landscape that increasingly values interdisciplinarity. To the extent that EP becomes an isolated content-based intellectual community, EP may run into the kinds of problems that typify any isolated community that is under attack. Evolutionary psychologists may come up with ways of defending their discipline that are plausible within their intellectual circles, but that backfire in the broader arena of public opinion. An over-reliance on accusations of the naturalistic fallacy [52] and a generally dismissive approach to dealing with criticisms may actually help evolutionary psychologists dig their own graves – feeding the fires lit by the Far Right and the Far Left. To the extent that evolutionary psychologists react to such resistance in a self-destructive manner, EP’s demise may actually be fostered by its own survival efforts. Therefore, evolutionary psychologists need to keep an open mind. While the EP framework has been wildly successful in uncovering many aspects of human nature, several of the basic premises of EP, such as the notion of human evolution stopping at the start of the Holocene (and end of the Pleistocene) Epoch and the fully modularized view of the human mind, are likely too strongly stated (see Pankseep and Pankseep [83], Richerson and Boyd [21], Wilson [61]). Future

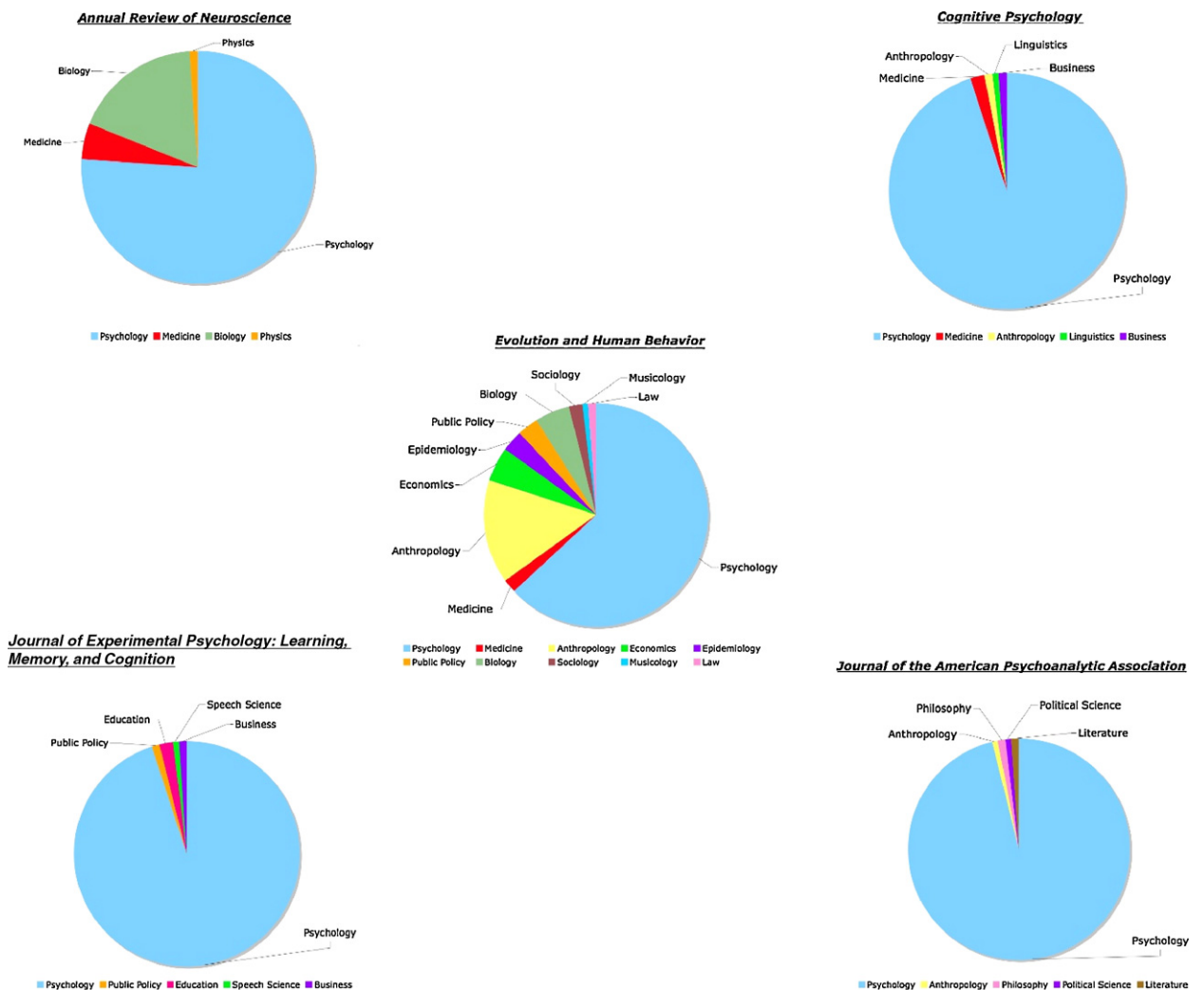


Fig. 1. Frequency of contribution to psychology journals by academic department (note that only five journals are included in the above charts in the interest of space).

research in the fields of cognitive neuroscience, archaeology, and genetics (to name a few) will likely question some of EP's basic premises, a hallmark of any evolving and maturing scientific discipline. Further, recent work in a variety of disciplines may suggest that some of the methodological foundations of EP have been overstated and are in need of reassessment [61,74,84–87], which has major implications for the ability of EP scholars to assert *a priori* hypotheses regarding human nature. To the extent that evolutionary psychologists keep an open mind and work with scholars across these fields to help revise the premises of EP – if and when such revisions are warranted by data – evolutionary psychologists will be helping the future of the field. On the other hand, to the extent that evolutionary psychologists close their minds to the idea of revisions of some premises of EP (i.e., narrow adaptationism, strict modularity), and discount the work of others, they may well be picking up the spade to dig their own grave. Ultimately, science can be an auto-corrective process, and as such all scientists including evolutionary psychologists need to refrain from intellectual dogmatism should new information require a revision of foundational premises.

8.4. EP builds bridges across the Ivory Archipelago

As scholars steeped within the evolutionary behavioral sciences, we undoubtedly have a vested interest in helping assure the discipline's future. We have made the case that EP is a uniquely interdisciplinary field – helping build bridges among disciplines as varied as medicine, anthropology, economics, biology, geology, literature, business, law, and sociology. With its foundational tenets rooted in the core principles of evolution, EP makes connections with disciplines outside psychology more than any other psychological perspective (see Fig. 1).

The interdisciplinary nature of EP is exactly what should be nurtured – and it is precisely this feature that will permit EP to expand its intellectual influence. To the extent that EP functions across disciplinary boundaries, it becomes part of the intellectual fabric of all academic areas. Having footholds in varying departments will surely help this field remain vibrant in the future of academia writ large.

We are particularly optimistic about this scenario – which sees EP expanding its influence across academic areas well beyond the next half-century – in light of the current trend for universities to adopt interdisciplinary Evolutionary Studies programs. With such programs, we are training the next generation of scholars to naturally think about EP in an interdisciplinary context – a fact that should surely help the paradigm capitalize on its interdisciplinary nature in the future. Coupled with the widespread growth of interdisciplinary Evolutionary Studies programs worldwide, EP finds a natural home at intellectual institutions of all varieties. Fields across the social and behavioral sciences become Darwinized – and Darwin's hope that human behavior would be studied with an evolutionary lens becomes increasingly realized with each passing day.

9. Conclusion

As we delineate in the previous section, there are many possible futures for EP. Evolutionists working on human behavior should make strides in responding to some of their strongest critiques and also establish novel collaborations. EP is poised to further bridge ultimate and proximate level explanations, and support more complete (i.e., biocultural) models of human behavior. In so doing, EP can continue to add to a more complete understanding of human behavior, highlighting how evolutionary biology has shaped the modern human brain and mind, and how this interacts with our contemporary environments. In this complete view of evolution and human behavior, there remains a smorgasbord of research questions to tackle, and holistic “Darwinized” perspectives to produce. This suggests that the future is one that not only sustains but also promotes interdisciplinarity, maintaining evolutionary psychology as a rich and holistic approach for the study of human nature in contemporary society.

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