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TARGET ARTICLES

Graduate Interdisciplinary Programs for Training Students in Human Behavior, Evolution, and Development

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Introduction

While the traditional ethological study of human behavior has long championed analyses of both proximate and ultimate causes of behavior, recent advances in the sciences relevant to these levels of analysis provide fresh ground for interdisciplinary research collaboration, and a need for graduate student training in a new integrative approach to human behavior. Indeed, we believe that we are witnessing a transformation in our conceptual understanding of the interplay between proximate and ultimate factors in the generation of behavior that more and more will require novel thinking about and design of new research strategies concerning the causes of behavior. In this article, we will explore the idea of creating a graduate interdisciplinary program (GIDP) that trains students in the rapidly emerging conceptual advances and methods pertinent to the study of human behavior. We begin by describing what is new about such a GIDP, address why it is needed now, outline its key components, and explore its pros and cons. Finally, we invite your comments on the proposed program. We

anticipate that your constructive commentary will allow us to gauge the appropriateness and desirability of such a program as viewed by a wider international audience.

What's New?

We believe that the study of the causes of human behavior stands at an exciting new frontier that heralds a not heretofore possible degree and scope of integrating among what is classically known as proximate and ultimate levels of causal explanation. Further, we suggest that this development demands new approaches to graduate training and in turn offers the beneficiaries of this training novel research opportunities that will further a holistic and unified understanding of human behavior. We realize that this is a strong claim about the role of a GIDP in advancing this frontier in the study of human behavior, especially since on the face of it, nothing may appear to be particularly new about bringing these levels of explanation to bear on the study of human behavior. We might well ask, for example, how our proposed endeavor is different from an ethological approach to behavior? After all, the founders of modern ethology (Lorenz, Tinbergen, von Frisch) firmly argued and established the core of an ethological approach to animal behavior as consisting of the combined study of proximate and ultimate causes of behavior (see Hinde, 1982, for a history of the ethological approach). After Tinbergen, these levels of analysis became widely known as the "four causes" of behavior (i.e., proximate causes include immediate and developmental factors, while ultimate causes include adaptive function and phylogenetic derivation).

Our proposal here is that while our GIDP's approach to human behavior is fully in keeping with the traditional goals of modern ethology, steady advances particularly in evolutionary theory, genetics, epigenetics, neuroscience, and human development now permit a more fully integrated understanding and novel

exploration of the points of articulation between proximate and ultimate levels of explanations than was possible earlier. We could say that the emergence of the field of "evo-devo" some years ago heralded this emerging new exploration and understanding of the connection between evolution and development (Raff and Kaufman, 1983; West-Eberhard, 2003; Carroll, 2005). But more recent and continuing aggressive inroads beyond the genome into the epigenome, and the exploration of their evolutionary implications, arguably, have so radically altered the present landscape of our understanding and approach to the evolution and mechanisms of human behavior as to warrant our thinking of it as a new frontier. And given this rapid transformation in our understanding of the causes of behavior, there is now a pressing need for educating our students accordingly.

We cannot here review the many recent advances in the scientific areas just mentioned, but given that these advances and their implications for the study of behavior have gotten much attention in peer-reviewed publications (e.g., see Diamond, 2009; Zhang and Meaney, 2010; Sameroff, 2010) and public media (e.g., Cloud, 2010), we are hopeful that most of the present readership will appreciate the potentially transformative nature of this growing body of research. Nevertheless, we can in broad strokes describe a little more of what we believe is "new" about the field and thus our view of a GIDP. A key advance is in the infusion of evolutionary theory into studies of human development and other proximate mechanisms of behavior. Until very recently, in psychology and other disciplines, the study of human behavioral development has proceeded largely independently of (or uninformed by) evolutionary theory (Moore, 2008, and other papers in same journal issue). One way, for example, in which we might think of our view of the evolution and development of the organism as transformed, is in our understanding of the influence of

“local ecology” on adaptive variation in gene expression and regulation of phenotypic development. Numerous studies on a broad range of species (insects, rodents, human and other primates) have demonstrated the sensitivity of genomic expression (e.g., on/off; up-or-down regulation) and hence phenotypic expression to specific environmental stimuli or features present at various stages of organismic development and even later in adulthood (e.g., Champagne and Mashood, 2009; Cole, 2009). In several studies, the pathways from environmentally-induced modification of gene expression to alterations in neural function to behavior have been carefully defined (e.g., Champagne and Curley, 2005; Meaney, 2010), and surprisingly in some cases these epigenetic mechanisms produce transgenerational behavioral effects (e.g., Champagne, 2008; Curley et. al., 2009; Franklin et al., 2010). While not all such environmental influences (e.g., toxins) produce adaptive phenotypic responses, the evolved range of individual adaptive responses or strategies of many organisms, including humans (e.g., see recent model by Ellis et al., 2006 on “orchid” vs. “dandelion” children behavioral strategies), is greater than previously imagined from the standpoint of primarily mutation-regulated phenotypic variation.

This newly discovered range of adaptive plasticity is bringing together researchers from the social-behavioral and biological sciences in new collaborative ventures (e.g., risky adolescent behavior, see Ellis et. al. submitted) offering newly integrative perspectives. Work on adaptive plasticity, for example, is forcing us to reconsider the potential evolutionary significance of variation in individual phenotypes (e.g., adaptive adjustment in individual life history strategies to local social or ecological conditions, see Ellis et al., 2009; 2011), leading to extensions in evolutionary metatheory (e.g., the evolutionary dynamics of populations, evolvability of phenotypes, Lamn and Jablonka, 2008). Importantly, the

development of global gene assay techniques has overturned the common view that there have been no significant recent evolutionary changes in the human genome (Cochran and Harpending, 2009). Rapid genomic sequencing technology, in turn, has allowed us to move beyond mapping the entire genomes of species to honing in on the regulation of specific regions of DNA that affect neurodevelopment and underlie adaptive phenotypic plasticity. As well, advances in brain imaging technology, is providing detailed insights into the neural substrates of behavior and cognition in real time. This, too, invites new understanding of concepts and methodologies by researchers in diverse disciplines and spawns new research collaborations between social and biological scientists, often posing fundamentally new questions about the mechanisms and evolution of behavior.

At this juncture, it may be helpful to present in a little more detail one set of studies just referred to (summarized in Ellis et al., 2011) in order to illustrate both the advances in the integration of proximate and ultimate causes of behavior and the new fruitful cross-disciplinary collaborations involved. The multi-disciplinary team of investigators shows convincingly how an evolutionary approach brings greater understanding of children’s differential susceptibility to variations in rearing environment in comparison to customary developmental psychopathology models. In the latter traditional clinical framework, children’s susceptibility to environmental stress (e.g., parental neglect) is explained on the basis of (endogenous) characteristics (e.g., of genetic, physiologic, or behavioral origin) that either render them vulnerable or resilient to adverse rearing environments. Environmental adversity does not affect resilient children, however, in vulnerable children it leads to functional impairments or pathology in later life (e.g., depression, high risk-taking). As the authors note, the implicit assumption of this model has

been that vulnerable and resilient children, while clearly responding differentially to adverse environments, would respond similarly to nonadverse or supportive environments, and investigators saw no need to compare resilient and vulnerable children in such favorable environments. However, if from an evolutionary standpoint children's differential susceptibility to the environment (adverse or nonadverse) is regarded as environmentally-cued distinct adaptive developmental responses ("conditional adaptation"), then we can make sense of the unexpected finding that vulnerable children (the "orchids") do better in supportive environments than resilient children (the "dandelions"). It turns out that orchid children show heightened sensitivity (mediated by differences in endocrine stress physiology) to both adverse and supportive environments, which leads to their making the best of both harsh and supportive environments. The point here is that traditional developmental psychopathology explanations of susceptibility were not wrong, but their lack of an evolutionary framework restricted the scope of research and made it difficult to incorporate the neuropsychological bases of differential susceptibility. In the end, we have not only a fuller integrated understanding of the proximate and ultimate causes of children's differential susceptibility, but also different sets of recommendations for ameliorative strategies (e.g., focus on providing supportive environments).

All this is to say, that while all of us have long understood the necessity of bringing multi-level explanations (i.e., proximate/ultimate) to behavior, until relatively recently we had no clear view or example of such integration. This in turn has resulted in scientists from different disciplines, working at different levels of explanation, doing their work in isolation of one another and in the absence of a framework for integrating across levels of analysis. Historically, this has led to considerable

conceptual clutter, misunderstanding, and much heated and fruitless debate about the relative importance of environmental versus biological influences on behavior.

This is a well-known history, of course, familiar to us as the pervasive "nature vs. nurture" debate, which has been declared as "dead" many times over. One of us (HDS) recalls the often acrimonious exchanges on this matter between Lehrman and Lorenz, when it frustratingly appeared that both were right in their points of view but neither our state of knowledge nor conceptual understanding seemed to be able to align the two perspectives. On both sides of the debate, few if any believed that genes played no role in behavior or, conversely, that nurture played no role in the expression of behavior. Rather, it seemed to be a "power struggle" between which source was seen as having a greater relative influence on behavior. Hence, ethology (and later sociobiology) unjustifiably became branded as deterministic or reductionistic in its view of behavior, despite the clear recognition by ethologists (including Lorenz) of the contribution of the environment and developmental history to the unfolding of behavior. It seems that for the greater part of the 20th century those studying proximate mechanisms of behavior were little influenced by either ethology or evolutionary biology, and only a handful of social scientists were willing to risk championing an evolutionary (or "zoological") approach to human behavior, more often than not incurring the wrath of their social science colleagues.

We draw attention to this bit of history because had it been otherwise, we might well more simply be proposing a graduate program in "Human Ethology". We are, in other words, clearly standing on the broad intellectual shoulders of ethology. But the fact is that the developments in the various sciences we have alluded to have now taken us to a new kind of understanding and integration of the

traditional levels of explanation that “ethology” at the time neither did nor could achieve. As we mentioned before, the founders of human ethology (e.g. Eibl-Eibesfeldt) were strong advocates of integration across levels of explanation, but we suggest that such integration could not be achieved prior to the relatively recent advances in the sciences of genetics, epigenetics, and neuro-behavioral development. As a result, we believe it appropriate to launch a program to signal this emerging new understanding and integration, while in no way disavowing its historical debt and connections to ethology. In a sense, we see the proposed GIDP as the full flowering of human ethology.

Why Now?

It strikes us that perhaps for the first time reports of the death of the “nature vs. nurture” debate may not be exaggerated (e.g., see Stotz, 2008). At the risk of over-simplifying, it is now all a matter of working out the two-way pathways from genes to nervous system to behavior and environment, with hypotheses informed by evolutionary theory. The multi-level approach makes no a priori claims about which level is more important in the generation of behavior, nor does it seek to reduce among levels of explanation, but rather it looks toward integration and complementarity among levels of explanation. In this view, and depending on the particular behavior, socio-environmental (proximate) factors, for example, may play as much of a “causal” role in behavior as genes do because evolution sculpted their pathways of causal influence on nervous system function and gene expression. Matt Ridley’s phrase and book title “Nature via Nurture” (2003) well-captures this new interplay among causal factors. We believe that this emerging understanding of the multi-level causes of behavior will usher in a new rapprochement between the social and biological sciences, one that sets aside the old tensions and misunderstandings and provides a fertile

ground for interdisciplinary training, research collaborations, and ultimately new applications and career pathways.

One important consequence of the integrative (ethological) approach is that all levels of behavior analysis are cast in an evolutionary framework. In other words, scientists with research interests in proximate causes, for example, in adopting this approach will have their research questions informed by ultimate considerations (evolutionary metatheory, phylogeny). Similarly, scientists working on evolutionary accounts of behavior, must consider the implications of their work for proximate mechanisms. Here, we might note that this neglect has been laid at the door of much of evolutionary psychology, which has largely concentrated on adaptive explanations of human behavior with little thought to how such adaptations might be constrained by or implemented by the underlying biological mechanisms, including developmental ones (Lickliter, 2008). Insofar as an evolutionary framework is foundational to this interdisciplinary approach to the study of behavior, there will have to be wide acceptance across disciplines of the merits of evolutionary theory and methods. While the level of public acceptance of evolution in the US is still embarrassingly low, renewed “outreach” education efforts, such as the recently launched Binghamton University-based undergraduate “Evolutionary Studies (EvoS) Consortium” program (see <http://evostudies.org>), hold promise for changing both public attitudes and receptivity of the wider research community. The EvoS Consortium has grown rapidly since its inception two years ago to now include 41 (mostly) North American colleges and universities, with international membership expected to grow rapidly in the near future. A graduate interdisciplinary program would be well-timed with the expansion of the EvoS Consortium and its gaining of national attention and support from funding agencies. This proposed graduate program would

benefit from the increasing awareness of the broad applicability of evolutionary analysis to human affairs, and the Consortium's growing resources for teaching and research collaboration. Though this new graduate interdisciplinary program will have a broader training and research mission than EvoS, we would expect significant synergies between the programs, including the incorporation of the EvoS course ("Evolution for Everyone", or E4E) as a training arena for graduate students (more below).

What are the Key Components?

Envisioning a new GIDP in human behavior requires some thought as to its academic content and related graduate training. First and foremost, such a program will assemble courses drawn from upper division and graduate level courses from participating departments, selected so as to cover the basic theories and methods pertaining to the integrated study of behavior as we have described it. Initial participating departments would include the most obviously relevant, such as Anthropology, Ecology and Evolutionary Biology, Family Studies and Human Development, and Psychology. Content would also be drawn from other departments that offer courses in either methods or applications, such as genetics, or research design and statistics. The second component of such a GIDP is collaborative research. We expect that student advising, research, and dissertation committee membership will involve an appropriate mix of faculty from participating departments. Included in this mix could be an advisor that encourages and assists students in seeking "real world" applications of their research. The third important component that we envision for such a GIDP is professional development for graduate students. As mentioned earlier, one can offer an 'E4E-Evolution for Everyone' undergraduate course that serves as a significant training opportunity for graduate

students. As Teaching Assistants, graduate students will receive training in "best practices" or effective teaching to undergraduates from diverse academic backgrounds, including how to evaluate efficacy. These skills can easily be co-opted for public presentations or 'translation' of scientific/evolutionary concepts to a lay public. Professional development would also include workshops on effective collaboration, such as interdisciplinary grant writing/seeking, collaborative behavior among colleagues, and new collaborative tools/technology.

A final component to consider is the university culture. As the saying goes, "timing is everything". In our view, the success of such a GIDP depends on more than intellectual justification, planning, and good will. There must also be already in place evidence of fruitful cross-disciplinary collaboration and ongoing discourse among faculty and students from diverse disciplines, as these are the seedlings from which a GIDP can grow. Either by historical accident or by design, prospects of a GIDP would need a core group of faculty and students with a strong shared interest in the multi-level analysis of human behavior who are willing to or already assemble from several departments at a university —such as Anthropology, Ecology and Evolutionary Biology, Family Studies and Human Development, and Psychology. The particular research interests and professional expertise among these faculty members should cover the full consideration of proximate and ultimate causes of behavior, and most importantly, must be fully oriented toward their integration. Informal cross-disciplinary discussion groups that bring together students and faculty with a shared interest in human behavior are a good way to stimulate interest, encourage collaboration, and gauge the future feasibility of a GIDP.

Many colleges and universities these days are hesitant to implement new programs due to

cost considerations, and so there may be significant administrative hurdles to overcome. One solution may be to launch a GIDP in phases. A phased approach would allow the assessment of the student demand and collaborative climate at the institution, prior to making a large programmatic commitment. During the first phase, one could launch the GIDP as a *minor* that minimally would be available to graduate students in the aforementioned participating departments. For example, a student in Psychology or Family Studies would get a Ph.D. in their “home” department but complete a minor in the GIDP. This mode of implementation will allow for gauging the attractiveness and success of the

minor program, with a view toward the eventual creation of a separate, PhD-granting GIDP *major*.

Pros and Cons

We strongly believe that the proposed GIDP will contribute to a truly new understanding of the human condition. As such we would like to think that both students would be attracted to such a program and that university administrators would be supportive. However, despite such a worthy potential benefit, we need also to consider some of the potential drawbacks or disadvantages, both from the student perspective, and from the university’s perspective.

Table 1. *Student’s Perspective on Enrolling in the Proposed GIDP*

Pro	Con
Wide array of training looks good for job seeking in interdisciplinary-oriented institutions	Wide array of training may look like “jack of all trades, master of none”
Able to apply for jobs in a variety of disciplines	Hard to pin-point which discipline best matches the graduate’s training
Diverse training	More course work
Able to communicate evolutionary concepts to all (not just for teaching)	
Higher probability of getting a grant (because of collaboration) and funders preferring collaborative projects	

Table 2. *University’s Perspective on Supporting the Proposed GIDP*

Pro	Con
Attracts more and better graduate students	
Become forefront of interdisciplinary thinking on human behavior	
The program can be self-sustaining by utilizing the E4E enrollment income to fund graduate students	Initial support may be needed for admin/coordination
	Additional course (E4E) faculty must teach
Higher probability of getting a grant with overhead (because of collaboration)	

What Do You Think?

Following are some questions about the proposed GIDP to which we seek your responses. These can be answered in two ways: (1) within the context of the Open Peer Commentary process in the *Human Ethology Bulletin*, or (2) via completing the following online survey, to which a link is posted on www.wildminds.org:

- Do you agree/disagree that the new advances in the scientific study of behavior now open a new arena of cross-disciplinary research (between biological and social sciences)?
- Will a formalized GIDP program serve as a significant stimulus for *new* interdisciplinary research and funding?
- Will the GIDP graduate look more attractive when job seeking? Will a GIDP graduate be more employable (broad training) or less (diluted/non-traditional) employable in your “home” discipline? Will a GIDP degree be preferable to a standard PhD in one department?
- What name captures the program’s perspective/goals?
- Are there costs/benefits associated with naming the GIDP “Human Ethology”?
- Are there any other benefits or problems of a GIDP that we should consider?

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