The New Biological Anthropology: Bringing Washburn's New Physical Anthropology Into 2010 and Beyond—The 2008 AAPA Luncheon Lecture

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ABSTRACT Nearly 60 years ago, Sherwood Washburn issued a call for a "New Physical Anthropology," a transition from measurement and classification toward a focus on the processes and mechanisms of evolutionary change. He advocated multidisciplinary and interdisciplinary approaches to the understanding of human behavior, biology, and history. Many interpret this as a call for a practice that is both biological and anthropological. Is this what we do? Are we biological anthropologists yet? In this essay, I explore what we, Physical Anthropologists, as a discipline are doing in the context of a New Physical Anthropology, where we might be headed, and why this discussion is crucial to our relevance. Yrbk Phys Anthropol 53:2–12, 2010.

The front page of our (the AAPA) Website opens with the following quote:

> "Physical anthropology is a biological science that deals with the adaptations, variability, and evolution of human beings and their living and fossil relatives. Because it studies human biology in the context of human culture and behavior, physical anthropology is also a social science"

We are then, by our own definition, simultaneously, a social and a biological science. This is a perspective that has substantial implications if we think that concept through. In this essay, I would like to try and convince you that one of the major figures in our discipline, Sherwood Washburn, saw those implications nearly 60 years ago and laid out some ideas on how to effectively follow them through. I also want you to consider that in the past few decades we have expanded on his vision and are now poised to be a more thoroughly effective and engaging biosocial science and a central contributor to both academic/scholarly issues and to popular topics of relevance to everyday life.

In 1951, Sherwood Washburn called for a New Physical Anthropology, a "move from measurement and classification to the processes and mechanisms of evolutionary change" (Strum et al., 1999) and a "multidisciplinary and interdisciplinary approach" (Washburn, 1951) to the understanding of human behavior and biology. Striding ahead of many contemporaries, Washburn considered behavior, biology, and history to be inseparable in answers, not only interrelated as factors. This theme is noted and discussed in the homage book, *The New Physical Anthropology: Science, Humanism and Critical Reflection* (Strum et al., 1999), but it is worth expanding on here.

One can look around the discipline of Physical Anthropology today and ask where is Physical Anthropology now? Are we to the point envisioned by Washburn nearly 60 years ago? With all respect to Ales Hrdlicka, the founder of the American Association of Physical Anthropologists, the real question we need to ask is after being around as an organization for nearly 80 years is "are we Biological Anthropologists yet?"

A BIT OF CONTEXT

Before embarking on the body of this essay and an answer to this question, I think it is important to address why I am writing this piece. When I was asked to give the luncheon address at the 2008 annual meeting of our association, I was fully aware that such keynote talks often make their way into the pages of the Yearbook of Physical Anthropology. So, to begin with, I saw this opportunity as a platform to address the state of our discipline and our name. However, the real reason I write on this topic, and am so thoroughly committed to this discussion, is because of my academic lineage, my experience in our discipline, and, most importantly, because this question matters to our profession, our practice, and to our role in academia and society at large. We need to be as aware as possible of our histories because they are so critical to who we are and what we do (e.g. Little and Kennedy, 2010). There is an alarming trend among many students and practitioners in our discipline to ignore historical contexts for our questions, perspectives, and theoretical orientations today. I even wonder how many of today's undergraduate students will hear Sherwood Washburn's name, read anything he wrote, or understand the impact of his ideas.

The initial drive to discuss this topic and its questions emerges directly from my academic lineage: I represent a small twig in an enormously important genealogical tree of American Physical Anthropology and Primatology: the Sherwood Washburn lineage. A very high

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percentage of practicing North American biological anthropologists and primatologists have their academic genealogies firmly rooted in training from Sherwood Washburn or one of his students (Kelley and Sussman, 2007). Washburn and his students are responsible for over 60% of the physical anthropology trained primatologists since the 1960s and have had substantial influence on the direction and scope of research programs and publications in the discipline at large (Haraway, 1989, Kelley and Sussman, 2007, Stini, 2010). The training provided, or influenced, by Washburn reflected his interest in evolutionary theory, in integrated biological approaches, and in a comparative, multi- and interdisciplinary approach. That is the heritage of the Washburn lineage.

As a student, I benefited from the milieu at UC Berkeley in the 1980s and early 1990s in large part created by Sherry Washburn and his students Phyllis Dolhinow and F. Clark Howell, among others. My interest in a "move from measurement and classification to the processes and mechanisms of evolutionary change" and a "multidisciplinary and interdisciplinary approach" and my perceptions of our field emanate from the hybrid nature of my training in the "Washburn school" via my mentor Phyllis Dolhinow. I had my undergraduate degrees from UC Berkeley's Department of Anthropology and the UC Berkeley Department of Zoology (now part of the Department of Integrative Biology). As a graduate student, I received my PhD from the UC Berkeley Department of Anthropology but continued to work with faculty from the Integrative Biology Department and the Museum of Vertebrate Zoology. Throughout my career at Berkeley I also benefited enormously from the influence and perspectives of some exceedingly gracious and talented Socio/Cultural Anthropologists and Archeologists. Despite the substantial cleavage between Anthropologists and subfields in the UC Berkeley Department of Anthropology, and in our discipline on the whole, I was encouraged to exploit an explicitly comparative and interdisciplinary approach throughout my undergraduate and graduate career. Because of this one could say that I was academically "brought up" to practice a multidisciplinary approach.

The 16 years since receiving my PhD have only reinforced the perspectives initiated in my training. As a visiting lecturer at UC Berkeley, assistant and associate professor at Central Washington University, and associate and full professor at the University of Notre Dame, I have come into contact with hundreds of bright and inquisitive students. These experiences teaching and mentoring students continue to demonstrate the core importance and relevance of integrated evolutionary and anthropological approaches to understanding humans and our relatives. This theme has been a dominant one in my work, and the work of so many colleagues, as I moved through the professorial ranks, attended our meetings, published in a wide array of journals, and conducted research in the field and the laboratory. This trajectory of experience leads me to the current point where I suggest that what we do today, as a discipline, is best represented by the term Biological Anthropology, not physical anthropology, and that this view resonates with the published calls of Sherwood Washburn from nearly 60 years ago.

WHAT DOES WASHBURN'S CALL MEAN IN 2010 AND BEYOND?

I would like to take the bulk of this essay to give a brief overview of what I see in Sherwood Washburn's conceptualization of a New Physical Anthropology and how we can extend his perceptions and implications into today. I want us to think about how his call translates to 2010 and beyond in the sense of contextualizing who we are and what we do in a milieu of changing evolutionary, methodological, and theoretical paradigms. I suggest that examining emerging concepts in evolutionary theory, what members of the association of physical anthropologists and our allied colleagues do today, and how these threads tie together provides a robust, affirmative, answer to my question at the start of this essay: are we biological anthropologists yet?

At the same time that Washburn was engaged in his early career in physical anthropology, contemporary innovation in evolutionary thinking, termed the modern synthesis, was exploding theoretical and practical perceptions and activities in the biological sciences (Stini, 2010). In this evolutionary synthesis, there was an understanding that the genotype does not generally interact directly with the environment, rather that the phenotype (morphology and behavior) interacts with the environment, and the genotype is affected by the phenotype's success in a given environment. The initial focus on the modern synthesis was on modes of change (Huxley, 1942; Gould, 2002). This initial recognition of the complexities of the interconnections between natural selection, genetic drift, and gene flow alongside improved theoretical understandings of mutation, and some inklings that development mattered, made clear the necessity to move beyond static approaches to the analysis of living and fossil organisms (e.g., Simpson, 1951). During this time period (1930–50s), it became increasingly evident that measurement as an end unto itself, static taxonomies without phylogenetic context, and a lack of connection among studies of behavior, form, and development precluded real advancement in the understanding of evolution, form, and function.

Washburn himself was becoming quite attuned to the shifts in evolutionary theory and advances in the biological and social sciences as he was maturing academically in the 1930–40s (Strum et al., 1999; Howell, 2003; Stini, 2010). By the 1950s, he saw the practice of anthropology, physical anthropology in particular, as being mired in a primarily descriptive and classificatory mode, detached from the energizing and complex ideas and possibilities emerging all around it. A ditty from his writings serves to highlight his view about a static reliance on taxonomy and description:

> "There once were scientists three
> they are better than you or me
> they looked at old bones
> and often intoned
> the religion of taxonomy"
> —from the Sherwood Washburn papers (The Bancroft Library, UC Berkeley)

Washburn distilled his thoughts in the seminal 1951 statement on the New Physical Anthropology.

> "The new physical anthropology has much to offer anyone interested in the structure or evolution of man, but this is only the beginning. To build it, we must collaborate with social scientists, geneticists, anatomists, and paleontologists. We need new ideas, new methods, new workers. There is nothing we do today which will not be done better tomorrow."
> —Washburn (1951)

Combined with a later but thematically related quote by Washburn's longtime friend the evolutionary biologist

Theodosius Dobzhansky, we can see the call for a core role of evolutionary and biobehavioral complexity in understanding humanity:

> "As theoretical possibilities, one can envisage that man might be genetically determined as aggressive or submissive, warlike or peaceful, territorial or wanderer, selfish or generous, mean or good. Are any of these possibilities likely to be realized? Would the fixation of any of these dispositions, so that they become uncontrollable urges or drives, increase the adaptiveness of a species which relies on culture for its survival? I believe that the answers to these questions are in the negative."
>
> Dobzhansky (1972)

I suggest that Washburn's ideas were more radical than many give him credit for. What did his call mean? What was a "new" physical anthropology? In a general sense, this is a call for a comparative, evolutionary, and multi- and interdisciplinary approach to understanding humanity and our relatives; a move away from reliance on primarily typological/classificatory approaches. He was stimulated and engaged by the excitement and innovation introduced/disseminated by the modern synthesis. Washburn was in the middle of a milieu of emergent evolutionary theory in the late 1940–60s, including the work of theorists like Dobzhansky, Mayr, Haldane, Fisher, Wright, and physical anthropology colleagues such as Ashley Montague, Frank Livingstone, and Loring Brace. In particular, his longstanding relationship with Dobzhansky, including their co-organizing of the 1950 Cold Springs Harbor symposium, *The Evolution and Origin of Man*, acted as a catalyst for his integrative views (Stini, 2010). I explicitly interpret Washburn's call and intent to represent a move to have real and sincere evolutionary engagement in physical anthropology: a fusion of typological, functional, behavioral, and evolutionary understandings and an expansion beyond measurement as the core of the practice of physical anthropology. For me, this is a call for a Biological Anthropology; a context in which both words (biological and anthropology) are interacting and contributing synergistically rather than merely complementing one another. This is different from a physical anthropology where the name can be seen as prioritizing the descriptive and structural rather than the dynamic and evolutionary.

This interest and orientation can be best seen in the contributions of Washburn at the level of publications, the mentoring of students, and the innovative contributions he made to the AAPA, including the origination of the extremely important Wenner-Gren/AAPA summer workshops and spearheading the initiative to create the *Yearbook of Physical Anthropology* (initially edited by G.W. Lasker (Comas, 1969 in Alfonso and Little, 2005), whose 2010 edition you are reading now.

Washburn was focused primarily on understanding questions about adaptation and function. Although he was a brilliant thinker, he was not fully in a research sense, a doer. His main dissatisfaction was with the emphasis on description and his fear that by naming you stop analyzing. This drove him to think, teach, and write about these themes. However, I do need to emphasize that theoretically, conceptually, and methodologically we are currently in a much richer research and intellectual environment than Washburn could even have imagined. The modern synthesis is past and a new, much more complex, and sophisticated evolutionary landscape has emerged (Oyama et al., 2001; Gould, 2002; Odling-Smee et al., 2003; Fuentes, 2009a). I should note that I am probably interpreting, and expanding, Washburn's positions in a more radical inter- and multidisciplinary way than he himself did, given what is available to us today because of the explosion in methodological and theoretical innovations over the past three decades. Today, in 2010, there are reasons for using his call for a basis to reflect on our discipline, reasons which will hopefully be evident to you by the end of this essay if they are not already so.

MOVING WASHBURN'S IDEAS, AND THEIR OFFSPRING, INTO THE PRESENT

In a chapter entitled "Description, hypothesis testing, and conceptual advances in physical anthropology: Have we moved on?," Larsen (2010) refers to a paper given by George Armelagos and his former students at the 50th anniversary of the AAPA where they criticized skeletal biologists for not reaching "the analytical or theoretical successes of the other sciences..." and that such articles in the AJPA lacked inference, theory, problem, and overemphasized description. Larsen goes on to ask: "Have we heeded the advice given in 1981, and begun to develop hypothesis driven research that allows inference about wider issues relating our findings to the human condition? Has our science matured, keeping pace with other sciences, even in comparison with other subareas of our discipline?" (2010, p 238) Here, Larsen refers specifically to skeletal biology, but the call and question are in the exact same vein as that posed by Washburn in 1951 and reiterated by Armelagos et al. (for skeletal biology) again in 1981.

The 1981 conference, in many ways, illustrated the mixed successes of Washburn's call 30 years on, but where are we when nearing the 60-year mark? I would like to suggest that by and large the field of Physical Anthropology, in all of its areas, was well on the way to becoming the field of Biological Anthropology 30 years ago and is even further along that path today. This is semantically borne out in Little and Kennedy's (2010) edited volume *Histories of American Physical Anthropology in the Twentieth Century*, where most chapters begin by referencing "Physical Anthropology" and end speaking about "Biological Anthropology." This is probably not an intentional pattern, but one that characterizes how many practitioners see the field today.

But this transition is a process, not an abrupt transformation. As noted by Howell (2003), "For close on to four decades Sherwood Washburn sought to encourage, urge, insist, and cajole practitioners of biological anthropology-particularly the core of human evolutionary studies-to shift away from outdated methodologies, abandon outmoded or questionable precepts, adopt modern perspectives of an emergent evolutionary biology, and practice analytical, comparative, and experimental methods relevant to elucidation of the nature and roots of the human condition. His epiphany emerged progressively and sweepingly across prevalent biological and social science and wrenched but did not utterly revolutionize scientific praxis in biological anthropology as he sought and overtly intended it should." Washburn's call has not been completed, but it is well on the way.

Howell (2003) described Washburn's thinking process as follows: "His focus was programmatic across a general concern, fortunately having at best fuzzy boundaries; in fact his mode of thought (or play) was to ignore, to transgress such traditional limits and to usurp or to engulf

the useful and the relevant, regardless of disciplinary and historical priority. He was openly and frankly iconoclastic in such respects and thus pan-disciplinary in vision." This is a core facet that we need to hold as a priority. I think we are now finally at the stage where Washburn's (and others) pushing is at the point of actually materializing as change in our scientific praxis. We (the AAPA) are, in a large part, practicing a biological anthropology. To understand what I mean by this, there are three main elements I will touch upon in the remainder of this essay: our name, recent innovations in theory and methodologies, and the need to truly embrace bio- and sociocomplexity in effective quantitative and qualitative ways.

WHAT IS IN A NAME?

Washburn (1968) said: "...human biology has no meaning without society. For a particular problem in the short run, either biological or social facts may be stressed, but the evolution of man can only be understood as a biosocial problem." This conceptualization is core to our modern science, relevance, and complexity. To move forward, we must be multidisciplinary and interdisciplinary. So, it is equally important that we be both biological and anthropological. Our current name denotes a practice of a "Physical Anthropology"...what is in a name? That is a good question, and it is relevant to what we do.

Are we living up to the expectation of multidisciplinary and interdisciplinary approach? Yes, in many ways we are (as I will outline below). Using the term Biological Anthropology is a more accurate, encompassing view of what we do. It denotes an integration of themes, perspectives, methodologies, and a dynamism, that is absent from the image and content evoked by a "physical anthropology." If you look at what is happening in our field and what is being represented at our annual meetings it is obvious that the AAPA consists, mainly, of biological anthropologists. It is critical to note that this innovation and dynamism in methods and approaches is in addition to ongoing classical measurement and classification usually associated with a physical anthropology. This original core of our practice remains central to our success because without such hardcore hands-on and detailed work the rest is not usually possible.

For example, the two species that I am currently working with are enormously variable morphologically and adaptively (humans and long-tailed macaques) forcing me to think simultaneously about basic measurements/assessments *and* integrative/synergistic approaches. My team's research into the human–macaque interface in Asia and Gibraltar requires integrating genetic analyses, physiological measurements, geospatial modeling, evolutionary theory, behavioral and ecological observations, ethnographic investigations, and epidemiological assessments (Fuentes et al., 2005; Fuentes, 2006; Lane et al., 2010). This synergistic and multifaceted approach is increasingly characteristic of many of the research projects in Biological Anthropology.

In addition to reflecting what Washburn called for over 50 years ago, the name Biological Anthropology has a currency that reflects an integrative stance on things biological and social in a way that is potentially accessible to the public. But, why is it important that we practice biological anthropology and publicly own the arena that sits at the interface of biology, culture, and popular perception? Because others, many of whom do not have our skill set and the depth of understanding, are taking this access away from us. A quick purview of Amazon.com or the *New York Times* shows that most of the books or editorials on topics that we (members of the AAPA) specialize in are not by biological anthropologists! People such as Jared Diamond (geographer/physiologist), Paul Erlich (biologist), Frans DeWaal (primatologist/psychologist), Steven Pinker (evolutionary psychologist), Nicholas Wade, Anne Gibbons, Natalie Angier, and Carl Zimmer (science writers) are considered the experts on human biology, behavior, ecology, and evolution and are more known for our topics than most of us. Not that I think that some of these books and editorials are not very good (some are, others are not) and that Biological Anthropologists are not publishing in the popular sphere (recent books by Craig Stanford (2003) (*Upright: The Evolutionary Key to Becoming Human*), Adrian Zihlman (2001) (*The Human Evolution Coloring Book*), Clark Larsen (2002) (*Skeletons in Our Closet: Revealing Our Past Through Bioarchaeology*), Ian Tattersal (2008) (*The Fossil Trail: How We Know What We Think We Know About Human Evolution*), Jon Marks (2009) (*Why I Am Not a Scientist: Anthropology and Modern Knowledge*), and, especially, Nina Jablonski (2008) (*Skin: A Natural History*) do pretty well for example) but that we need to be there in greater numbers. Being called Biological Anthropologists, and thinking like a biological anthropologist, makes that easier than being labeled a Physical Anthropologist, which, in the eyes of the public and in those of many science writers, confines us to a limited sphere and does not engender visions of us as "adopting modern perspectives of an emergent evolutionary biology, and practice analytical, comparative, and experimental methods relevant to elucidation of the nature and roots of the human condition" (Howell, 2003). Even if it is somewhat superficial to think about a name in this context, public perception matters. The ways in which the public perceives of Physical/Biological anthropologists affects how our research results, perspectives, and proclamations about humans, and our closest relatives are received and incorporated into popular culture. This can shape the ways in which we achieve public relevance, governmental funding support, and impact school curricula and general science knowledge. Because public perception matters, our name matters.

EMERGING COMPLEXITY AND PATTERNS AND PROCESS IN BIOLOGICAL ANTHROPOLOGY

Doing biological anthropology in its most sincere forms, really accepting the field for what it entails, means realizing that an extreme level of biological and social complexity exists in understanding humans, and our close relatives, and that this impacts our research/teaching/practice. This complexity is a modern version of what Washburn was talking about; no one person can master it all, nor can one subarea stand fully alone, detached from other allied, overlapping, arenas of investigation. We must be cognizant of the presence and implications of this complexity, practically and theoretically. This is not easy and, currently, it is not always recognized or supported by practitioners and academics at the top of our current academic hierarchies.

There is no shame in admitting that there are currently multiple, potentially competing perspectives within a field. In fact, we are healthier for it. Why not

acknowledge and embrace it? This diversity is evident via a look through all the current biological anthropology introductory textbooks on the market. We can see it when reading and engaging with the recent publications on *Ardipithecus* and the debates surrounding *Homo floresiensis*. Recent articles in the 2008 and 2009 *Yearbook of Physical Anthropology* also exemplify these approaches. For example, James Rilling's "Neuroscientific approaches and applications within anthropology," Thomas Gillespie et al.'s "Integrative approaches to the study of infectious disease: implications for biodiversity conservation and public health," and Virginia Vitzhum's "The ecology and evolutionary endocrinology of reproduction in the female human" all demonstrate the need to acknowledge and incorporate complexity, diversity, and a biological anthropology as core to our discipline. Reading Heather Edgar's and Keith Hunley's co-edited special issue of the *American Journal of Physical Anthropology* (Vol. 139(1)) "Race reconciled: How Biological Anthropologists View Human Variation" is a perfect example of this complexity, the simultaneous intellectual and public importance of what we do, and the fact that we must practice a biological anthropology to be successful. In an interesting note reinforcing the importance of history, the Edgar and Hunley AJPA issue shares much in common (including many conclusions and the range of authors) with the 1964 volume, *The Concept of Race*, edited by the Biological Anthropologist Ashley Montague (1964), in which Sherwood Washburn wrote the final chapter.

This theme of complexity extends to a wide array of other aspects of what we do from the discussions on animal culture, learning, imitation, and social niches, to the debates about interactions between uterine environments, maternal health, social and economic contexts, fetal development, and later in life physiologies and growth patterns, to the discourse on anthropoid origins and its relationships to primate phylogeny and primate wide adaptations. Perspectives employing biosocial, developmental, and evolutionary complexity are here to stay and must be acknowledged in real and integrative ways. Because of this, sometimes we need to attempt new ways of talking, thinking, and learning about our subject to accomplish our goals. We have to work across our traditional boundaries and be open to terminologies, theoretical perspectives, and methodological patterns outside of what we might have been exposed to in 1970, 1980, or even 1990.

Sherry Washburn noticed this over 40 years ago (1968) when he said "The understanding of human behavior is too complicated and too important to be hindered by departmental structures whose origin lies in the 19th Century. If there is only one lesson from the last 100 (142 in our case) years of biological anthropology, it is that knowledge cannot be usefully divided along the traditional lines and that, perhaps even more than a synthetic theory of evolution, we need a synthetic theory of education." That new space for education and synthesis is today's biological anthropology.

EMERGENT EVOLUTIONARY THEORY AS IT RELATES TO BIOLOGICAL ANTHROPOLOGY

In this penultimate section of the essay, I provide a few examples from emergent perspectives in evolutionary theory relevant to biological anthropology to (hopefully) drive home my points on complexity.

Today is a time of a renewed interest in complexity and diversity in evolutionary theory. The grasp of patterns and contexts of selection and the ways in which epigenetic and developmental interactors affect outcomes are growing by leaps and bounds. Evolutionary biologists are expanding the toolkit for understanding and theorizing about evolutionary processes and enhancing our abilities to test and measure them. One could argue that we are in the midst of a major expansion in evolutionary theory akin to the impact of the modern synthesis in the 1940–50s. Washburn would have seen this as crucial moment for biological anthropology, as he noted in 1951 with the emergence of the modern synthesis and its insights and challenges to the status quo. Today, we are in the midst of what might be termed a "new modern synthesis" in evolutionary theory, and I suggest that we should share in the essence of the Washburnian perspective and look for ways to integrate our practice with it (see also Fuentes, 2009a,b).

Mary Jane West-Eberhard's broad overview (2003) of developmental plasticity and evolution led her to suggest that plasticity is one of the key factors for our understanding of adaptive evolution. She argues, like many other prominent evolutionary biologists, that reducing the processes of development and evolutionary change to genomic levels is not always possible or preferable. These analyses demonstrate that evolved plasticity in development enables the evolution of new or variant, but adaptive, phenotypes without substantial, or even marked, genetic change. This phenotypic plasticity and its relation to ecologies and evolutionary patterns is of core interest in evolutionary theory.

Recent reviews define basic phenotypic plasticity as "the production of multiple phenotypes from a single genotype, depending on environmental conditions" (Miner et al., 2005). However, more important than the basic definition is the evidence that a range of organisms express phenotypic plasticity via changes in behavior, physiology, morphology, growth, life history, and demography, and that this plasticity can occur in both individually and intergenerational contexts (Pigliucci, 2001; Miner et al., 2005). Research into modeling this plasticity, its potential adaptive value and contexts, and its ecological impact all suggest that phenotypic plasticity is a significant factor for many organisms' evolutionary histories and current behavior/morphology. Obviously, this is important for practically all aspects of biological anthropology research.

The biologists Eva Jablonka and Marion Lamb (2005) argue for recognition of "evolution in four dimensions" rather than a focus on just one. They note that many researchers principally focus on only the genetic system of inheritance in their models of evolutionary patterns and change. This results in the majority of hypotheses proposed for scenarios regarding selection and adaptation relying on perspectives with explanations of causal factors residing at the genic level, or some proxy for genic effect. Jablonka and Lamb argue that we also must be cognizant of up to three other inheritance systems that, potentially, have causal roles in evolutionary change. These other systems are the epigenetic, behavioral, and symbolic inheritance systems. Epigenetic inheritance is found in all organisms, behavioral inheritance in most, and symbolic inheritance is found only in humans. Jablonka and Lamb (2005) state that there is more to heredity than genes, that some hereditary variations are nonrandom in origin, that some acquired

information is inherited, and that evolutionary change can result from instruction as well as selection. Beyond biological structure, behavioral inheritance arises from the potential selective advantage of social attention and social learning. Many organisms transmit information via behavior; thus, acquisition of behavioral patterns that confer selective benefits can occur through socially mediated learning via observation and the reproduction of behavioral patterns and cues.

The concept that selection can target more than the genetic level, that information transfer occurs at multiple levels, and that instruction (at epigenetic, behavioral, or symbolic levels) can also impact evolutionary change forces a broader toolkit when constructing hypotheses and building models of evolutionary patterns in humans and their close relatives. This will influence the way biological anthropologists can envision, and model, human evolution. Models using this system will be more complex than the models of traditional Neo-Darwinian theory; however, they may be better attuned to the actual interactions of systems.

Developmental Systems Theory (DST) is proposed as an alternative to what Susan Oyama calls the "developmental dualism" approach (Oyama, 2000). This developmental dualism approach represents development as having some aspects driven by "internal" causes (genes) and other driven by external causes (environment, or memes/culture variants). DST is an approach that attempts to combine multiple dimensions and interactants using a systems approach to understand development, in the broadest sense, and its evolutionary impact.

Oyama et al. (2001) summarize the main theses of DST in six major points (in italics below). I add additional explanatory text tying the points directly to our broader consideration of human evolution in biological anthropology (from Fuentes, 2004, 2009b):

Joint determination by multiple causes: Every trait is produced by the interaction of many developmental resources. The gene/environment dichotomy is only one of the many ways to divide up the interactants in evolutionary processes. Therefore, Neo-Darwinian explanations assuming the primacy of "genes," although forceful and important avenues for research, are not the only venues for inquiry into human evolution. As Washburn and many others emphasized, multiple elements affect the development and expression of morphology and behavior. The concepts of multiple interactants in the evolutionary process resonates well with our increased understanding of developmental, behavioral, and other epigenetic influences on the subjects we study in biological anthropology.

Context sensitivity and contingency: The significance of any one cause is contingent on the state of the rest of the system. Single aspects of human behavior or morphology cannot be seen as independent in an evolutionary sense from any others, especially given the types of plasticity and extrasomatic manipulations evident in human response to selection pressures. This is especially important in studies of morphology and development, as we are increasingly aware of patterns and processes affecting pathways during growth and interconnectiveness of various features in the evolution of complex morphological systems (such as in bipedalism).

Extended inheritance: An organism inherits a wide range of resources that interact to construct that organism's life cycle. In humans, inherited resources include the memory and experience of group members, the previous manipulation of the area in which the group lives, and the patterns of cultural interaction extant in that population. This perspective, similar to the behavioral inheritance of Jablonka and Lamb and to niche construction (below), resonates well with the recent foci on fire, hyper-cooperation, and extrasomatic manipulation in human evolution.

Development as construction: Neither traits nor representations of traits are transmitted to offspring. Instead, traits are made—reconstructed—in development. Human life histories are extended relative to many animals and the symbol-rich social environment in which they exist requires dynamic learning and is primarily socially negotiated (see also Herrmann et al., 2007). Human development is equally affected by somatic and extrasomatic factors interacting with one another during the course of constructing the adult human. The assumption of inheritance of specific, discrete behavioral traits as units that emerge during development is highly questionable. Human development is a bioculturally contingent phenomenon.

Distributed control: No one type of interactant controls development. A focus solely on selection and linear gene–phenotype–environment relationships, while ignoring other dimensions of inheritance, is unlikely to effectively explain the full range of human evolutionary patterns and processes, or of modern human growth and development.

Evolution as construction: Evolution is not a matter of organisms or populations being molded by their environments but of organism-environment systems changing over time. This conceptualization envisions human evolutionary patterns as constantly constructing, and being constructed by, constituent elements of demography, social interactions, cultural variations, complex information transfer, and manipulation of the environment in intra- and intergroup contexts in addition to the developmental, morphological, and ecological factors throughout the course of life history.

Building on work of Lewontin (1983) and earlier perspectives proposed by Mayr (1963) and Waddington (1959) and borrowing from the "extended phenotype" concept of Dawkins (1982), Odling-Smee et al. (2003) propose Niche Construction as a significant evolutionary force. Niche construction reflects a feedback system such that organisms engaged in niche construction significantly modify the selection pressures acting on them, on their descendants, and on unrelated sympatric populations (Day et al., 2003, Odling-Smee et al., 2003).

Odling-Smee et al. (2003) describe the major consequences of niche construction and their resultant three prime implications. Niche construction impacts/alters energy flows in ecosystems through ecosystem engineering. It holds that organisms modify their, and other, organisms' selective environments. Niche construction creates an ecological inheritance (similar to DST extended inheritance), including modified selection pressures, for subsequent populations, and it is a process, in addition to natural selection, that contributes to changes over time in the dynamic relationship between organisms and environments (niches). In the context of evolutionary theory, niche construction provides a second role for phenotypes. For ecological theory, the focus on co-evolution between organisms and their abiotic/biotic environments promotes closer integration of ecological and evolutionary frameworks. For the study of humans, niche construction provides an important, potentially

integrative, framework for connecting evolutionary approaches to the social sciences (especially human evolutionary studies; Odling-Smee et al., 2003; Fuentes, 2009a,b; Fuentes et al., 2010).

It is highly probable that humans are the "ultimate niche constructors" and that adding niche construction to attempts to understand evolution makes such attempts more complicated, but, ultimately, this complexity will be more beneficial, and attractive, to researchers looking into human evolution and behavior (Fuentes, 2009a,b). Niche construction is of particular relevance to humans as Odling-Smee et al. (2003) see cultural processes as providing a particular vehicle for niche construction; humans are born in to a world (local environments) that is largely "constructed" (anthropogenic ecologies) whether they are urban dwellers, hunter/foragers, or nomadic herders. Because of this, niche construction, in general, and ecological inheritance, in particular, are likely to have been very important throughout human evolution.

COMPLEXITY IN OUR AREAS OF RESEARCH

Finally, I would like to move on to point out just a few recent examples of energizing work in and around biological anthropology to demonstrate the kinds of increasing complexity that touches and shapes our research foci, the questions we ask, and the ways we go about answering those questions. This is by no means a comprehensive review of the relevant publications; rather, it is a sampling to reinforce the main points of this essay.

Genomics

The emergence of genomics is having a major impact on biological anthropology. For example, the emergent understanding of changes in allelic function and variance in regards to mobile elements is significant. Xing et al. (2007) demonstrate that roughly 50% of the primate genome consists of mobile, repetitive DNA sequences such as Alu and LINE1 elements. They state that, because of their unique mutational mechanisms, these elements are highly useful for answering phylogenetic questions (including the human–chimpanzee–gorilla trichotomy and New World primate phylogeny). Xing et al. (2007) also review how these elements have influenced fundamental ongoing processes like nonhomologous recombination, genomic deletion, and X chromosome inactivation.

The human microbiome project (http://nihroadmap.nih.gov/hmp/) is another example of how our understandings and conceptualizations of molecular genetics are changing our perceptions of how organisms interact and function. Turnbaugh et al. (2007) describe this project as a strategy to understand the microbial components of the human genetic and metabolic landscape and how they contribute to normal physiology and predisposition to disease. They note the surprise generated by the announcement that the human genome contains only ~20,000 protein-coding genes. However, they argue that if the view of what constitutes a human is extended, then may be more than 100,000 genes may be relevant for humans. The microorganisms that live inside and on humans (the microbiota) are estimated to outnumber human somatic and germ cells by a factor of ten. Turnbaugh et al. (2007) argue that the genomes of these microbial symbionts (called "the microbiome") provide traits that humans did not need to evolve on their own. To understand the range of human genetic and physiological diversity, the microbiome and the factors that influence the distribution and evolution of the constituent microorganisms also need to be identified and understood. This results in important connections to ideas about epigenetic inheritance, developmental plasticity, niche construction, and systems approaches.

Mirror neurons

Another major issue of complexity in themes related to biological anthropology is in mirror neurobiology; the discovery and investigation into the patterns and functioning of mirror neurons especially in the context of mirror neuron learning. The mirror system, found in premotor and parietal cortices of human and monkey brains, is thought to provide a foundation for social understanding, social learning, and to enable the development of theory of mind and language (Rizzolati and Sinigalia, 2008). Catmur et al. (2007) point out that cells in the neural "mirror system" fire not only when an individual performs an action but also when one observes the same action performed by another agent. However, it is unclear how mirror neurons acquire their mirror properties and how they derive the information necessary to match observed with executed actions. Rizzolatti and Sinigaglia and Catmur et al.'s findings indicate that the human and macaque mirror system is, to some extent, both a product and a process of social interaction. This is especially important given the recent emphasis on learning, cognition, and social cooperation in primate and human evolution (Herrmann et al., 2007; Silk, 2007; Hart and Sussman, 2008; Burkart et al., 2009) as it might provide a specific mechanism for the transmission of social behaviors and for a particular kind of social niche construction.

Increased complexity in the fossil record

In areas that have long been a traditional forte in physical, and now biological, anthropology, the ways we can provide context for the fossil record and the radical expansion in the fossil and primatological data sets have substantial impacts on our understandings, recreations and research questions in ways that were not available even 15 years ago. For example, Potts's (1999, 2004) work on variable climate patterns and variability selection, Kingston's (2007) focus on a comprehensive paleoenvironmental context forcing us to consider dynamism in the morphological, archeological, and environmental records, and Wells and Stock's (2007) notion of the core role of plasticity and adaptive flexibility in the hominins and a "biology of a colonizing ape" all argue effectively for integrating a more dynamic, systems approach to understanding human evolution. The publication of the *Ardipithecus* (White et al., 2009) and *Australopithecus sediba* fossils (Berger et al., 2010), the ongoing investigation into *Homo floresiensis* (Brown et al., 2004; Falk et al., 2007; Jungers and Baab, 2009; Aiello, 2010), and the recent substantial reviews of fossil data sets and our understandings of *Australopithecus afarensis* (Kimbel and Delezene, 2009), *Paranthropus boisei* (Wood and Constantino, 2007), and *Homo erectus* (Anton, 2003) are moving us closer to a true natural history of fossil taxa rather than a reliance on extreme speculation, and eventually to real intra and interpopulational studies. These

overviews will start to enable the kinds of integrative comparisons that Washburn envisioned; we are closer to understanding how fossil hominins lived and looked more than ever, but only a comprehensive and complex approach will get us there. The same is true in the nonhuman primate literature as more substantial overviews are published demonstrating a primacy of intraspecific and intrapopulational variation (Campbell et al., 2011) and long-standing explanatory frameworks are assessed, modified, challenged, and possibly even discarded (Thierry, 2008; Koenig and Borries, 2009,).

Expanding methodologies

In addition to new understandings from discoveries and the accumulation of ever growing data sets, we are also in the midst of a number of methodological improvements/innovations that are altering the types, qualities, and densities of data that we can collect. For example, Di Fiore (2003) describes how, in the past several decades, the development of novel molecular techniques and the advent of noninvasive DNA sampling, coupled with the ease and speed with which molecular analyses can now be performed, have made it possible for primatologists to directly examine the fitness effects of individual behavior and to explore how variation in behavior and social systems influences primate population genetic structure. Genetic assessments and characterizations of living primates enables actual testing of hypotheses previously only assessed at superficial levels. More recently Long et al. (2009) and The HUGO Pan-Asian SNP Consortium et al. (2009) used advances in genetic analyses to more effectively examine and articulate how humans really vary genetically and what that might mean in understanding human migrations, human variation, and our evolutionary histories.

In the context of reconstructing diets Lee-Thorp and Sponheimer (2006) review the suite of emerging biochemical paleodietary tools based on stable isotope and trace element archives within fossil calcified tissues. These tools provide innovative and important ways to get at the actual ecologies and behaviors of fossils and might provide some insight into niche constructive behaviors. Some significant outcomes derived using these methods include the demonstration of high trophic-level diets among Neanderthals and Late Pleistocene modern humans in Glacial Europe, and the persistent inclusion of C4 grass-related foods in the diets of Plio-Pleistocene hominins in South Africa. Of course, Lee-Thorp and Sponheimer conclude that more contextual data from modern ecosystem and experimental studies are needed to fully realize the potential of these isotopic analyses, emphasizing the fact that innovations in methods and theory do not necessarily replace long-standing data collection techniques and perspectives, but rather integrate with them and expand our toolkits. On a similar line, Schoeninger (2009) uses similar stable isotope methodologies on dietary patterns in North American indigenous groups to demonstrate the complexity in the emergence and use of maize agriculture. She shows that the stable isotope data force us to conclude that social, economic, and environmental conditions varied from region to region and even within regions of North America. This means that biological assessment of human diet and the emergence of agriculture "must include the social environment in addition to any consideration of the physical and technological environments in which human groups construct their dietary strategies" (p 638).

Biocultural anthropology

Finally, I want to acknowledge the explosion in biocultural investigations in biological anthropology as epitomizing the complexity in theory and practice. Biocultural approaches integrate ethnographic, physiological, morphometric, and evolutionary approaches (among others) to arrive at system-based complex and interactive conclusion about being human. For example, McDade (2005) points out that immune function is notoriously complex, and current biomedical research elaborates this complexity by focusing on the cellular and molecular mechanisms that characterize immune defenses. At population level, the use of ethnographic and cross-cultural perspectives is a necessary complement to the microlevels of analysis in biomedical immunology. The results of field-based research on human immunity demonstrate the relevance of cultural ecological factors, specifically the ecologies of nutrition, infectious disease, reproduction, and psychosocial stress. McDade argues that future research in human ecological immunology must integrate theory and method for a more contextualized understanding of this important physiological system.

Sapolsky (2004) comes to the same conclusion as McDade (see also Kuzawa and Sweet, 2009). Integrating methods from field primatology, general animal studies, and physiology, he reviews the nature of stress, the stress response, and stress-related disease, as well as the varieties of hierarchical systems in animals. He reviews the literature derived from nonhuman species concerning the connections between rank and functioning of the adrenocortical, cardiovascular, reproductive, and immune system, and the relationship is neither linear nor clean. Sapolsky expands these findings to consider whether rank is a relevant concept in humans and argues that socioeconomic status (SES) is the nearest human approximation to social rank and that SES markedly influences health. This theme and its methodologies are markedly tested and developed by Gravlee and colleagues (Gravlee, 2009; Gravlee et al., 2009). They demonstrate that social inequality (in this case racial inequality) becomes literally "embodied" in the physiological functioning and well-being of racialized groups. Human social perception and social structuring differentially influence the physiological functioning of human bodies and minds. This approach requires a synthesis of cultural, physiological, historical, and structural data sets and fits well within the emergent notions of plasticity, system-based approaches, and niche construction that I covered earlier.

Resonating throughout all of these examples is the reality that in modern biological anthropology research team approaches are core, and that integrative evolutionary and cross-disciplinary approaches are central to a majority of research in our discipline. I argue that these themes are very much in line with what I propose to be the central spine of Washburn's Biological Anthropology version 2010.

SO, ARE WE BIOLOGICAL ANTHROPOLOGISTS YET?

We are, and the work of members of our association shows that we are. I have attempted to demonstrate in this essay that we are well along into the emergence of

the New Physical Anthropology, a Biological Anthropology, that Washburn called for.

However, despite my cheerleading and optimism for who we are and what we do, there are also a number of places that we are failing to really reach the kind of synthesis and integration that enables us to fulfill the promise of a truly Biological Anthropology. More than anything, there is a need to interact across divisions within Biological Anthropology and beyond. So, my final question for this essay is: How can we be better Biological Anthropologists? Here are a few parting thoughts on where we need to improve to reach the lofty (and may be idealistic) goals I have outlined.

We require a more sincere and engaged integration and communication within our discipline. We need to overcome historical divisions that have subdivided biological anthropology and start communicating more extensively with each other. May be we could take a line from Washburn's playbook and consider attempting to rejuvenate the Wenner-Gren summer seminars or an AAPA sponsored equivalent? Such a process would be a good place to start intensive talks with one another beyond the standard AAPA conference format. Along these same lines, we (members of the AAPA) need to overcome the divisions with other anthropologists. The current state of disjuncture between many biological, social, and archeological anthropologists sometimes acts to inhibit fuller and more effective inquiry into our shared topics of interest. This is not all on the shoulders of biological anthropologists; many other "stripes" of anthropologists are at fault here as well. Although I am aware that in some cases it would not be beneficial to work collaboratively with certain colleagues, I remain convinced that we do need to link up with social and archeological anthropologists more than we do, or at least we can try harder. Those anthropologists who do not understand the importance of our views and what biological anthropology offers can go play by themselves, but their answers will always be incomplete at best, as will ours, if we do not more effectively reach across the aisles.

I have made a point to emphasize the role of complexity in our topics of study, our methodologies, and our theoretical orientations. As Biological Anthropologists, we need to accept complexity as here to stay and the possibility that we might have to incorporate new terminology/perspectives in addition to the ones currently dominating in our association (not instead of, but in addition to). A bit of reflective and integrative, may be even philosophical, discourse is good for us and should be part of our toolkit.

In the light of the increasingly recognized importance of diversity in evolutionary theory, in human evolution, in primate studies, and in almost everything we do, we really need to increase the diversity in practitioners of Biological Anthropology. We are relatively homogenous in regards to race, SES, life experience, overt sexual orientation, etc., as a discipline. Although there are no published data available to examine this assertion, looking around at the annual meetings of the American Association of Physical Anthropologists suggests at least anecdotal support for this view. Also, a recent survey (initiated by the AAPA *ad hoc* committee on diversity, which I co-chair) of underrepresented ethnic groups at the undergraduate, graduate, and faculty levels in physical anthropology programs in the United States revealed strong negative correlation between degree level and underrepresented ethnic group representation (AAPA, unpublished data). We need to incorporate more diverse voices and perspectives in our teaching and research. This, more than anything, is going to help us reach out to get our value as a discipline and an association more public.

Finally, there needs to be more of a popular Biological Anthropology. The public is hungry for reports on science, including areas addressed by biological anthropologists. The substantial public responses to the *Ardipithecus* publications and the announcement that Neanderthal "genes" continue in human populations tell us that we can access the public interest. But, we need to be engaging in the public eye with a wider variety of topics and debates. We need to be better represented when issues of core interest to our discipline are front and center on the public stage; human variation and race, biomedicine and evolution, health and disease, etc. This means more than press releases around our meetings and a few outreach programs (although those are terrific as well). We need to reflect and ask ourselves why do so few in the public know what we do. We have better things to say about being human than many doctors, psychologists, and science writers, but they are the "go to" targets for the media with much more regularity than we are. We need to be more active in public debate, on editorial pages, in popular books and the New York Times, on NPR, MSNBC, and CNN (even show up on Fox if you want to).

I sincerely believe we *are* Biological Anthropologists, and there is a great diversity of fantastic multidisciplinary and interdisciplinary work within our practice. As Sherwood Washburn called on us to do nearly 60 years ago, we must foster and enhance these activities and perspectives inside and outside of our association and discipline. Looking forward, we need more than ever to continue heeding the advice of Washburn and to build on the strengths and advances made in the recent history of our science.

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