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Competition and social and personality development: Some consequences of taking Darwin seriously

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Careful consideration of the evolutionary implications of competition and cooperation has significant repercussions for social dominance in humans across the life span. For example, two broad and phenomenologically distinct classes of resource control strategy appear to emerge in early childhood and persist through adulthood; namely, prosocial and coercive. Though these behavior classes are traditionally considered to be opposites in (non-evolutionary) psychology, they may ultimately function similarly. The present paper summarizes a novel theory of social dominance, exemplifies its utility by sketching an empirical program of research on children and adolescents, and reviews possible implications for traditional views of child behavior.
Keywords: *social dominance, evolution, aggression, peer relationships, personality.*

Competencia y desarrollo social y de la personalidad: algunas consecuencias de tomar a Darwin en serio

Una valoración cuidadosa de las implicaciones evolucionistas de la competencia y la cooperación tiene importantes repercusiones en el análisis de los procesos de dominancia social entre seres humanos a lo largo del ciclo vital. Por ejemplo, dos grandes estrategias para el control de recursos, aparentemente distintas, parecen surgir durante la infancia temprana y persistir a lo largo de la vida adulta; concretamente, la prosocial y la coercitiva. Aunque estos dos tipos de comportamiento se han considerado tradicionalmente como opuestos en psicología (no-evolucionista), pueden estar desempeñando, en última instancia, una función parecida. En este artículo, se presenta un resumen de una nueva teoría de la dominancia social, se ejemplifica su utilidad esbozando un programa de investigación con niños y adolescentes, y se revisan sus posibles implicaciones para una concepción clásica del comportamiento infantil.
Palabras clave: *dominancia social, evolución, agresión, relaciones entre iguales, personalidad.*

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The birth of evolutionary psychology has led many to ask, was psychology ever non-evolutionary? The answer is an unequivocal "yes", and in some domains it still is (Pinker, 2002). But how has evolutionary theory impacted developmental psychology?

The present paper explores the influence of evolutionary theories on developmental thought and makes the case that natural selection implies that competition is at the heart of social and personality development. A theory of social dominance is presented as an example of how a modern evolutionary framework can be integrated with contemporary developmental models.

Evolution and developmental psychology

Many developmental psychologists have the impression that Darwin deeply influenced developmental thought. Prominent Yale developmentalist, William Kessen, for example, opened a chapter of *The Child* (1965) with, (it is hard to imagine) «...what scholars thought of children before the publication and slow assimilation of *The Origin of Species* (1859)». Kessen claimed that Darwin introduced the study of change to psychology, the very essence of development. Even still, Darwin's baby biography (1877) frequently is hailed in introductory textbooks as the first systematic study of a child's behavior.

Not only was Darwin's baby biography predated by 90 years by German scientist Dieterich Tiedemann (1787), the evolutionary concepts addressed by several of the founding fathers of developmental psychology (e.g., James, McDougall, Freud, and Baldwin) were discussed in the literature long before the writings of Charles Darwin (1859). The late 19th century was a hotbed of biological argument and theorizing. Accordingly, there were several treatises regarding mechanisms of phyletic change including Darwin's "natural selection". Two stand out as noteworthy: Lamarck theory of the inheritance of acquired characteristics (1809) and Ernst Haeckel´s Biogenetic Law (1866). Though Lamarck's contribution has long been discredited (early glimmers of doubt were emerging as early as the late 1880s; Charlesworth, 1992), Haeckel's Biogenetic Law had lasting influence still visible today. In some senses then, it may be correct to say that early developmentalists, while perhaps evolutionary, were Haeckelian rather than Darwinian.

Haeckel famously proposed that the stages of ontogeny repeat the adult forms of animals lower on the phylogenetic scale by way of "terminal addition"; the human embryo passes through the stage resembling an adult fish because the fish provided the foundation for later adaptations that eventually led to land life, mammals, and then humans. Development, Haeckel argued, accelerates over time such that ancestral features were pushed back to earlier stages of the embryos of descendant species ("condensation"). The Biogenetic Law actually meshed nicely not only with the older Lamarckian notion of "inheritance of acquired characteristics", but also with the even older vision of the hierarchical order of life as reflected in "the great chain of being". This model made a good deal of sense at the time; one can see the lowly beasts

striving towards perfection (as represented by Man), as humans strive to be Godly. As Haeckel pointed out, one could see the remnants of such lowly beasts in the human embryo, leading him to famously claim "ontogeny recapitulates phylogeny", or the individual's development summarizes the development of the species.

The relationship between ontogeny and phylogeny is complex (see Gould, 1977 for example), and has caused a great deal of understandable confusion over the last century (see Morss, 1990 for a detailed treatment). On the dark side, the religious and biological linear ordering of life fueled Herbert Spencer's racist agenda of human perfection, the application of his notion of "survival of the fittest" to human society (i.e., "Social Darwinism", so named after Spencer's reading of *Origin of Species*, but outlined well before *Origin*'s publication). Nonetheless, the Biogenetic Law continued to be very popular well beyond the turn of the 20th century and the recapitulationist heuristic is evident in many older psychological theories. For example, the developing human was not only believed to pass through the stages of other species, but also through the history of mankind. G. S. Hall argued that the natural progression of children through these stages, including that of "savages", needed to be considered in childhood education. Freud linked oral and anal stages of sexual development with what he believed to be our quadrapedal ancestry, and he presumed that repressed primitive core stages to be part of the adult brain. Furthermore, he arranged the neuroses in phyletic order and attributed narcissism to the "primitive races". Even the child rearing guru Dr. Spock (1957) described the child as progressing "through the whole of human history".

The misapplication of evolutionary theory (or theories) leads to a sense of newness to "evolutionary developmental psychology". Outside of attachment theory (e.g., Bowlby, 1969), one sees few serious (correct) integrations of evolution by natural selection and child development until fairly recently (Bjorklund & Pellegrini, 2002; Ellis & Bjorklund, 2005; but see Fishbein, 1976; Bruner, Jolly, & Sylva, 1976). Though evolutionary psychology tends to presently focus on universals (e.g., Buss, 2007), evolutionary developmental psychology is well-poised to integrate developmental psychology's interest in individual differences with evolutionary principles (see Belsky, Steinberg, & Draper, 1991, Boyce & Ellis, 2005; Ellis, 2004), as the present application hopes to show.

Natural selection and competition

What set Darwin's evolutionary theory apart from the other evolutionary theories of his day was the inspiration of demographer/economist, Thomas Malthus, whose 1803 treatise argued that population growth is constrained by available resources. Consequently, Darwin believed that more individuals are born than survive to reproduce, and variations in phenotypes were related to differential survival and reproduction. Natural selection then can be characterized as competition between phenotypes. It is by no means the only force driving evolution, but it is the only one that is relevant to this discussion.

The competitive essence of natural selection suggests, at least at some level, that individualism, selfishness, and/or egocentrism are inherent to organisms and this individualism is well captured within many of theories of psychological importance (e.g., parent-infant conflict, sexual selection, jealousy, homicide). Where competitive aspects of evolution have had less impact are theories concerning the development of children. Developmentalists have typically preferred to focus on the bright side of development and as such align their philosophical roots more closely with Rousseau than with Hobbes (though Freud of course was a notable exception). Concerning negative behaviors such as aggression, for example, developmentalists typically look for perturbations that push a child off track of "normal" development (e.g., goodness).

Cooperation as a competitive venture

Darwin's "struggle for existence" (Darwin, 1859) creates powerful and influential imagery of aggressive competition both within and between species. This alignment is especially unambiguous in the sexual selection literature (male-male competition for females; Darwin, 1871; Trivers, 1972; Pellegrini & Archer, 2005) outlining sexual dimorphism for size and strength. This gladatorial perspective («...the strongest, the swiftest, and the cunningest live to fight another day», Huxley, 1888) heavily influence European naturalists and popular writers (e.g., Lorenz, 1967) and made the evolution of altruism one of the greatest quandaries in theoretical biology.

Yet, writings on the evolution of other-oriented behavior can be found as early as the turn to the 20th century. Anarchist Russian prince Pyotr Kropotkin (1902) contended that under harsh conditions and low population density, cooperation would evolve over aggressive competition. According to Kropotkin's minority view, the "struggle for existence" also entailed individual against environment and that this struggle could best be won via *mutual aid*.

It was not until Robert Trivers's seminal work on reciprocal altruism (1971) that individual level selection (cf. group selection; e.g., Wynne-Edwards, 1962; Wilson, 2006) was united with a viable theory of other-oriented behavior (see also Hamilton, 1964). Here, "altruism" bears limited cost when one considers delayed benefits; that is, social individuals perform altruistic acts with the implicit expectation that favors will be reciprocated. According to Trivers, social emotions such as trust and liking evolved to regulate these exchange processes. For example, we are disinclined toward those we do not trust to reciprocate and those who fail to reciprocate fall quickly out of favor.

Social Exchange theories are certainly not unknown in psychology, and similar to Trivers' perspective, claim that we are sensitive to inequities in exchange processes (e.g., Byrne, 1964; Walster, Walster, & Bersheid, 1978). From both perspectives, the appeal of a potential social partner is a function of what s/he brings to the relationship as a commodity (e.g., status, information, social connections, or wealth). These perspectives –while generally not embraced by developmentalists perhaps in light of their inherent cynical view of social relationships in general and friendships in particulars– are central to the

theory of social dominance presented below because they help explain the proximal mechanisms that maintain the social centrality of a socially dominant individual, even if s/he is aggressive. In the end, these individualist perspectives all suggest that we pick our friends, alliances, social networks in part as a result of a calculus determining what these people can do for us. Thus, in a very real sense, material goals can be achieved via sociality as well as aggression.

Dualism in human nature

One can construe the above to implicate a dualism in human motivation and behavior (see also Freud, 1930; Bakan, 1966). This dualism –that competitive forces give rise to both antagonistic and other oriented behavioral strategies– underlies the present theoretical perspective, Resource Control Theory (RCT; Hawley, 1999a).

According to the outline laid out above, successful competition can be achieved directly or indirectly. Direct means are relatively straight forward and can be seen readily in nature; that is, resources are sought via agonistic contests, for example. Consideration for the goals and motivations of others are simply by-passed. Instrumental aggression is a very direct *antisocial* means of resource access in zero-sum conditions. Indirect means of resource competition derive from evolutionary models of cooperation. Here, competition takes on a more non-zero sum quality; both interactants (or more) stand to gain in this cooperative or reciprocal context (see also Wilson, 2006). Instead of bypassing the social group as direct means do, indirect strategies exploit the mediating effect of the social group to access resources *prosocially*.

The bulk of psychology considers antisociality and prosociality opposite ends of a single continuum and, as such, assumes that they serve opposing functions. In contrast, here they are considered to serve the same function, or "two sides of the same coin" (Hawley, 2002; Charlesworth, 1996). As a consequence they may be assumed to be either independent or positively related (for extended discussion see Hawley, 1999a, 2002, 2007).

Resource control theory attempts to capture this dualism concretely in its translation of these direct and indirect strategies. That is, RCT posits that competition can come in at least two broad forms. So called *coercive strategies of resource control* are direct, aversive, and immediate (e.g., taking, threatening) and as such are equal to traditional conceptions of social dominance in the ethological literature (e.g., Strayer & Strayer, 1976; Bernstein, 1981). *Prosocial strategies of resource control*, finding their theoretical roots in evolutionary approaches to cooperation, include reciprocity, cooperation, unsolicited help, and positive alliance formation (i.e., friendships) –all behaviors that can serve successful resource acquisition with the approval of others. In contrast to coercive strategies, they are indirect, prolonged, and generally win positive group regard.

Theoretical and methodological implications for human social dominance and power

The above outlined approach to social dominance has several important theoretical ramifications for human social dominance and avenues of scholarly pursuit. Dominance hierarchies have been proven to be a highly visible central organizing feature of social behavior across *taxa*. If their effect is as profound as biological approaches might suggest and competition is a central organizing feature of social groups, then we ought to see social dominance play out in human social groups, even in early childhood. Our research program has centered on social dominance as an aspect of relationships, distinguishing the form of the behavior from its function, investigating the utility of a person-centered approach, and exhibiting continuity between species by demonstrating the social centrality of the dominant individual. Each of these points will be addressed in turn.

Social dominance and interpersonal relationships

First, social dominance describes a relative differential in competitive ability, and as such is an aspect of a *relationship*. The relationship aspect of social dominance had long been overlooked by ethologists who failed to explore competitive asymmetries within a complex system of interpersonal relationships, and instead focused on hierarchies (see Vaughn, 1999 for extended discussion). That is, social behavior, including that involving a contested resource is highly dependent on the identities of the interactants, their personal characteristics, and the unique history of their interactions (Hawley & Little, 1999). Moreover, because ethology derived from zoology, ethologists neglected aspects of human functioning long measured from psychological traditions. Thus, rather than focusing simply on gender, age, and size, we can (and should) measure social cognitions, personality, cognitive age, morality, etc., as predictors of social dominance (see for example, Hawley & Little, 1999; Hawley, 2003a, b).

To exemplify these points and to explore whether pursuing of intragroup competition made any sense at all, our first foray into the social dominance construct asked whether dominance is something that is of psychological significance to members of a social group (Hawley & Little, 1999). It is one thing to show that young children can be ordered in a hierarchy in terms of contest wins; it is quite another to demonstrate that the outcome of these wins influence social behavior outside of the competitive setting. If the social dominance construct is of any utility, we should see, for example, children of "middle rank" changing their behavior in the presence of those dominant to themselves relative to those who are subordinate. Secondly, we sought to know whether relative competitive ability could be predicted with psychological traits beyond the usual suspects of size and gender.

For this study, we recruited 1.5 – 3.2 year olds and their families from an institute-affiliated day care facility in Berlin, Germany, comprising two care groups of eight children. We assessed cognitive age (Bayley Scales of Infant

Development, 1993) and parent-rated temperament (Toddler Temperament Scale; Saile, 1987), along with size (height and weight), gender, and time spent at the daycare center. Social dominance was assessed by teacher ratings and observations of group play. For our outcome behavioral interactions, we borrowed a measurement paradigm used in social psychology (i.e., the Social Relations Model; Kenney & LaVoie, 1984) which means experimentally creating a "round robin" design where each child is repeatedly paired with a single peer and filmed for a set time (here, 5 minutes) in a semi-structured play encounter. Multiple dyadic interactions allow the exploration of the effects of each participant along with effects due to their unique combination. Our coding schema was ethologically inspired; we recorded micro-level behaviors such as directed comments, gazing, taking, thwarting, requesting, imitating, complying, etc. The end result was a rich dataset with the dyad as the unit of analysis (making the most of small groups).

This work demonstrated that social dominance as relative competitive ability mediates the relationship between individual-level attributes (i.e., cognitive age, persistence, gender, tenure) and social behavior in an experimental play setting (directing, passive watching, imitating, and social play). As one would expect from a relationship perspective, dyadic behavioral outcomes were also a function of how well the interactants knew each other. Moreover, we detected how children's behavior changed depending on the rank of their social partner. With peers dominant to themselves, there was more passive watching. With peers subordinate to themselves, they were more directing. Thus, relative competitive ability appears to be meaningful to children in their dyadic interactions in everyday play contexts, even before the age of three.

Function vs. form

Breaking from traditional perspectives, resource control theory shifts the focus from the *form* of behavior (what the behavior looks like) to the *function* of behavior (see Hawley 1999a,b for extended discussions). By focusing on resource acquisition first (the underlying function), we can then pose questions about how individuals (or species, or cultures) control resources (i.e., strategies employed or the structure of behavior), and how these strategies change over time (via developmental differentiation, social learning, etc.). The theory suggests that humans employ unrefined coercive strategies like other mammals, but diverge from other species with the development of strategies that necessitate a theory of mind and other higher order cognitive abilities (e.g., some of the more sophisticated prosocial strategies and deception).

While well-differentiated strategies may not be evident in very young children (e.g., less than three), by the ages of three to five one can explore *how dominant children dominate* to determine whether prosocial and coercive behavior are related to resource use (Hawley, 2002). To this end we used a "block design", a relative of the round robin design described above. Here we paired children rated as dominant by teachers with multiple subordinate partners. Our semi-structured play situation was designed expressly to pull for

resource-controlling behavior; namely, we presented a game-like task with two unequal roles. We reasoned that the primary role of the game would be a resource over which children would compete. How would dominant children secure and maintain the primary role for themselves?

Here, prosocial strategies were defined as making suggestions, issuing polite requests, and offering unsolicited help (the play material is thus effectively commandeered). Coercive strategies involved taking, aggression, and insults. As we expected, both classes of behavior were associated with occupation of the primary role (r = .53 for prosocial strategies, r = .46 for coercive), and both strategies were highly related to each other (r = .67). In fact, prosocial strategies were employed at twice the frequency of coercive strategies. In the end, socially dominant children occupied the primary role 71% of the time when occupation could be determined, while subordinate children only occupied it 19% of the time. Speaking to the idea that competition outcomes should be highly visible, teacher ratings of social dominance and control of the play material in the observation occasion were correlated .67.

By the time children are in late elementary school, they can self-report their own behavior and intentions. Questionnaire items for resource control query children about their success at goal attainment. Prosocial strategies include "I get what I want by reciprocating", "...by being nice", or "...promising friendship". Coercive strategies are indicated by items such as, "I get what I want by taking", "...threatening" or "...bullying". For adolescents we can use such items for peer nomination (e.g., "Who gets what they want by..."), friendship inventory ("My friend gets what they want by..."), and, of course, teacher reports at all ages (Hawley, 2003 a,b).

A person-centered typology

A third implication melds methodological concerns with the theoretical; namely, because resource control theory rests upon two foundational strategic orientations, we can now consider *types* of individuals who share common patterns of strategy employment (i.e., a person-centered approach*;* Hawley, Johnson *et al.,* 2007). On the basis of the relative degree of endorsement (self-report) or employment (teacher or peer report) of the strategies, we have defined subgroups of individuals depending on their placement in distributions divided into tertiles; bistrategic controllers by definition are in the top tertiles of both prosocial and coercive strategies, coercive controllers are in the top tertile of coercive strategies only, prosocial controllers are in the top tertile of prosocial strategies only, and noncontrollers are in the lowest tertile of both strategies. Typical controllers comprise the remainder. Regardless of whether the types are formed via teacher report (Hawley, 2003a), self-report (e.g., Hawley, 2003b) or peer nomination (Hawley, Card, & Little, 2007), bistrategic controllers are the most successful at resource control by far, followed by prosocial and coercive controllers, with the non-controllers being the least successful. Thus, bistrategic controllers are considered to be of the highest social dominance status and noncontrollers the lowest from this perspective by definition.

Thus far, a key goal of this research program has been to explore the personal and social outcomes and attributes of different types of resource controllers. In principle, how strategies are wielded should reveal driving motivational orientations (e.g., extrinsic motivation to attract others), personality (e.g., agreeableness), and social skills (e.g., emotional intelligence) of the actors. Not surprisingly, prosocial controllers display positive and attractive attributes such as intrinsic motivations for pursuing friendships (e.g., for joy and personal fulfillment; Hawley, Little, Pasupathi, 2002), agreeableness, and social skills. As a result, they are well-liked by peers and enjoy intimate, high-quality friendships (Hawley, Little, & Card, 2007). In contrast, coercive controllers are aggressive, hostile, unskilled (Hawley, 2003b), and motivated by power and popularity. Consequently, their friendships are low-quality and conflictual.

Bistrategic controllers perhaps make the greatest novel contribution to our understanding of human behavior. In part because of their dual strategy approach, they are by far the most successful at resource control. Yet another contribution to their success is their motivational profile. Like coercive controllers, bistrategics are aggressive, manipulative, and extrinsically motivated to pursue relationships. They have a high need for recognition for their accomplishments and place the highest value on the material world of all the groups (Hawley, 2003b; Hawley, Shorey, & Alderman, 2008). At the same time, they appear to have many of the skills of prosocial controllers such as a sophisticated understanding of others and a moral attunement (Hawley, 2003 a, b). This combination of skills balanced with aggression appears to embody the dualism of human nature described above.

What are we going to think of the decidedly successful yet manipulative individual? Some imagine the psychopath or social deviant while others envision the "Chief Executive Officer" or politician. Nowhere is the drive to evaluate the bistrategic controller in moral terms stronger than in developmental circles, a topic to which I will return shortly. Before we address how they are evaluated by researchers, we will address how they are evaluated by the social group.

Social dominance and social centrality

Because resource control theory was ultimately derived from the animal behavior literature (Hawley, 1999a), it predicts that the socially dominant individuals of a social group will hold social power and be socially central because of their evident mastery over the material world. That is, effective resource control should attract others (i.e., *the social centrality hypothesis*; Hawley, 1999a). Not only does instrumental competence in the material world win admiration, but resource holders bring much to the table in terms of social exchange processes.

Our studies with preschoolers and adolescents have repeatedly shown that bistrategic controllers garner a good deal of positive social attention (as do prosocial controllers), despite their high levels of aggression. When preschoolers

report "who they like", bistrategic controllers win among the most nominations (and coercive controllers the least; Hawley, 2003a). This pattern is replicated in adolescence, where bistrategic controllers not only win "like nominations", but also win among the most "s/he is my best friend" nominations, and are seen as popular and high status (Hawley, Little, & Card, 2007). These patterns are not easy to explain from predominant developmental psychopathology perspectives that hold aggression to be repellent and thus a risk factor (Coie & Dodge, 1998). We may wish to believe that children and adolescents don't see the aggression of the bistrategic, or that bistrategic behavior is nearer to assertion than aggression. But bistrategics are described by peers as aggressive and their friends report being targets of aggression within the relationship (Hawley, Little, & Card, 2007). Moreover, teachers rate them as physically attractive, despite being fully aware of their negative behavior (Hawley, Johnson *et al*., 2007). Coercive controllers, in contrast, are rated as the least attractive by teachers. People who don't know the children do not differentiate the two groups when rating photographs. To us this implies that teachers ultimately view bistrategic controllers favorably and coercive controllers unfavorably because of their behavior.

Implications for the developmental literature

The research program described above may raise thought-provoking questions regarding values and beliefs presently predominant in the field; namely, one's philosophical orientation, one's abhorrence of aggression, assumptions about gender, and the role of context in a biologically based construct. Each will be taken in turn.

Moral neutrality vs. melioration (Hobbes vs Rousseau)

The theory of evolution by natural selection *a lá* Darwin is a morally neutral theoretical orientation. To many, however, moral neutrality –that is, failure to take a moral stance– implies wickedness. That so many are led to such conclusions has been the bane of the theory since its inception. Historically, religious conservatives have claimed that the theory denies the human soul and special creation, and antagonists from the left claim that the theory justifies human violence and male domination. Most scientists operating within an evolutionary perspective deny both of these allegations (but see Dawkins, 2006, for a contrasting view).

In contrast, developmental psychology has characteristically adopted a morally *non-neutral* stance. One can still clearly see the Rousseaunian doctrine of the noble savage (*Émile,* 1762) inherent in the bulk of modern developmental work, especially in the social domain. Recall that Rousseau maintained that uncivilized (i.e., untainted) man is peaceful, egalitarian, and in possession of inborn moral instincts. The darker side of humanity (e.g., competition, greed, violence) stems from the corrupting influence of modern civilization. Consis-

tent with this belief, predominant modern views of child social behavior and development implicitly assume that with proper care (e.g., minimal corruption), children will grow to be moral, other-oriented, and non-aggressive. Antisocial tendencies (broadly defined) are held to arise from poor parenting, deviant peers, impoverished urban environments, or toxic media influences. Consequent to this deep philosophical orientation, child psychology throughout the 20th century adopted a "social engineering ethos" and an ameliorative mindset (Smith, 2007; Charlesworth, 1992); developmentalists focused their attention on bettering potentially corrupting environments to improve child development outcomes and thereby society.

In contrast to the bulk of 20th century child psychology, Freud (1930/1961) took a less rosy view of human development which partially underlies ill-will towards his theory today. Namely, one sees the unmistakable influence of Thomas Hobbes, who, though preceding Rousseau, adopted a nearly opposite view; namely, that man's natural propensity to behave out of self interest leads to perpetual struggle, and that societal controls (e.g., socialization) are necessary to enforce a collective will (Hobbes, 1651/1885). Like Freud, evolutionists by and large believe that human nature can lead to interactions marked by aggression and self-servingness, and much of this aggression can (and should) be controlled by constraints constructed by the social group at large (e.g., Pinker, 2007). At the same time, evolutionists more so than traditionally trained developmentalists allow that aggression may be functional, regardless of the moral evaluation of the act (see e.g., Pellegrini, 2007; Vaughn & Santos, 2007).

Aggression and social reception

Nowhere is this "morally neutral stance" more evident than in the study of aggression. Traditional developmental orientations deriving from psychopathology perspectives assume *a priori* that aggression is *evil*, and consequent to this malevolence the social group will castigate the aggressive individual. Accordingly, coercive strategies of resource control, though indisputably effective, are generally held to be "antisocial" from conventional psychological perspectives. Several well-established lines in the developmental literature have shown that early childhood aggression puts the child at risk for poor developmental outcomes, most germane to the discussion at hand, peer rejection (Coie, Dodge, & Kupershmidt, 1990; Coie & Dodge, 1998). Yet, I have proposed that at least in some contexts, this apparently maladaptive behavior in the proximal sense is in fact adaptive evolutionarily. How can this contradiction be reconciled?

The social centrality hypothesis of resource control theory suggests that aggression *–in the service of effective resource control–* is not as socially repellent as is suggested by the literature or conventional wisdom, and to assume so may be an oversimplification. Work since the mid-90's has shown that a subset of aggressors can be socially skilled (Sutton, Smith, Swettenham, 1999a,b; Hawley, 2003a,b) and socially appealing (Rodkin, Farmer, Pearl, van

Aker, 2000; Hawley 2003a, b; Cairns & Cairns, 1994). Though variable focused approaches (i.e., those that focus on relationships among variables via correlations and regressions) still tend to support the view that aggression leads to peer censure (e.g., Cillessen & Mayeaux, 2004), person-centered approaches (i.e., those that focus on *types* of individuals who score commonly on variables of interest) demonstrate that there are subtypes of aggressive individuals who fare quite well. This latter point is made clear by comparing the profiles and outcomes associated with the resource control typology described above. Namely, there are two groups of aggressive youths; bistrategic and coercive controllers. Despite their similarity on some dimensions, the social experiences of the bistrategic controllers and coercive controllers are quite distinct already by the age of five.

Thus, RCT attempts to resolve this quandary by focusing on the social dominance achieved by these individuals first, and their aggression only secondarily. By doing so, we can turn back to the social centrality hypothesis: Dominant individuals of many species command a good deal of attention from the social group due to their evident mastery of the material world. They are looked to, imitated, and sought out social partners (Hawley, 1999a; Chance, 1976). Additionally, in terms of social exchange parlance, they bring a good deal of material rewards and power to relationships. In the end, the benefits of associating with them appear to outweigh the substantial costs; they make very good friends, but very bad enemies.

In the end, do we characterize these bistrategic children as "good" or "bad"? Developmentalists driven to improve the lives of children may lean toward the latter over the former. I only wish to conclude that bistrategic children are probably not the ones attracting the bulk of attention from teachers and school service professionals in terms of intervention services targeting aggression. Those children would be the unskilled coercive controllers and the anxious, withdrawn non-controllers.

Social dominance and gender

Aggression and social dominance evoke thoughts of masculinity. As mentioned above, zoology-based ethological approaches to social dominance tended to strongly align social dominance with overt aggression or agonistic contexts. When dominance is approached this way, it tends to naturally favor males. In contrast, the present approach allows for, indeed stipulates, alternative strategies of resource control and dominance. If one assumes that females are more prosocially oriented than males, then would females thus have an alternate legitimate path to resource control?

Sexual selection theory outlines an unequivocally gendered view of competition. Based on differential parental investments, males are expected to be larger, more status striving, and more aggressive than females (see e.g., Buss, 1988; Geary, 1998). In contrast, RCT has been rather agnostic regarding gender differences and instead adopts the minority perspective of anthropologist, Sarah Blaffer Hrdy (1981/1999): «Visionaries of male-male competition stressed the

imagery of primate females ... so preoccupied with motherhood that they have little respite to influence their species' social organization. Alternate possibilities were neglected: that selection favored females who were assertive, sexually active, or highly competitive, who adroitly manipulated male consorts, or who were as strongly motivated to gain high social status...» (Hrdy, 1999; pp. 13-14).

Dovetailing beautifully with Hrdy's contribution is the work in developmental circles on aggression in girls. Although boys and men have long been considered more physically aggressive than girls and women (Maccoby & Jacklin, 1974; Lorenz, 1967) and more lethal in their aggression (Daly & Wilson, 1994; Wrangham & Peterson, 1996), more subtle forms of aggression that target the victims social standing or social well being appear to be the *modus operandi* of girls (e.g., Björkqvist & Niemelä, 1992; Crick & Grotpeter, 1995). Thus, rather than succumbing to clichés and concluding coercive strategies are the province of boys while prosocial strategies are that of the girls, we now can entertain that girls may be in fact quite aggressive, albeit in less visible ways.

Are males more resource controlling than females? In all work, including our own, it appears that they are. More interesting to us, however, is within gender variability. In study after study, we find bistrategic controllers to be equally male and female, even though the groups are derived *by exactly the same criteria*. Moreover, dominant bistrategic males and females are more alike than they are different; they are both highly resource directed, relationally and physically aggressive, and enjoy positive reception from their peers (Hawley, Card, & Little, 2008). Thus it appears that males have little advantage at achieving very high social dominance when both prosocial and coercive strategies are considered. In the end we conclude that social dominance is well-served by employing a wide range of behaviors and adopting all manner of skills and motivations characteristic of humans in general.

Learning winningness (and losingness): The role of context

Typically, writers in evolutionary psychology are searching for "human universals" (Buss, 2007). The present theory of social dominance is unusual because it is one of individual differences. Social dominance is an aspect of a relationship; the presence of others is a necessary condition for one to prevail. Thus, social dominance, or competitive superiority, is highly dependent on the composition of the social group and thus cannot be a genetically coded trait of the individual per se (see also Bernstein, 1981). At the same time, asymmetry of competitive ability can be predicted by the interpersonal characteristics of the individuals involved, some of which may have genetic underpinnings, such as persistence, extraversion, and pugnacity.

Others predictors of relative competitive ability may be entirely context dependent. For example, superiority may depend on the win-loss histories of the competitors. Doubtless the form and intensity of future attempts at resource control are influenced by the learning history of the individual. Early

loss experiences in competitive contexts (such as preschool classrooms or sibling circles) could intensify (indeed cause) individual differences in persistence. On this point, early developmentalists manipulated the experience of characteristic non-winners. These experiences led to greater success at resource control in subsequent interactions (Jack, 1934). As a result of these experiments, Jack correctly concluded that "ascendancy" was a function of the individual-context interface and that such behavior could be learned. Thus, because controlling strategies can be created experientially (e.g., learning that control attempts will be effective), direct genetic mechanisms need not be invoked.

Conclusions

If social dominance is a central organizing feature of the social group, and long term behavioral propensities can develop within competitive contests, then it appears as though competition is at the heart of personality development. This evolutionary view is a bit unusual because it is an individual differences perspective rather than a human universals perspective. As such, RCT is ultimately an evolutionary theory of human personality (Hawley, 2006).

The early evolutionists of the 19th century were developmentalists in that they looked to embryology to reveal human origins. Similarly, we cannot fully understand human social dominance and power without understanding the development of children and their behavior in peer groups.

REFERENCES

Bakan, D. (1966). *The duality of human existence.* Boston: Beacon Press.

Belsky, J., Steinberg, L., & Draper, P. (1991). Childhood experiences, interpersonal development, and reproductive strategy: An evolutionary theory of socialization. *Child Development, 62*, 647-670.

Bernstein, I.S. (1981). Dominance: The baby and the bathwater. *Behavioral and Brain Sciences, 4*, 419–457.

Bjorklund, D.F., & Pellegrini, A.D. (2002). *The origins of human nature: Evolutionary developmental psychology*. Washington D.C.: APA.

Björkqvist, K., & Niemelä, P. (1992). New trends in the study of female aggression. In K. Björkqvist & P. Niemelä (Eds.), *Of mice and women: Aspects of female aggression* (pp. 3-16). San Diego, CA: Academic Press.

Bowlby, J. (1969/82). *Attachment and loss: Vol. 1. Attachmen*t. New York: Basic Books.

Boyce, W.T., & Ellis, B.J. (2005). Biological sensitivity to context: I. An evolutionary-developmental theory of the origins and functions of stress reactivity. *Development and Psychopathology, 17*, 271-301.

Bruner, J.S., Jolly, A., & Sylva, K. (1976). *Play: Its role in development and evolution*. New York, NY: Basic Books.

Buss, D.M. (1988). From vigilance to violence: Tactics of mate retention. *Ethology and Sociobiology, 9*, 291-317.

Buss, D.M. (2007). *Evolutionary psychology: The new science of the mind (3ed)*. Boston, MA: Allyn & Bacon.

Byrne, P.M. (1964). *Exchange and power in social life*. New Brunswick: Transaction.

Cairns, R.B., & Cairns, B.D. (1994). *Lifelines and risks: Pathways of youth in our time*. Cambridge, England: University of Cambridge Press.

Chance, M.R.A. (1976). Attention structures as the basis of primate rank orders. *Man, 2*, 503-518.

Charlesworth, W.R. (1988). Resources and resource acquisition during ontogeny. In K.B.M. Donald (Ed.), *Sociobiological perspectives on human development* (pp. 24– 77). New York: Springer-Verlag.

Charlesworth, W.R. (1992). Darwin and developmental psychology: Past and present. *Developmental Psychology, 28*, 5-16.

Charlesworth, W.R. (1996). Co-operation and competition: Contributions to an evolutionary and developmental model. *International Journal of Behavioral Development, 19*, 25-39.
Cillessen, A.H.N., & Mayeux, L. (2004). From censure to reinforcement: Developmental changes in the association between aggression and social status. *Child Development, 75*, 147-163.
Coie, J.D., & Dodge, K.A. (1998). Aggression and antisocial behavior. In W. Damon (Series Ed.) & N. Eisenberg (Vol. Ed.), *Handbook of child psychology: Vol. 3. Social, emotional, and personality development* (5th ed., pp. 779–862). New York: Wiley.
Coie, J.D., Dodge, K.A., & Kupersmidt, J. (1990). Peer group behavior and social status. In S. R. Asher & J. D. Coie (Eds.), *Peer rejection in childhood* (pp. 17–59). New York: Cambridge University Press.
Crick, N.R., & Grotpeter, J.K. (1995). Relational aggression, gender, and social-psychological adjustment. *Child Development, 66*, 710-722.
Daly, M., & Wilson, M. (1994). Evolutionary psychology of male violence. In J. Archer (Ed.), *Male violence* (pp. 253-288). New York: Routledge.
Darwin, C. (1859). *On the origin of species*. London: Murray.
Darwin, C. (1871). *The descent of man and selection in relation to sex*. London: Murray.
Darwin C. (1877). A biographical sketch of an infant. *Mind, 7*, 285-93.
Dawkins, R. (2006). *The God delusion*. Boston: Houghton Mifflin
Ellis, B.J. (2004). Timing of pubertal maturation in girls: An integrated life history approach. *Psychological Bulletin, 130,* 920-958.
Ellis, B.J., & Bjorklund, D.F. (Eds.) (2005). *Origins of the social mind: Evolutionary psychology and child development*. New York, NY: Guilford.
Fishbein, H.D. (1976). *Evolution, development, and children's learning*. Santa Monica, CA: Goodyear.
Freud, S. (1930/1961). *Civilization and its discontents*. New York: W.W. Norton.
Geary, D.C. (1998). *Male, female: The evolution of human sex differences*. Washington DC: American Psychological Association.
Gould, S.J. (1977). *Ontogeny and phylogeny*. Cambridge, MA: Harvard University Press.
Haeckel, E. (1866). *Generelle Morphologie der Organismen*. Berlin: Georg Reimer.
Hamilton, W.D. (1964). The genetical evolution of social behaviour I and II. *Journal of Theoretical Biology, 7*, 1-52.
Hawley, P.H. (1999a). The ontogenesis of social dominance: A strategy-based evolutionary perspective. *Developmental Review, 19*, 97–132.
Hawley, P.H. (1999b). Strategies of play and winning the game: A reply to Brian Vaughn. *Merrill-Palmer Quarterly, 45*, 363-369.
Hawley, P.H. (2002). Social dominance and prosocial and coercive strategies of resource control in preschoolers. *International Journal of Behavioral Development, 26,* 167-176.
Hawley, P.H. (2003a). Strategies of control, aggression and morality in preschoolers: An evolutionary perspective. *Journal of Experimental Child Psychology, 85*, 213-235.
Hawley, P.H. (2003b). Prosocial and coercive configurations of resource control in early adolescence: A case for the well-adapted Machiavellian. *Merrill-Palmer Quarterly, 49*, 279-309.
Hawley, P.H. (2006). Evolution and personality: A new look at Machiavellianism. In D.K. Mroczek & T.D. Little (Eds), *The handbook of personality development* (pp. 147-161). Mahwah, NJ: Erlbaum.
Hawley, P.H. (2007). Social dominance in childhood and adolescence: Why social competence and aggression may go hand in hand. In P.H. Hawley, T.D Little, & P. Rodkin (Eds.). *Aggression and adaptation: The bright side to bad behavior.* Hillsdale, NJ: Lawrence Erlbaum and Associates.
Hawley, P.H., Card, N.A., & Little, T.D. (2008). The myth of the alpha male: A new look at dominance related beliefs and behaviors among adolescent males and females. *International Journal of Behavioral Development, 32,* 76-88.
Hawley, P.H., Johnson, S.E., Mize, J.A., & McNamara, K.A. (2007). Physical attractiveness in preschoolers: Relationships with power, status, aggression, and social skills. *Journal of School Psychology,* 45, 499-521.
Hawley, P.H., & Little, T.D. (1999). Winning some and losing some: A social relations approach to social dominance in toddlers. *Merrill-Palmer Quarterly, 45*, 185–214.
Hawley, P.H., Little, T.D., & Card, N.A. (2007). The allure of a mean friend: Relationship quality and processes of aggressive adolescents with prosocial skills. *International Journal of Behavioral Development, 31,* 170-180.
Hawley, P.H., Little, T.D., & Pasupathi, M. (2002). Winning friends and influencing peers: Strategies of peer influence in late childhood. *International Journal of Behavioral Development, 26,* 466-474.
Hawley, P.H., Shorey, H.S., & Alderman, P.M. (2007). The origins of social dominance and power: Perspectives from resource control and attachment theories. Manuscript under review.
Hobbes, T. (1651/1885). *Leviathan, or the matter, form and power of a commonwealth, ecclesiastical and civil*. London: Routledge & Sons.

Hrdy, S.B. (1999). *The woman that never evolved*. Cambridge, MA: Harvard University Press. (Original work published 1981).
Huxley, T. (1888). The struggle for existence in human society. *The Nineteenth Century, 23*, 195-236.
Jack, L.M. (1934). An experimental study of the ascendant behavior in preschool children. Behavior of the preschool child. In G.D. Stoddard (Ed), *University of Iowa Studies in Child Welfare, 9*, 9-65.
Kenny, D.A., & LaVoie, L. (1984). *The social relations model*. In L. Berkowitz (Ed.)*, Advances in experimental social psychology*. New York: Academic.
Kessen, W. (1965). *The child.* New York: Wiley.
Kropotkin, P. (1902). *Mutual aid: A factor of evolution*. London: Doubleday.
Lamarck, J.-B. de (1809/2006). *Zoological philosophy: An exposition with regard to the natural history of animals*. London: Bill Huth Publishing.
Lorenz, K. (1967). *On aggression*. New York: Bantam.
Maccoby, E.E., & Jacklin, C.N. (1974). *The psychology of gender differences*. Stanford, CA: Stanford University Press.
Morss, J.R. (1990). *The biologising of childhood: Developmental psychology and the Darwinian myth*. Hillsdale, NJ: Lawrence Erlbaum.
Pellegrini, A.D. (2007). Is aggression adaptive? Yes: Some kinds are and in some ways. In P.H. Hawley, T.D. Little, & P.C. Rodkin (Eds.), *Aggression and adaptation: The bright side to bad behavior* (pp. 85-105). Mahwah, NJ: Erlbaum.
Pellegrini, A.D., & Archer, J. (2005). Sex differences in competitive and aggressive behavior: A view from sexual selection theory. In B.J. Ellis & D.F. Bjorklund (Eds.), *Origins of the social mind: Evolutionary psychology and child development* (pp. 219-244). NY: Guilford Press.
Pinker, S. (2002). *The blank slate: The modern denial of human nature*. New York: Viking.
Pinker, S. (2007). A history of violence. *The New Republic,* Mar. 19, 2007.
Rodkin, P.C., Farmer, T.W., Pearl, R., & Van Acker, R. (2000). Heterogeneity of popular boys: Antisocial and prosocial configurations. *Developmental Psychology, 36*, 14–24.
Rousseau, J.J. (1762/1955). *Émile*. New York: Dutton.
Saile, H. (1987). *Entwicklunspsychologische Beitrage zur psychischen Belastung von Kindern durch einen Krankenhausaufenhalt.* [Developmental influences on psychic stressors of hospitalized children]. Frankfurt: Lang.
Smith, P.K. (2007). Why has aggression been thought of as maladaptive? In P.H. Hawley, T.D. Little, & P.C. Rodkin (Eds.), *Aggression and adaptation: The bright side to bad behavior* (pp. 65-83). Mahwah, NJ: Erlbaum.
Spock, B.M. (1957). *Baby and child care*. New York: Pocket Cardinal.
Strayer, F.F., & Strayer, J. (1976). An ethological analysis of social agonism and dominance relations among preschool children. *Child Development, 47*, 980–989.
Sutton, J., Smith, P.K., & Swettenham, J. (1999a). Bullying and "theory of mind": A critique of the "social skills deficit"view of anti-social behaviour. *Social Development, 8*, 117-127.
Sutton, J., Smith, P.K., & Swettenham, J. (1999b). Socially undesirable need not be incompetent: A response to Crick and Dodge. *Social Development, 8,* 132-134.
Tiedemann, D. (1787). Beobachtungen über die Entwicklung der Seelenfähigkeiten bei Kindern (Observations on the development of children's mental capacities). *Hessische Beiträge zur Gelehrsamkeit und Kunst, 2,* 313-333.
Trivers, R.L. (1971). The evolution of reciprocal altruism. *Quarterly Review of Biology, 46,* 35-57.
Trivers, R.L. (1972). Parental investment and sexual selection. In B. Campbell (Ed.), *Sexual selection and the descent of man 1871-1971* (pp. 136-179). Chicago: Aldine.
Vaughn, B.E. (1999). Power is knowledge (and vice versa): A commentary on "On winning some and losing some: A social relations approach to social dominance in toddlers". *Merrill-Palmer Quarterly, 45*, 215-225.
Walster, E., Walster, G.W., & Berscheid, E. (1978). *Equity: Theory and research*. Boston: Allyn and Bacon.
Wilson, D.S. (2006). Human groups as adaptive units: Toward a permanent concensus. In P. Carruthers, S. Laurence and S. Stich (Eds.), *The Innate Mind: vol 2, Culture and Cognition*. Oxford: Oxford University Press.
Wrangham, R., & Peterson, D. (1996). *Demonic males: Apes and the origins of human violence*. New York: Houghton.
Wynne-Edwards, V.C. (1962). *Animal dispersion in relation to social behaviour*. London: Oliver & Boyd.

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Children's academic development: Where evolution meets culture

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Schools are the interface between evolution and culture. They are the contexts in which children's evolved learning and motivational biases intersect with the need to learn the vast array of evolutionarily-novel skills (e.g., reading) and knowledge (e.g., geometric concepts) needed to function as adults in modern societies. The rapid cross-generational accumulation of knowledge during the past several millennia has created a gap between children's evolved learning and motivational biases and the types of learning needed to master evolutionarily-novel skills and knowledge. I provide a brief overview of these evolved learning and motivational biases, and place them in the context of children's learning and motivation to learn in modern-day schools.
Key words: *evolution, development, cognitive development, academic learning.*

Desarrollo académico infantil: donde la evolución se encuentra con la cultura

Las escuelas constituyen el punto de encuentro entre la evolución y la cultura. Son los contextos donde los aprendizajes y motivaciones infantiles predispuestos durante la evolución se entrecruzan con la necesidad de aprender una gran cantidad de habilidades (e.g., leer) y conocimientos (e.g., conceptos geométricos) evolutivamente nuevos, precisos para el funcionamiento adulto en las sociedades modernas. La rápida acumulación de conocimientos durante los pasados milenios ha producido un vacío entre estas predisposiciones de aprendizaje y motivación infantiles generadas durante la evolución, y los tipos de aprendizaje requeridos para dominar las habilidades y conocimientos evolutivamente nuevos. Aquí se realiza una breve descripción de estas predisposiciones de aprendizaje y motivación evolutivas, y se las sitúa en el contexto de los aprendizajes y la motivación para aprender de los niños en las escuelas modernas.
Palabras clave: *evolución, desarrollo, desarrollo cognitivo, aprendizaje académico.*

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Schooling is at the interface between evolved biases in children's learning and the processes through which culturally-important knowledge and skills are transmitted across generations. An understanding of this interface is especially critical for societies with vast and rapidly accumulating stores of knowledge (e.g., in books). These are societies in which a gap has emerged –and is rapidly widening– between what children find easy to learn and are motivated to learn based on human evolutionary history, and what they need to learn to be successful adults in these societies. Unfortunately, the distinction between evolved biases in children's learning and motivation to learn and their ability and motivation to learn cultural knowledge that has accumulated during the past several millennia has not been made in educational research or practice. In fact, the application of insights from evolutionary theory has not frequently occurred at all in the field of education, despite increasing acceptance among psychological scientists (e.g., Buss, 2005). In this article, I provide a brief introduction to the interface between evolved aspects of children's development and their schooling in modern societies (see also Geary, 2007, in press). In the first two sections, I outline the evolved cognitive, developmental, and motivational foundations for learning in evolutionarily-novel contexts, and in the third I discuss implications for children's motivation and learning in modern schools.

Evolution of the human mind

The mechanisms that drove the evolution of the human mind and brain and the corresponding ability to learn throughout the lifespan are vigorously debated. The proposals range from the ability to anticipate and adjust to climatic fluctuations (Ash & Gallup, 2007; Kanazawa, 2004) to learning complex hunting skills (Kaplan, Hill, Lancaster, & Hurtado, 2000) to the demands of living in large, dynamic social groups (Alexander, 1989; Dunbar, 1998; Flinn, Geary, Ward, 2005; Geary, 2005; Humphrey, 1976). At the core of all of these proposals is the ability to anticipate changing conditions (e.g., climate or social relationships) and then to generate and mentally rehearse potential behavioral responses to these changes. The mechanisms that resulted in our ability to anticipate and cope with change are also the mechanisms that now allow us to create culture and to accumulate a wealth of evolutionarily-novel knowledge (Geary, 2005). The corresponding cognitive systems support children's ability to learn evolutionarily-novel information (e.g., sum of the interior angles of a triangle is 180) and skills (e.g., reading) in school, and the evolved motivational components influence their motivation, or lack thereof, to engage in school learning.

Learning in school

All theories on how the human mind evolved focus on our ability to cope with conditions that were not entirely predictable from one situation to the next and had the potential to influence survival or reproductive prospects during

our evolutionary history. As an example, there are features of social life –marriage, investment in children, competition with other groups– that are found in all human cultures and presumably during human evolution (Brown, 1991), but the specifics differ from one group to the next, from one person to the next and across time. This is true in other primates as well, but their social behavior is much more stereotypical than that found in humans. In Hamadryas baboons (*Papio hamadryas*), for instance, the behavior of subordinate individuals to dominant individuals follows the same script, more or less, across dyads (see Parker, 2004). The social behavior of chimpanzees (*Pan troglodyte*s), and other great apes, is scripted to some extent but it is also more varied and flexible, requiring some degree of anticipation and planning. The latter requires a social apprenticeship whereby the scripts for some of the more complex features of social life are elaborated upon during development, with the aid of older group members. This pattern is taken to the extreme in humans, making scripted "hardwired" responses to social relationships maladaptive; people who always respond in the same way are easily out maneuvered socially and thus at a disadvantage.

I proposed in my 2005 book, *Origin of Mind: Evolution of Brain, Cognition, and General Intelligence*, that the mechanisms that allow people to cope with novelty and change include general fluid intelligence and the underlying ability to focus attention and inhibit irrelevant information from entering into working memory. These mechanisms use information generated from folk-modular systems (see below). The simultaneous representation of different pieces of information in working memory appears to be linked to the associated brain systems. In this way, evolved modular systems can be linked in novel ways (Sporns, Tononi, & Edelman, 2000), creating evolutionarily-novel abilities. For example, the linking of language systems to visual object-naming systems may contribute to our ability to read (Geary, 2007). Many modular systems are also internally modifiable in response to experience, especially early experience (Geary & Huffman, 2002); this means the systems can respond to a range of information, within constraints (Sperber, 1994).

Motivation to learn in school

The source or sources of the unpredictability that resulted in our ability to anticipate and adapt to novelty and change are predicted to have also resulted in motivational biases for the associated content. If anticipating and adapting to climatic change was a key evolutionary pressure, then humans are predicted to be biased to attend to corresponding information (e.g., cloud patterns) and engage in activities during development that facilitates the ability to predict climate change. In other words, if climatic variation was a selective pressure that drove the evolution of the human mind and brain, then children should be biased to learn about weather patterns. This knowledge cannot be "hardwired" because weather is too variable and thus a motivational bias to learn how to predict this variation should be part of children's natural development. If learning the nuances of social dynamics was the driving force in human cogni-

tive evolution, then learning and motivational biases organized around common social relationships, such as parents and peers, should be found. In either case, the predicted motivational biases are for content that differs from much of that taught in modern schools.

Modular domains of mind

Whether the pressure were climatic, ecological, or social, the human mind and brain evolved to attend to, process, and guide behavioral responses to core types information: information that correlated with survival and reproductive prospects during our evolutionary history. Figure 1 shows a taxonomy of these *biologically primary* or core domains of human cognition (Geary, 2005).

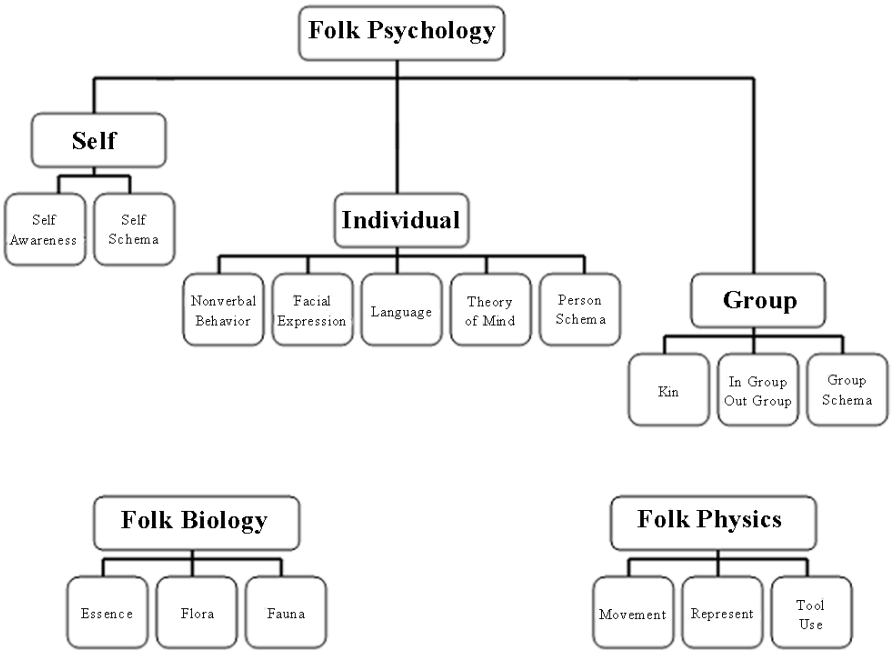

Figure 1: Evolutionarily salient information-processing domains, and associated cognitive modules that compose the domains of folk psychology, folk biology, and folk physics.

The domains coalesce around folk psychology, folk biology, and folk physics (Atran, 1998; Baron-Cohen, 1995; Geary, 1995; Leslie, Freidman, & German, 2004; Mithen, 1996; Wellman & Gelman, 1992); there is also evidence for an evolved set of quantitative abilities (Geary, 1995, R. Gelman,

1990; Spelke, 2000). I have suggested these folk systems are composed of a constellation of "soft" modular mechanisms. They are modular because they process specific forms of information and they are soft because they are sensitive to and change in response to variation in the corresponding information patterns. A bias to orient to the human face and to automatically process key pieces of facial information (e.g., eyes) is an example of a modular primary ability (Kanwisher, McDermott, & Chun, 1997). If the ability to discriminate one person from the next affords a social advantage over those who cannot make these discriminations, then evolution should produce a soft module, one with some degree of plasticity, but within constraints. Plasticity results in a capacity for the face-processing system to respond to experience with different people such that the system codes and stores information that allows people to discriminate one person from the next.

I have argued that the function of these folk competencies is to focus behavior on attempts to achieve access to and control of the social, biological, and physical resources that tended to enhance survival or reproductive prospects during human evolution (Geary, 2005). Achieving control is not guaranteed, and if it occurs it is typically without conscious awareness of the corresponding evolved function. Peer relationships are supported by folk-psychological competencies, and much of the corresponding social behavior is not explicitly guided by a motivation to control the behavior of friends. Children's peer relationships allow them to learn the nuances of social dynamics and to come to understand how they can influence other children and how others in the social group try to influence them. In traditional societies and during much of human evolution, these peers will become the adults with whom they will cooperate and compete for mates and other key resources. Early peer relationships become the social-reproductive milieu of adulthood, and thus early learning can have evolutionary outcomes. In other words, whether people are aware of the evolved function, friendships are social resources that can enhance survival and reproductive prospects under the types of conditions found in traditional societies and presumably throughout human evolution.

Folk systems

Folk psychology. The folk-psychological systems at the top of Figure 1 represent three sets of modules that process information related to the self, other individuals, and group dynamics, respectively. The first includes awareness of the self as a social being and awareness of one's relationships with other people (e.g., Harter, 2006). Self awareness is tied to the ability to mentally project the self backward in time to recall episodes that are of personal importance and to project oneself forward in time; to create a self-centered mental simulation of potential future states (Suddendorf & Corballis, 1997; Tulving, 2002). Individual level modules process the information need for one-on-one social dynamics and to maintain social relationships (Bugental, 2000). Group-level modules enable individuals to parse their social world into

categories of kin, members of favored in-groups, and members of disfavored out-groups.

People also have the unique ability to form in-groups on the basis of ideology, such as nation (Alexander, 1989). These ideologies include moral edicts regarding the treatment of in-group members, and mechanisms for their enforcement (Haidt, 2007). These ideologies support the formation of large-scale cooperative communities, provide stability across generations, and support the cross-generational accumulation of cultural knowledge. These biases evolved because they allow the formation of large competitive groups that are better able to control ecologies and social politics than are poorly organized groups. These ideologies are the foundation for the emergence of modern societies. The formation of these societies supports the division of labor needed for the creation of vast amounts of evolutionarily-novel information and supports the development of schools. Most adults are freed from foraging and hunting demands and some specialize in generating new knowledge (e.g., scientists, poets). The formation of institutions that specialize in the creation of new knowledge, such as universities, has resulted in the exponential increase in evolutionarily-novel knowledge over the past several thousand years, and especially during the 20th century. This trend is only going to increase and will result in an even greater importance for children's schooling in the 21st century.

Folk biology and folk physics. Folk biological modules orient people to the biological world and result in the ability to develop taxonomies of other species and knowledge systems about their behavior, growth, and "essence" (Atran, 1998; New, Cosmides, & Tooby, 2007). In traditional societies, these competencies support behavioral activities that allow people to use ecological resources for survival or reproductive purposes, such as hunting and horticulture (Kaplan *et al.,* 2000). Folk physical systems support navigation, the formation of mental representations of physical features of the ecology, and the construction of tools (Pinker, 1997; Shepard, 1994).

Folk heuristics

The behavioral features of folk domains can be described as "rules of thumb" (Gigerenzer, Todd, & ABC Research Group, 1999). The corresponding information is processed implicitly and the behavioral component is more or less automatically executed (Simon, 1956). Returning to face processing, the pattern generated by the shape of the eyes and nose provides information on the sex of the individual, whereas the pattern generated by the configuration of the mouth provides information about the individual's emotional state (Schyns, Bonnar, & Gosselin, 2002). These patterns are automatically and implicitly processed by the receiver, who in turn expresses corresponding emotional and other social signals (e.g., smile). The receiver may also make implicit decisions regarding the interaction, but these do not need to be explicitly represented in working memory and made available to conscious awareness. These quick, rule-of-thumb decisions can be based on automatically generated

feelings and other social information. Negative feelings, such as fear elicited by an angry expression, may prompt withdrawal; and positive feelings, such as happiness generated by a smile, a continuance of the interaction (Damasio, 2003).

Folk heuristics can also include explicit inferential and attributional biases. People often make attributions about the cause of their failures to achieve desired outcomes and often attribute such failures to bad luck or biases in other people. An evolved tendency to make attributions of this type has the benefit of maintaining effort and control-related behavioral strategies in the face of inevitable failures (Heckhausen & Schultz, 1995). Social attributional biases that favor members of the in-group and derogate members of out-groups are also well known (Fiske, 2002) and facilitate intergroup competition (Horowitz, 2001). Similar attributional biases have been identified in the areas of folk biology and folk physics (Atran, 1998; Clement, 1982).

These biases provide good enough explanations for day-to-day living and self-serving explanations for social and other phenomena. An evolved usefulness for everyday living does not mean the explanations are accurate from a scientific perspective. In fact, *descriptions* of psychological, physical, and biological phenomena are often correct (Wellman & Gelman, 1992), but many of the explicit explanations and attributional biases regarding the *causes* of these phenomena are objectively and scientifically inaccurate.

Evolution and cognitive development

From an evolutionary perspective, cognitive development is the experience-driven adaptation of biologically primary modular competencies to the nuances of the local social, biological, and physical ecologies (Geary & Bjorklund, 2000). As noted, modular systems are predicted to be open to experiential modification to the extent that sensitivity to variation within these domains has been of potential survival or reproductive significance during human evolution. At a macro level, prenatal brain organization provides the skeletal structure that comprises neural and perceptual modules that guide attention to and the processing of stable forms of information (e.g., the general shape of the human face) in the folk domains shown in Figure 1 (see also R. Gelman, 1990). In support of this proposal, studies of infants' attentional biases and preschool children's nascent and implicit knowledge are often focused on these three folk domains (S. Gelman, 2003; Keil, Levin, Richman, & Gutheil, 1999; Mandler, 1992; Wellman & Gelman, 1992).

The result are biases in postnatal attentional, affective, and information-processing capacities, and in self-initiated behavioral engagement of the environment (Bjorklund, 2007; Bjorklund & Pellegrini, 2002; Scarr, 1992). The latter generate evolutionarily-expectant experiences, that is, experiences that provide the social and ecological feedback needed to adjust modular architecture to variation in information patterns in these domains (Greenough, Black, & Wallace, 1987). These behavioral biases are expressed as common

juvenile activities, such as social play and exploration of the ecology. Experience-expectant processes result in the modification of plastic features of the modular systems. The result is the ability to identify and respond to variation (e.g., to discriminate one individual from another) within folk domains, and the ability to create the forms of category shown in Figure 1, such as in-groups/out-groups or flora/fauna.

Folk domains

Folk psychology. Human infants' biases to attend to human faces, movement patterns, and speech reflects the initial and inherent organizational and motivational structure of folk psychological modules (Freedman, 1974). These biases reflect the evolutionary significance of social relationships and re-create the microconditions (e.g., parent-child interactions) associated with the evolution of the corresponding modules (Caporael, 1997). Attention to and processing of this information provides exposure to the within-category variation needed to adapt the architecture of these modules to variation in parental faces, behavior, and so forth (R. Gelman & Williams, 1998). One result is that infants are able to discriminate the voice of their parents from the voice of other potential parents with only minimal exposure. When human fetuses (~ 38 weeks gestation) are exposed in utero to human voices, their heart-rate patterns suggest they are sensitive to and learn the voice patterns of their mother, and discriminate her voice from that of other women (Kisilevsky, Hains, Lee, Xie, Huang, Ye *et al*., 2003).

Folk biology and folk physics. The complexity of hunting and foraging demands varies across ecologies and thus creates a situation that should select for plasticity in the folk biological and physical systems. Children's implicit folk biological knowledge and inherent interest in living things reflect a motivation to engage in experiences that automatically create taxonomies of local flora and fauna and result in the accrual of an extensive knowledge base of these species. In traditional societies, these experiences include assisting with foraging and play hunting (Blurton Jones, Hawkes, & O'Connell, 1997; Bock, 2005). Anthropological research indicates that it often takes many years of engaging in these forms of play and early work to master the skills and knowledge needed for successful hunting and foraging in many of these societies (Kaplan *et al.,* 2000).

Learning about the physical world is a complex endeavor for humans and requires an extended developmental period, in comparison with the more rapid learning that occurs in species that occupy a more narrow range of physical ecologies (Gallistel, 2000). The importance of early experience in this domain is illustrated by development of the ability to mentally form map-like representations of the large-scale environment. The initial ability to form these representations emerges by three years of age (DeLoache, Kolstad, & Anderson, 1991), improves gradually through adolescence, and often requires extensive exploration and exposure to the local environment to perfect (Matthews, 1992). Matthews' research shows that children automatically attend to geo-

metric features of the environment and landmarks within this environment and at a later time can generate a cognitive representation of landmarks and their geometric relations. Children's skill at generating these representations increases with repeated explorations of the physical environment. Chen and Siegler's (2000) finding that 18-month-olds have an implicit understanding of how to use simple tools and with experience learn to use these tools in increasingly effective ways suggests that similar processes occur for tool use (see also Gredlein & Bjorklund, 2005).

Academic development

There is a cost to our extraordinary ability to create evolutionarily novel – *biologically secondary*– knowledge and competencies: During the last several thousand years the cross-generational accumulation of cultural knowledge (e.g., through books) has occurred at such a rapid pace (Richerson & Boyd, 2005), that the attentional and cognitive biases that facilitate the modification of folk abilities during children's natural activities do not have evolved counterparts to facilitate the learning of secondary abilities. A thorough discussion of the implications are elaborated elsewhere (Geary, 2007), but I highlight key aspects in the following sections.

Motivation to learn

Theoretical and empirical research on children's early attentional biases and activity preferences can be placed within an evolutionary perspective. And a broader understanding of these preferences and how they are expressed in school settings has the potential to significantly improve our understanding of children's motivation (or not) to learn biologically secondary material.

A core prediction is that children's evolved motivational biases will be focused on learning in folk domains and that they will prefer to engage in this learning through play and exploration. Children are also predicted to show a preference for the activities that promote the cross-generational transfer of knowledge in traditional societies. These activities involve stories to convey morals (i.e., cultural rules for social behavior) and other themes relevant to day-to-day living, and apprenticeships whereby culturally important skills (e.g., hunting, tool making) are learned through observation of or direct instruction by more skilled individuals (Brown, 1991). The specific content of these activities is centered on features of social living or the ecology that children will need to learn before assuming adult responsibilities. In other words, there are universal mechanisms that support the learning of culture-specific information (e.g., observational learning; Bandura, 1986), in addition to the attentional, motivational, and cognitive mechanisms described in Evolution and Cognitive Development. The combination results in human universals, such as face processing and language, as well as many cultural particulars that are variations on these themes.

From this perspective, it is not surprising many school children value achievement in sports –ritualized practice of organized in-group/out-group competition (Geary, Byrd-Craven, Hoard, Vigil, & Numtee, 2003)– more than achievement in core academic areas (Eccles, Wigfield, Harold, & Blumenfeld, 1993). It is also not surprising that many students report in-school activities to be a significant source of negative affect (Larson & Asmussen, 1991). Csikszentmihalyi and Hunter (2003) found that the lowest levels of happiness were experienced by children and adolescents while they were doing homework, listening to lectures, and doing mathematics, and the highest levels were experienced when they were talking with friends. For high-school students, the weekend is the highlight of their week, because they can socialize with their peers (Larson & Richards, 1998).

A preference for engagement in peer relationships might not be useful for mastery of many biologically secondary competencies taught in school, but it supports the prediction of an evolved bias for children to self-organize social activities during development; it is necessary to learn about one's specific peer group and how to manage and influence dynamics in this group. Schooling is not, however, at odds with all evolved learning and motivational biases. This is because a long developmental period is predicted to have co-evolved with an interest in and an ability to transfer culturally important information across generations (Bjorklund, 2007; Flinn, 1997; Richerson & Boyd, 2005). A species-typical curiosity about and an ability to learn evolutionarily-novel information is predicted, but so are substantive individual differences in the motivation and ability to learn this information. The gist is if there were not a gap between the secondary knowledge needed to function well in modern societies and evolved motivational and learning biases, then the motivational dispositions, interests, and abilities of the creative-productive individuals who developed this secondary knowledge (e.g., Murray, 2003) would be mundane and easily acquired without schooling. This is not the case.

If our goal is universal education that encompasses a variety of evolutionarily novel academic domains (e.g., mathematics) and abilities (e.g., phonetic decoding as related to reading), then we cannot assume that an inherent curiosity or motivation to learn will be sufficient for most children and adolescents. Children's and adolescent's explicit valuation of academic learning, the perceived utility of academic skills, and the centrality of these areas to their overall self esteem is predicted to be highly dependent on social-cultural valuation of academic competencies, such as explicit rewards for academic achievement (e.g., honor rolls) and valuation of cultural innovators (e.g., Edison). In contrast, the child's and adolescent's valuation and perceived efficacy of their physical traits or social relationships are implicit features of their evolved folk psychology and will manifest with or without cultural supports.

Learning in school

Biologically secondary learning is the acquisition of culturally important information and skills using the mechanisms that evolved to enable people to

cope with novelty and change within lifetimes and that enable the cross-generational transfer of cultural knowledge. I provide the details of the mechanisms I suggest support secondary learning elsewhere (Geary, 2005, 2007). In the following sections, I use the relation between folk psychological modules and reading to illustrate how secondary abilities appear to be constructed from primary systems.

Folk psychology and learning to read

Writing is the primary means through which secondary knowledge has accumulated over the past several millennia and reading this material is the primary means for transmitting this knowledge across generations. From an evolutionary perspective, writing initially emerged from the motivation of people to communicate with and influence other people, and the desire to read from the benefits of learning from others. It has been proposed that reading is built upon evolved language systems (e.g., Mann, 1984; Rozin, 1976). I elaborate on this proposal by linking the learning of how to read and reading comprehension to several folk psychological domains.

Research on children's reading acquisition supports the prediction that many components of reading competency are dependent on language systems (Bradley & Bryant, 1983; Hindson, Byrne, Shankweiler, Fielding-Barnsley, Newman, & Hine, 2005; Wagner & Torgesen, 1987). Core early components include phonemic awareness –explicit awareness of distinct language sounds– and the ability to decode unfamiliar written words into basic sounds. Decoding requires an *explicit* representation of the sound (e.g., *ba*, *da*, *ka*) in phonemic working memory and the association of this sound and blends of sounds with corresponding visual patterns (Bradley & Bryant, 1983). The ease of learning basic word-decoding skills in first grade is predicted by the fidelity of children's phonological processing systems (e.g., skill at discriminating language sounds) in kindergarten (Wagner, Torgesen, & Rashotte, 1994). Children who show a strong explicit awareness of basic language sounds easily learn to associate these sounds with the symbol system of the written language. In contrast with natural language learning, the majority of children acquire these competencies most effectively with systematic, organized, and teacher-directed explicit instruction on phoneme identification, blending, and word decoding (e.g., Hindson *et al.,* 2005). Skilled reading also requires text comprehension which is dependent on several component skills, such as locating main themes and distinguishing relevant from less relevant passages. As with more basic reading skills, many children require explicit instruction in the use of these strategies to aid in text comprehension (Connor, Morrison, & Petrella, 2004).

From an evolutionary perspective, text comprehension will be dependent in part on theory of mind and other folk psychological domains, at least for genre that involve human relationships (Geary, 1998). Most of these stories involve the re-creation of social relationships, more complex patterns of social dynamics, and even elaborate person schema knowledge for main characters. The theme of many of the most popular genre involves the dynamics of mating relationships and competition for mates. One implication is that once people learn to

read, they engage in this secondary activity because it allows for the representation of evolutionarily salient themes, particularly the mental representation and rehearsal of social dynamics. In addition, some people are predicted to be interested in reading about mechanical things and biological phenomena, reflecting interests associated with folk –physical and– biological systems.

Conclusion

People have evolved to create cultural ideologies and rules for social behavior. These provide the structure for the formation and stability of large cooperative groups (Baumeister, 2005; Richerson & Boyd, 2005). Children and adults have evolved corresponding learning and motivational mechanisms that support the cross-generational transfer of knowledge that is useful in their culture. In traditional societies, the mechanisms that support the cross-generational transfer of knowledge include child-initiated play, observational learning, and adults' use of stories and apprenticeships to teach cultural knowledge. These mechanisms may no longer be sufficient for preparing children for adulthood in modern societies, because of the vast amount of cultural knowledge that has accumulated during the past several thousand years and the array and complexity of secondary abilities (e.g., reading, algebra) needed to function in these societies. Schools emerged in modern societies to address the limitations of these mechanisms and to formalize the cross-generational transfer of knowledge. In other words, schools are the central interface between evolution and culture –they are the venues in which children's evolved biases in learning and motivation intersect with the need to learn the secondary abilities and knowledge needed to be successful in modern societies.

This perspective has the potential to answer many questions in instruction and learning that are not otherwise fully understandable. Why do most children need explicit instruction to learn word decoding and text comprehension but do not need instruction to produce and understand natural language? Why do most children value peer relationships more than they value academic learning? Among many implications, effective instruction in secondary academic domains will be dependant on the same attentional control and working memory systems that evolved to cope with variation and novelty within lifetimes (see Geary, 2005, 2007), and leads to the hypothesis that many children will need to have any associated problem-solving steps explicitly organized by instructional materials and extensively practiced for long-term retention (e.g., Sweller, 2004). Unlike the adaptation of primary systems (e.g., language, folk biology) to the nuances of the local social group and ecology, learning in these domains is not privileged by inherent attentional, cognitive, and motivational systems. Because of this, teachers must provide the structure and organization to secondary learning that has been provided to primary learning by our evolutionary history. With respect to motivation, children's natural curiosity and desire to learn cannot be assumed to be sufficient to support the long and effortful learning needed to master secondary domains, such as algebra.

REFERENCES

Alexander, R.D. (1989). Evolution of the human psyche. In P. Mellars & C. Stringer (Eds.), *The human revolution: Behavioural and biological perspectives on the origins of modern humans* (pp. 455-513). Princeton, NJ: Princeton University Press.

Ash, J., & Gallup, G.G.Jr. (2007). Paleoclimatic variation and brain expansion during human evolution. *Human Nature, 18,* 109-124.

Atran, S. (1998). Folk biology and the anthropology of science: Cognitive universals and cultural particulars. *Behavioral and Brain Sciences, 21*, 547-609.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.

Baron-Cohen, S. (1995). *Mindblindness: An essay on autism and theory of mind*. Cambridge, MA: MIT Press/Bradford Books.

Baumeister, R.F. (2005). *The cultural animal: Human nature, meaning, and social life.* New York: Oxford University Press.

Bjorklund, D.F. (2007). *Why youth is not wasted on the young: Immaturity in human development*. Malden, MA: Blackwell Publishing.

Bjorklund, D. F., & Pellegrini, A. D. (2002). *The origins of human nature: Evolutionary developmental psychology*. Washington, DC: American Psychological Association.

Blurton Jones, N. G., Hawkes, K., & O'Connell, J. F. (1997). Why do Hadza children forage? In N.L. Segal, G.E. Weisfeld, & C.C. Weisfeld (Eds.), *Uniting psychology and biology. Integrative perspectives on human development* (pp. 279-313). Washington, DC: American Psychological Association.

Bock, J. (2005). What makes a competent adult forager? In B. S. Hewlett & M. E. Lamb (Eds.), *Hunter-gatherer childhoods: Evolutionary, developmental & cultural perspectives* (109-128). New Brunswick, NJ: Transaction Publishers.

Bradley, L., & Bryant, P.E. (1983, February 3). Categorizing sounds and learning to read – A causal connection. *Nature, 301*, 419-421.

Brown, D.E. (1991). *Human universals*. Philadelphia, PA: Temple University Press.

Bugental, D.B. (2000). Acquisition of the algorithms of social life: A domain-based approach. *Psychological Bulletin, 126*, 187-219.

Buss, D.M. (Ed.) (2005). *The evolutionary psychology handbook*. Hoboken, NJ: Wiley & Sons.

Caporael, L.R. (1997). The evolution of truly social cognition: The core configurations model. *Personality & Social Psychology Review, 1*, 276-298.

Chen, Z., & Siegler, R.S. (2000). Across the great divide: Bridging the gap between understanding toddlers' and older children's thinking. *Monographs of the Society for Research in Child Development, 65* (No 2, serial no. 261).

Clement, J. (1982). Students' preconceptions in introductory mechanics. *American Journal of Physics, 50*, 66-71.

Connor, C.M., Morrison, F.J., & Petrella, J.N. (2004). Effective reading comprehension instruction: Examining child x instruction interactions. *Journal of Educational Psychology, 96*, 682-698.

Csikszentmihalyi, M., & Hunter, J. (2003). Happiness in everyday life: The uses of experience sampling. *Journal of Happiness Studies, 4*, 185-199.

Damasio, A. (2003). *Looking for Spinoza: Joy, sorrow, and the feeling brain.* Orlando, FL: Harcourt, Inc.

DeLoache, J.S., Kolstad, D.V., & Anderson, K.N. (1991). Physical similarity and young children's understanding of scale models. *Child Development, 62*, 111-126.

Dunbar, R.I.M. (1998). The social brain hypothesis. *Evolutionary Anthropology*, 6, 178-190.

Eccles, J., Wigfield, A., Harold, R.D., & Blumenfeld, P. (1993). Age and gender differences in children's self- and task perceptions during elementary school. *Child Development, 64*, 830-847.

Fiske, S.T. (2002). What we know now about bias and intergroup conflict, the problem of the century. *Current Directions in Psychological Science, 11*, 123-128.

Flinn, M.V. (1997). Culture and the evolution of social learning. *Evolution and Human Behavior, 18*, 23-67.

Flinn, M.V., Geary, D.C., & Ward, C.V. (2005). Ecological dominance, social competition, and coalitionary arms races: Why humans evolved extraordinary intelligence. *Evolution and Human Behavior, 26,* 10-46.

Freedman, D.G. (1974). *Human infancy: An evolutionary perspective*. New York: John Wiley & Sons.

Gallistel, C.R. (2000). The replacement of general-purpose learning models with adaptively specialized learning modules. In M.S. Gazzaniga (Ed.), *The new cognitive neurosciences* (second edition) (pp. 1179-1191). Cambridge, MA: Bradford Books/MIT Press.

Geary, D.C. (1995). Reflections of evolution and culture in children's cognition: Implications for mathematical development and instruction. *American Psychologist, 50*, 24-37.

Geary, D.C. (1998). *Male, female: The evolution of human sex differences*. Washington, DC: American Psychological Association.

Geary, D.C. (2005). *The origin of mind: Evolution of brain, cognition, and general intelligence*. Washington, DC: American Psychological Association.
Geary, D.C. (2007). Educating the evolved mind: Conceptual foundations for an evolutionary educational psychology. In J.S. Carlson & J.R. Levin (Eds.), *Educating the evolved mind* (pp. 1-99, Vol. 2, Psychological perspectives on contemporary educational issues). Greenwich, CT: Information Age.
Geary, D.C. (in press). An evolutionarily informed education science. *Educational Psychologist*.
Geary, D.C., & Bjorklund, D.F. (2000). Evolutionary developmental psychology. *Child Development, 71*, 57-65.
Geary, D.C., Byrd-Craven, J., Hoard, M. K., Vigil, J., & Numtee, C. (2003). Evolution and development of boys' social behavior. *Developmental Review, 23*, 444-470.
Geary, D.C., & Huffman, K.J. (2002). Brain and cognitive evolution: Forms of modularity and functions of mind. *Psychological Bulletin, 128*, 667-698.
Gelman, R. (1990). First principles organize attention to and learning about relevant data: Number and animate-inanimate distinction as examples. *Cognitive Science, 14*, 79-106.
Gelman, R., & Williams, E.M. (1998). Enabling constraints for cognitive development and learning: Domain-specificity and epigenesis. In D. Kuhl & R.S. Siegler (Vol. Eds.), *Cognition, perception, and language, Vol 2* (pp. 575-630). W. Damon (Gen. Ed.), *Handbook of child psychology* (Fifth Ed.). New York: John Wiley & Sons.
Gelman, S.A. (2003). *The essential child: Origins of essentialism in everyday thought*. New York: Oxford University Press.
Gigerenzer, G., Todd, P.M., & ABC Research Group (Eds.) (1999). *Simple heuristics that make us smart.* New York: Oxford University Press.
Gredlein, J.M., & Bjorklund, D.F. (2005). Sex differences in young children's use of tools in a problem-solving task. *Human Nature, 16*, 211-232.
Greenough, W.T., Black, J.E., & Wallace, C.S. (1987). Experience and brain development. *Child Development, 58*, 539-559.
Haidt, J. (2007, May 18). The new synthesis in moral psychology. *Science, 316*, 998-1002.
Harter, S. (2006). The self. In N. Eisenberg (Vol. Ed.), *Social, emotional, and personality development, Vol* 3 (pp. 505-570). W. Damon & R. M. Lerner (Gen. Eds.), *Handbook of child psychology* (6th Ed.). New York: John Wiley & Sons.
Heckhausen, J., & Schulz, R. (1995). A life-span theory of control. *Psychological Review, 102*, 284-304.
Hindson, B., Byrne, B., Shankweiler, D., Fielding-Barnsley, R., Newman, C., & Hine, D.W. (2005). Assessment and early instruction of preschool children at risk for reading disability. *Journal of Educational Psychology, 97*, 687-704.
Horowitz, D. L. (2001). *The deadly ethnic riot*. Berkeley, CA: University of California Press.
Humphrey, N.K. (1976). The social function of intellect. In P.P.G. Bateson & R.A. Hinde (Eds.), *Growing points in ethology* (pp. 303-317). New York: Cambridge University Press.
Kanazawa, S. (2004). General intelligence as a domain-specific adaptation. *Psychological Review, 111*, 512-523.
Kanwisher, N., McDermott, J., & Chun, M.M. (1997). The fusiform face area: A module in human extrastriate cortex specialized for face perception. *Journal of Neuroscience, 17*, 4302-4311.
Kaplan, H., Hill, K., Lancaster, J., & Hurtado, A.M. (2000). A theory of human life history evolution: Diet, intelligence, and longevity. *Evolutionary Anthropology, 9,* 156-185.
Keil, F.C., Levin, D.T., Richman, B.A., & Gutheil, G. (1999). Mechanism and explanation in the development of biological thought: The case of disease. In D.L. Medin & S. Atran (Eds.), *Folkbiology* (pp. 285-319). Cambridge, MA: MIT Press/Bradford Book.
Kisilevsky, B.S., Hains, S.M.J., Lee, K., Xie, X., Huang, H., Ye, H.H. *et al.* (2003). Effects of experience on fetal voice recognition. *Psychological Science, 14*, 220-224.
Larson, R., & Asmussen, L. (1991). Anger, worry, and hurt in early adolescence: An enlarging world of negative emotions. In M.E. Colten & S. Gore (Eds.), *Adolescent stress: Causes and consequences* (pp. 21-41). New York: Aldine de Gruyter.
Larson, R., & Richards, M. (1998). Waiting for the weekend: Friday and Saturday night as the emotional climax of the week. *New Directions for Child and Adolescent Development, 82*, 37-51.
Leslie, A.M., Friedman, O., & German, T. P. (2004). Core mechanisms in 'theory of mind'. *Trends in Cognitive Science, 8*, 528-533.
Mandler, J.M. (1992). How to build a baby: II. Conceptual primitives. *Psychological Review, 99*, 587-604.
Mann, V.A. (1984). Reading skill and language skill. *Developmental Review, 4*, 1-15.
Matthews, M.H. (1992). *Making sense of place: Children's understanding of large-scale environments*. Savage, MD: Barnes & Noble Books.
Mithen, S. (1996). *The prehistory of the mind: The cognitive origins of art and science*. New York: Thames and Hudson, Inc.

Murray, C. (2003). *Human accomplishment: The pursuit of excellence in the arts and sciences, 800 B.C. to 1950*. New York: HarperCollins.

New, J., Cosmides, L., & Tooby, J. (2007). Category-specific attention for animals reflects ancestral priorities, not expertise. *Proceedings of the National Academy of Sciences USA, 104*, 16598-16603.

Parker, S.T. (2004). The cognitive complexity of social organization and socialization in wild baboons and chimpanzees: Guided participation, socializing interactions, and event representation. In A.E. Russon and D.R. Begun (Eds.), *The evolution of thought: Evolutionary origins of great ape intelligence* (pp. 45-60). Cambridge, UK: Cambridge University Press.

Pinker, S. (1997). *How the mind works*. New York: W. W. Norton & Co.

Richerson, P.J., & Boyd, R. (2005). *Not by genes alone: How culture transformed human evolution*. Chicago, IL: University of Chicago Press.

Rozin, P. (1976). The evolution of intelligence and access to the cognitive unconscious. In J.M. Sprague & A.N. Epstein (Eds.), *Progress in psychobiology and physiological psychology* (Vol. 6, pp. 245-280). New York: Academic Press.

Scarr, S. (1992). Developmental theories of the 1990s: Developmental and individual differences. *Child Development, 63*, 1-19.

Schyns, P.G., Bonnar, L., & Gosselin, F. (2002). Show me the features! Understanding recognition from the use of visual information. *Psychological Science, 13,* 402-409.

Shepard, R.N. (1994). Perceptual-cognitive universals as reflections of the world. *Psychonomic Bulletin & Review, 1*, 2-28.

Simon, H. A. (1956). Rational choice and the structure of the environment. *Psychological Review, 63,* 129-138.

Spelke, E. S. (2000). Core knowledge. *American Psychologist, 55*, 1233-1243.

Sperber, D. (1994). The modularity of thought and the epidemiology of representations. In L.A. Hirschfeld & S.A. Gelman (Eds.), *Mapping the mind: Domain specificity in cognition and culture* (pp. 39-67). New York: Cambridge University Press.

Sporns, O., Tononi, G., & Edelman, G.M. (2000). Connectivity and complexity: The relationship between neuroanatomy and brain dynamics. *Neural Networks, 13*, 909-922.

Suddendorf, T., & Corballis, M.C. (1997). Mental time travel and the evolution of the human mind. *Genetic, Social, and General Psychology Monographs, 123*, 133-167.

Sweller, J. (2004). Instructional design consequences of an analogy between evolution by natural selection and human cognitive architecture. *Instructional Science, 32*, 9-31.

Wagner, R.K., & Torgesen, J.K. (1987). The nature of phonological processing and its causal role in the acquisition of reading skills. *Psychological Bulletin, 101*, 192-212.

Wagner, R.K., Torgesen, J.K., & Rashotte, C.A. (1994). Development of reading-related phonological processing abilities: New evidence of bidirectional causality from a latent variable longitudinal study. *Developmental Psychology, 30*, 73-87.

Wellman, H.M., & Gelman, S.A. (1992). Cognitive development: Foundational theories of core domains. *Annual Review of Psychology, 43*, 337-375.