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Growing physical, social and cognitive capacity: Engaging with natural environments

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Physical environments are a major contributor to human health, cognitive development, and social wellbeing but, until recently, these roles have largely been ignored. Historically the nature-nurture dichotomy divided understandings of human growth, learning and behaviour but the recent epigenetic research and the emergence of gene-environment interplay as a concept offers a contemporary integrated perspective. This paper reviews research demonstrating that environments significantly influence the expression of genetic information in ways that are critical to healthy human development. It then draws connections between these findings and studies that demonstrate natural environments support a range of significant human health, cognitive and cultural benefits. By linking the two fields the author posits that engaging with natural environments affects the expression of genetic and cultural information in ways that support human physical, psychological and social wellbeing. This hypothesis is explored through examining the measured learning outcomes achieved in naturalised school grounds. The author concludes there is sufficient evidence that 'natural' environments support wellbeing at many levels and recommends that students, communities and education professionals seek to naturalise school grounds through inclusive, action based learning programs.

Nature, nurture, environment, learning, human development, genetic information

INTRODUCTION

Contact with nature is known to stimulate healthy human development but, in many parts of the world, unfavourable public policies and changed cultural practices have reduced children's contact with nature (Collins & Kearns 2004). Moreover a range of studies suggest that reduced contact with nature is likely to have undesirable developmental, social and ultimately environmental consequences (Kellert 2002). This paper proposes that naturalised school grounds enrich learning environments and support student's physical, cognitive and social wellbeing. By summarising new epigenetic research the paper demonstrates the inter-dependence of genetic and experiential influences on both the pattern and development of human physical, behavioural and psychological characteristics. It then suggests that evolution has equipped humans with a genetic need to affiliate with nature to argue that individual wellbeing is strongly influenced by relations with the natural environment. Studies indicating that human's accrue profound benefits from engaging with nature are presented to demonstrate that, while access to nature is declining, regular experience of nature affords children significant benefits that support healthy development. Finally the paper reviews three meta-studies of learning in outdoor environments and concludes that inclusive programs that naturalise school grounds will enhance student learning and wellbeing if they are sensitive to participant's developmental and cultural needs.

In commencing, it is helpful to clarify a few definitional matters. This paper refers to 'affordances', a term coined by Gibson (1986) to describe the perceived qualities of an object, feature or change in the immediate environment. An observer, for example, might perceive a tree as affording climbing, fruit, shelter, building materials or aesthetic benefits. The 'environment'

refers to all the forces, elements, features and organisms that influence, either immediately or in an extended sense, a particular awareness. In addition it accepts that the environment is increasingly conceptualised holistically into 'natural', 'built', 'social' or other fragments (Rose 2001). However, while acknowledging these views, the paper necessarily discusses perceived environmental qualities that are typically described in the above terms. To this end 'natural environments' are defined as wild places and places with a diversity of landforms, vegetation and animals that may have been adapted by humans. Typical 'natural environments' include wilderness, pastures, fields, wooded parks and even golf courses (Ulrich 1993). Similarly the term 'naturalised school grounds' indicates school outdoor areas that reflect the qualities of natural environments. Finally 'epigenetic' refers to "mechanisms by which cells change form or function and then transmit that form or function to future cells in that cell line*" (*Gottesman & Hanson 2005, p.265).

NATURE – NURTURE

Heerwagen and Orians (2002) explain that a full appreciation of human development requires an understanding of how experiences in sociocultural, biological and physical environments influence individuals in the present and how these experiences influenced species development through evolutionary processes. However western discourse about the pattern and development of human physical and behavioural characteristics has been characterised by a long-standing, though evolving, dichotomy (Wyman 2005) that is generally described as 'nature or nurture' and is broadly based on arguments as to whether an organism's qualities are pre-determined or adaptable (Tuana 1983).

The so-called 'nature' standpoint maintains that all organisms have a range of species-typical qualities that govern individual physical and behavioural characteristics and is epitomised by religious traditions from around the globe which consider that individual species have unalterable traits. In the western tradition, the Bible, for example, explains that God created each species with its own unique but pre-determined nature (Wyman 2005). The theory of evolution contested beliefs about supernatural origins for each species by proposing that individual features and characteristics were subject to adaptation and natural selection over very long time frames. Moreover the theory suggested that evolutionary processes would eventually alter the characteristics of the originating species or result in the genesis of new species (Plotkin 1979). However, evolution's very long timeframes necessarily precluded adaptation within individual lifetimes and therefore required that a particular organism's characteristics were predetermined (Brandon 1990).

In regard to human's need for natural environments Nature perspectives argue that *Homo sapiens* evolved inter-dependently with the physical environment (Oerter 2003, Plomin & Bergeman, 1991 quoted in Saudino & Plomin 1996, Voland 2000) and genetic information embedded through evolution underlies a tendency for contemporary humans to affiliate with the natural world (Heerwagen & Orians 2002, Ulrich 1993). Lumsden and Wilson (1981) posited that human's long engagement with physical environments had genetic implications and Wilson (1984, 1993), a biologist, extended this concept to suggest that evolution equipped humans with a genetic need to affiliate with nature, a need he termed 'Biophilia'. In support of Wilson's hypothesis Ulrich (1993) positioned biophilia as a survival-related adaptation for early humans describing, for example, the advantages that accrued to early humans who displayed aversions to snakes and spiders. Furthermore he rationalised evidence that snake and spider phobias commonly persist in contemporary urban populations as evidence that early human adaptations influence contemporary individuals. Using similar logic Ulrich outlined strong evidence that people respond in fundamentally different ways to natural and built environments and proposed this offers persuasive circumstantial evidence that biophilia has a genetic aspect. Heerwagen and Orians (2002) concur and note that evolutionary based fears are more strongly manifest than those associated with contemporary dangers such as guns and cars. Drawing on a range of studies

Maller et al. (2002) also concluded that humans retained a tendency to affiliate with nature. Kylin's (1999) Scandinavian study describing children's preference for places that exhibit 'naturalness', variation in vegetation and ground level, moveable materials and water is typical of findings that support this conclusion. Similarly Winter's (2005) United States-based study described places where people preferred to walk as having variety in landscape forms, trees, water and birds. In Australia *Growing Conservation in Urban Communities* (NSW NPWS 2002) also described strong human affiliation with natural environments. For example, when surveyed about their preferred living conditions, 61 percent of respondents considered "a place that's leafy and green with lots of tree lined streets and parks" extremely or very important, 47 percent of respondents considered "a relaxing place where you'd hear the sounds of lots of birds" to be extremely or very important, and 50 percent of respondents considered "a place with parks close by where kids can play" to be extremely or very important. Interestingly 53 percent of respondents considered "a place that's not too close to busy streets or shopping centres" extremely or very important and only 12 percent of respondents considered "a place that's close to lots of cafes, restaurants and bars" extremely or very important. On the basis of such studies Van Den Born et al. (2001) concluded that, at least in western societies, there was a strong tendency for humans to affiliate with natural environments.

Nature perspectives are supported by the existence of other apparently typical human characteristics which are clearly not learned behaviours. The observed ability of infants to detect and turn away from unpleasant smells even in the first few days of life (Bower 1974) is one such case. More generally, early research into human genetic disorders suggested that, except for rare mutations, an organism's genetic code was fixed and its expression unalterable (Bjorklund & Pelligrini 2000, Gottesman & Hanson 2005).

Nature positions have been called into question by a range of studies showing, for example, that disorders in genetically identical twins can be expressed differently (Jablonka 2004, Townsend et al. 2005), or that exposure to chemicals may alter gene expression over several generations without causing DNA mutations (Kayser 2005). Studies reporting genetic influence on what were thought to be predominantly learned psychological characteristics such as religiosity, divorce and parenting style have also subjected nature perspectives to strong criticism (Rutter 2002a).

Nurture perspectives propose that an organism can adapt to its environment and perhaps pass on the adaptation to subsequent generations. Also emerging from religious traditions humanism, for example, argued that children entered the world with significant unformed characteristics which could be moulded through proper guidance and learning (Wyman 2005). In biology nurture perspectives were interpreted as suggesting that organisims might be able to adapt within their own lifetimes and pass on their adaptations to subsequent generations. Lamarck, for example, suggested that giraffes which stretched to reach higher branches could develop a slightly longer neck, that this characteristic could be inherited by its offspring, and that each succeeding generation could develop successively longer necks (Brandon 1990). Until recently biologists largely rejected the notion that physical characteristics could be modified within individual lifetimes (Gorelick 2004) but the ability of individuals and social groups to learn new behaviours was widely recognised (Wyman 2005). Much contemporary research could be said to broadly conform to behaviourist perspectives because it presented evidence that the environment did influence development and learning. Environmental affordances, for example, affected human perceptions, beliefs and values (Gibson 1986) and neurological studies demonstrated that human brains responded to experience and stimulation by developing new structures (Mc Michael 2001).

EMERGING UNDERSTANDINGS, GENE-ENVIRONMENT INTERPLAY

Today there is an increasing awareness that human health and wellbeing is inextricably linked with environmental quality (Jackson 2003) and there is some support for the view that natural environments influence human learning, health and development (Kellert 1993 & 2002).

Contemporary thinking also rejects the nature-nurture dichotomy (Mohr 2003) to assert the inter-dependence of genetic and experiential influences on both the pattern and development of an organism's physical, behavioural and psychological characteristics (Gorelick 2004, Granger & Kivlighan 2003, Jablonka & Lamb 2002, Schoon et al. 2002). The integration of nature-nurture perspectives has been facilitated by studies from the field of epigenetics which showed genetic mechanisms were quite sensitive to environmental changes and that genetic information could be expressed differently in different environments (Bjorklund & Pelligrini 2000). It is now understood that mechanisms which govern the expression of genetic information are naturally responsive to environmental conditions and that the two-way interplay of genetic and environmental influences can induce changes in individual features (Rutter 2002a) which can be inherited by subsequent generations (Gorelick 2004, Kayser 2005). In terms of human physiology Wu & Suzuki (2006), for example, postulated relations between an environmentally altered expression of genetic information in mothers and the rising prevalence of obesity in children. Additionally Jablonka (2004) describes research linking epigenetic factors with cancer and inflammatory bowel diseases. Gene-environment interplay has also been described at neurological and psychological levels. McMichael (2001), for example, attributed the significantly lower prevalence of schizophrenia in young males raised in rural settings - as compared with those brought up in cities - to environmental effects. Mohr (2003) also sited studies showing that genetic and environmental factors influenced human brain development and Nelson (2000) reported these could be translated into physical changes within the brain. Significantly Rutter (2002b) concluded that early childhood experiences had cognitive, social and neurological outcomes that extended into adulthood (Rutter 2002b).

By recognising the importance and inter-dependence of genetic and experiential influences on the pattern, development and inheritance of an organism's physical, behavioural and psychological characteristics (Gorelick 2004, Granger & Kivlighan 2003, Jablonka & Lamb 2002) epigenetics and the concept of gene-environment interplay effectively integrated understandings of development and therefore refuted traditional nature-nurture dichotomies (Rutter 2006).

Moreover epigenetic studies established that an organism's healthy development required that it inherited not only a species-typical genetic complement but also an environment that initiated and supported development for which the species had been biologically prepared (Bjorklund & Pelligrini 2000, Dawkins 1989, Jablonka 2002). This paper posits that humans need to access nature because it initiates and supports the growth, learning and behaviour for which our species has been biologically prepared. Persuasive evidence does indeed demonstrate that natural environments afford humans profound benefits. Sherman et al. (2005), for example, attributed significant physical and affective benefits to paediatric healing gardens. In addition, Kellert (2002) indicated that natural elements facilitated cognitive development, and other studies identified that direct and ongoing experience of natural environments stimulated and supported psychological and social wellbeing (Cosco & Moore 1999, Elliott 2003, Moore 1986, Orr 2005). Indeed a range of authoritative studies have indicated that the benefits of engaging with nature included:

(a) supporting and sustaining self-identity, self-awareness and social attachments (Korpela et. al. 2002, Manzo 2005, Spencer & Woolley 2000);

(b) promoting language development, collaboration and social interaction (Faber Taylor et al. 1998, Herrington & Studtmann 1998, Korpela et. al. 2000, Kylin M. 2003) while reducing anti-social behaviour (Moore & Cosco 2000) through age appropriate play;

(c) restoring attention (Korpela & Hartig 1996, Korpela et. al. 2002 and Faber Taylor et al. 2001);

(d) enhancing psychological well-being through improved feelings of security, privacy and control (Abbot-Chapman 2000, Kuo, Bacaicoa & Sullivan 1998, Kim-Cohen et. al. 2004, Kylin 2003, Korpela et al 2002, Wells & Evans 2003);

(e) facilitating emotional self-regulation and improved self-discipline (Abbot-Chapman 2000, Faber Taylor 2001a, Korpela and Hartig 1996, Kuo 2001, Sylvie 2003);

(f) improving cognitive functioning and academic success (Faber Taylor et. al. 2001 Lieberman & Hoody 2000, Mc Michael 2001 & Wells 2000);

(g) advancing physical fitness, coordination, balance and agility, and reducing incidents of sickness less (Fjørtoft 2001 and 2004) ; and

(h) contributing to the development of values and ethical use of places (Titman 1994, Vaske & Kobrin 2001).

Evidence of this type clearly illustrates that access to nature influences learning, health and development and suggests a link between beneficial environmental affordances and the healthy expression of genetic information.

ACCESS TO SUPPORTIVE ENVIRONMENTS

Epigenetic research also demonstrates that individuals have a critical need to interact with supportive environmental conditions during sensitive developmental phases (Granger & Kivlighan 2003, Mohr 2003, Mc Michael 2001, Oerter 2003, Rutter 2002b) and this is especially so for children (Neri et al. 2006). This suggests that reduced access to natural environments is likely to be detrimental to health and wellbeing (Maller et. al. 2002, White 2004). Furthermore studies showing that natural environments afford profound benefits indicate a need to design human environments so that places which afford these benefits are accessible (Kellert 2002). Studies have shown, however, that human contact with nature is decreasing in some parts of the world. For example, Tapsell et al. (2001) demonstrated that children's access to natural environments in the United Kingdom has declined *dramatically* over the past few decades and that a range of physical and social factors were accelerating this withdrawal from natural environments. Kellert (2002, p.143) notes that

> Major shifts in family traditions, recreational activity, social support networks, and community relations have eroded many children's traditional opportunities for contact with nature.

Widespread urban consolidation, for example, resulted in open space becoming increasingly rare (Recsci 2005) and this reduced the number of undeveloped places that were available to children. Furthermore studies showed that children and adolescents ranged in specific territories (Sallis & Glanz 2006) that expanded with age and evolved from the interactions within and between children's personalities, parents, cultural circumstances, and the physical environment (Moore 1986) so, early in a child's development, consolidation within the territory might have the effect of removing rather than displacing access to natural areas.

There is also evidence that growing use of private cars, an associated road safety anxiety, and fear of exposing children to crime are causing parent's to increasingly restrict children's use of streets and other public spaces (Fulton et al. 2005, Sylvie J 2003, Ziniani et al. 2006). Collins and Kearns (2004) argued that a policy emphasis on private cars and related infrastructure devalued children's unstructured outdoor play and exploration. By distracting attention from the need for safe and accessible outdoor spaces they argued that the development and use of urban public spaces created the perception that public open spaces were naturally or normally adult spaces. This view is reinforced by research showing that, while children and adolescents are still major users of remaining urban outdoor environments, they are marginalised by existing planning processes, their input is rarely sought, and that the token spaces which are provided rarely meet

their needs (Tapsell et. al. 2001). Kylin (1999) describes the outcome of this type of orientation as usually resulting in children being restricted to low-risk spaces such as school grounds and playgrounds despite their valuing natural places much more highly than manufactured ones (Titman 1994).

The overwhelming weight of evidence from science, psychology and education clearly demonstrates that where natural environments are accessible to children they afford children significant physical, cognitive and emotional benefits (Wells 2000). By concluding that learning in naturalised environments supports academic achievement, the development of social skills, and wellbeing in pupils of all ages a recent United Kingdom House of Commons Education and Skills Committee (2005) report also linked findings of this type with a need to renew contemporary practice in education. Indeed there was strong evidence that, where environments had been naturalised and used as the integrating context for learning, a wide range of valued outcomes had been achieved. Lieberman and Hoody (2000), for example, reviewed a ten year United States study and found that students performed better on standardised measures of academic achievement in reading, writing, mathematics, science and social studies. In a similar Canadian study Dyment (2004) mirrored many of Lieberman and Hoody's findings. In addition she found that naturalising school grounds provided safer, healthier and more inclusive places for students and had the effect of increasing student cooperation and collaboration while reducing incidents of violence and vandalism. Her study also found that naturalising school grounds enhanced interactions among students and teachers, increased teacher's opportunities for innovation, and renewed teacher's enthusiasm for their work. Boston's Education Development Center (2000) also conducted a study of 56 schools with naturalised grounds and found strong evidence of enhanced academic, behavioural and organisational outcomes. More specifically they found that many aspects of student learning, such as enthusiasm, engagement and creativity were enhanced by naturalised school grounds. They also indicated that teaching in natural learning environments had effects that extended beyond the formal curriculum. Reduced student discipline and management problems, both in class and at break times, were widely valued by staff and students, for example, and greater pride and ownership of learning and the learning environments were reported. These outcomes and the research described above demonstrate that nature animates child development, social interaction and learning. Furthermore, they indicate that naturalised school grounds have the potential to redress impoverishment of childhood experiences by providing access to natural environments.

CONCLUSIONS: IMPLICATIONS FOR SCHOOLING

Contemporary thinking and practice in science, business and the humanities increasingly recognises that relations within and between organisms and their framework of environmental qualities significantly influence both the organism's characteristics (Mohr 2003, Rose 2001, Sterling 2002) and those of the environment which it inhabits. In western traditions of education, however, established ways of knowing and doing often stress machine-like transmission of information, efficiency and certainty (Hicks 1994) that largely undervalue or ignore contextual influences (Cosco & Moore 1999, Ridgeway & Hammer 2006, Saul 2000). Consequently, at a time when children's play in natural environments is declining (Rivkin 1990 quoted in Herrington and Studtmann 1998), the physical environment's influence on learning is to a large extent not considered or clearly understood (Cosco & Moore 1999). UNESCO (2000) stated that successful education progams required an environment that encouraged learning but the design of school grounds had changed little over the last 50 years (Heerwagen & Orians 2002). In that time, however, convincing evidence had emerged showing that environmental quality was critical to healthy development (Granger & Kivlighan 2003, Mohr 2003, Mc Michael 2001, Neri et al. 2006, Oerter 2003, Rutter 2002b). Furthermore research clearly demonstrated that the physical qualities of school grounds strongly influenced the type and diversity of learning that occurred in them (Evans 2001, Herrington & Studtmann 1998, Huse 1995) and that access to natural elements supported student's physical, cognitive, emotional and social wellbeing (Dyment 2004, Education

Development Center 2000, Faber Taylor et. al. 2001, Fjørtoft 2001 & 2004, Herrington & Studtmann 1998, Lieberman & Hoody 2000, Moore & Cosco 2000, & Wells 2000). This evidence suggested, therefore, that policy makers and practitioners should initiate processes to naturalise school grounds.

However, while naturalised school grounds clearly had the capacity to encourage and support a range of valued educational outcomes, Cosco and Moore (1999) explained that normal practice of providing and maintaining school grounds without discussion, analysis of need, or consideration of function significantly constrained their usefulness. Adults, adolescents and children often appreciated environments differently (Malinowski & Thurber 1996) and children's attention to detail often perceived intricate qualities overlooked by adults (Tapsell 2001) so that the planning and management of school grounds required the identification and assessment of children's values of learner needs, child development and teaching practices to ensure optimum outcomes (Cosco & Moore 1999).

Students, teachers and local communities know and understand their schools uniquely so must be active participants in all stages of the design, creation, and maintenance of school environments. Furthermore, projects to naturalise school grounds need to be conceived and implemented primarily as learning programs. Learning, like gene-environment interplay, is an on-going interpretive adventure which emerges from tensions between existing schema, the context in which learning takes place, and the action of using both (Brooks & Brooks 1999, Collins 1997). It follows that, while naturalised school grounds provide a context that initiates and supports learning (and by implication gene-environment interplay), their existence is not sufficient to ensure that learning will occur. Rather learning requires that environmental affordances are perceived through learner actions. Therefore students, teachers, school leaders and communities must be authorised and supported to initiate and implement projects that use and adapt school grounds. Moreover, to maximise the learning outcomes, each project needs to be designed to:

- inspire participants to believe they can effect positive change;
- model learning processes that transform participants;
- develop people's ability to realise their vision; and
- foster futures oriented values, behaviour and lifestyles. (adapted from UNESCO 2005).

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