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Social Learning across Cultures: Universality and Cultural Variability

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An abstract of
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Abstract
Social Learning across Cultures: Universality and Cultural Variability
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The propensity for humans to transmit culture, skills, knowledge and information is unmatched in other species. Social learning mechanisms such as teaching and imitation have been investigated and various theoretical perspectives exist. Recently, a theory known as Natural Pedagogy suggests that the human capacity to transmit culture rests on a non-verbal communicative mechanism enabling humans to teach, or draw attention to relevant features during skill transmission. This theory has been refuted by ethnographic reports of an absence of teaching in many societies. I examined three different aspects of non-verbal social learning across cultures. First, I collected structured naturalistic observations of mother-infant face-to-face interactions across cultures, specifically examining non-verbal behaviors in three societies, Fiji, Kenya and US for evidence of contingent responding and affect mirroring. I report evidence for cross cultural universality in maternal responsiveness and affect mirroring, with cultural variations in the magnitude of affect mirroring. The frequency of these behaviors was low across all sites and implications for these findings are discussed. Next, I analyzed and compared acoustic properties of speech samples directed toward an infant and an adult in a non-western sample (Fiji and Kenya) and a western sample (US). I report the first acoustic evidence for the universality in infant directed speech. Age and education were significant predictors of the degree to which mothers modified their speech. Last, I examined the propensity to teach in six societies. I report the first universal evidence of non-verbal pedagogical signals across cultures. Implications regarding the Natural Pedagogy theory as well as current perspectives on the function of maternal responsiveness and affect mirroring in early caregiver-infant interactions are discussed.

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General Introduction

How do we learn the subtleties and complexities of our culture? Are humans predisposed to communicate information through subtle, often non-conscious, behavioral signals? Recently, Csibra and Gergely (2006) proposed that a specialized mechanism for transmitting information to and receiving information from others has evolved in modern humans, but not other species (Csibra, 2007; Csibra & Gergely, 2006, 2009, 2011; Gergely & Csibra, 2006). This specialized mechanism is referred to as *Natural Pedagogy* or the *Pedagogical Stance*. Under this theory, information, skills, knowledge, and information are transmitted by teaching (pedagogy) in which the responsibility for transmission rests on the teacher, yet the learner is predisposed to receive this information from the teacher. Teaching is defined as the ability to transmit information or skills through costly modification of behavior which would not otherwise occur in the absence of the learner (Csibra, 2007). The teacher produces non-verbal behavioral cues when motivated to teach, such as exaggerated movements, slowing down, repetitive steps, and specific gesture signals which cue a learner to attend to relevant information (Gergely & Csibra, 2006). The emergence of this specialized communication system may form the basis for other uniquely human abilities such as language and a sophisticated theory of mind (Csibra & Gergely, 2006, 2011). Csibra and Gergely provide evidence in support of their theory through a review of the developmental literature and suggest that many developmental phenomenon (such as gaze following and face preference) can be framed with respect to the Pedagogical Stance social learning mechanism. They suggest that the drive to learn from and teach others may facilitate a variety of different infant social cognition phenomenon. This social learning system, preceding the evolution of other

complex cognitive architecture, must not rely on language rather it relies on the ability to detect and produce non-verbal pedagogical signals through behavioral cues. They claim that humans engage in teaching, often unaware, through slowing down and providing a range of specific communicative gestures (which may be culturally specific) in order to draw attention to the relevant features of a learning situation. Unlike other social learning strategies, such as imitation, teaching is unique as it enables the learner to attend to only the relevant actions or information being communicated, enabling complex cultural forms to be transmitted with high fidelity (Gergely & Csibra, 2006).

Others have proposed alternative theories and there is a long history of the debate regarding the mechanism underlying this ability (Henrich & Gil-White, 2001; Horner & Whiten, 2005; Meltzoff & Moore, 1997; Tomasello, Kruger, & Ratner, 1993; Whiten & Ham, 1992; Whiten, Horner, & de Waal, 2005). Specifically, the human propensity to imitate others has been considered to facilitate social learning. Tomasello and colleagues have argued that the human specific propensity for imitation, in combination with other forms of social learning strategies, such as the drive to work collaboratively, and modify one's behavior to accommodate another individual, are the necessary features of cultural transmission (Tomasello, 1999, 2008). Humans are motivated to share psychological states with others, and have the capacity to read the intentions of others. In order to work collaboratively, one must have the capacity to communicate relevant information to the other individual. Communicating relevant information is not a necessary feature of the *collaborative* perspective and Csibra and Gergely (2006) argue that this capacity is essential for complex social learning.

The human unique propensity for imitation has been challenged by Whiten and colleagues as they provide evidence that non-human primates are capable of transmitting information through both imitation and emulation while retaining the features of the information being transmitted with high fidelity (Whiten & Ham, 1992). They argue that the tendency for humans to be 'flexible' in their social learning strategies, compared to chimpanzees who appear to be more conservative, enables this human unique ability (Horner & Whiten, 2005; Horner, Whiten, Flynn, & de Waal, 2006; Whiten & Ham, 1992; Whiten, et al., 2005). Humans are able to assess a situation and determine which social learning strategy to apply, although it is not always the most efficient strategy as we see with children's propensity to over-imitate. We do not see evidence for this flexible use of strategies in other primates, and Whiten and colleagues have argued that it is this flexibility which enables such complex social learning in humans.

Another theory has been proposed by Henrich and Gil-White (2001). They argue that humans are equipped with a 'prestige-bias' mechanism which drives them to detect, observe, and imitate prestigious individuals. Specifically, they propose that the 'selection' occurs at the level of the model, not the actions being imitated. They provide evidence demonstrating that potential learners over-generalize the knowledge of prestigious individuals and selectively imitate those with prestige over others (Chudek, Heller, Birch, & Henrich, submitted for publication; Foulsham, Cheng, Tracy, Henrich, & Kingstone, 2010; Henrich & Gil-White, 2001).

The underlying 'problem' each theory attempts to solve is the question of cumulative cultural evolution – how is it that we are able to pass on such complex information while retaining the essential features and losing the irrelevant features. Under

Gergely and Csibra's theory of Natural Pedagogy, teaching enables a learner to distinguish the relevant from irrelevant information. Under the prestige-bias theory, we selectively imitate only those individuals who appear to have more knowledge or valued skill in some form. Therefore, rather than selectively imitating during the transmission, we are selective about who we imitate, rather than what we imitate.

Although the focus of this project is on social learning as one mechanism driving human uniqueness, others have argued for different human capacities as the driving force that sets us apart from other primates (Premack, 2004; Preston & de Waal, 2002; Rochat, 2009, 2010). For example, Rochat (2009) claims that the capacity for self-consciousness – the ability to reflect upon the self as an entity in the minds of others is what makes us uniquely human. Some have suggested that the capacity to utilize a symbolic system, including language, and the social cognitive faculties which support it such as theory of mind, are the driving force behind human uniqueness (Premack, 2004). Others have claimed that the increased reliance on others leading to interdependency and the evolution of social cognitive capacities such as empathy and cooperation are the evolutionary driving force underlying human specificity (de Waal, 2009; de Waal & Tyack, 2003; Plotnik, 2010; Preston & de Waal, 2002).

The plausibility of the Natural Pedagogy theory has been questioned by existing ethnographic reports and detailed observations indicating an absence of teaching in many human societies (Lancy, 1996, 2008; Lancy & Grove, 2010; Odden & Rochat, 2004; Rogoff, 1990, 2003; Rogoff, Matusov, & White, 1996). These reports indicate that there is an exclusive reliance on observational learning in which the child, not the adult, is responsible for the transmission of new knowledge (Lancy, 1996, 2008; Lancy & Grove,

2010; Odden & Rochat, 2004; Rogoff, 1990, 2003; Rogoff, et al., 1996). Under the Natural Pedagogy theory, the propensity to teach is universal; therefore these two perspectives are irreconcilable. I will investigate the plausibility of this theory across human societies as well as examine non-verbal cues produced by mothers in the first year of her infant's life.

Determining specifically which of these theories supports a human social learning mechanism is beyond the scope of this paper. In this dissertation, I focus on the propensity for adults to transmit information through the use of non-verbal behaviors across diverse cultural settings – primarily Fiji, Kenya and the United States. I examined mothers, in three culturally distinct settings, engaging with their infants in face to face interactions. Through careful analysis, I examined their communicative interaction through the use of facial movements, hand gestures, eye gazes, and imitation of emotional expression to determine if mothers engage in similar ways across cultures. I also extracted and examined the acoustic properties of maternal vocalizations directed toward infants and compared it to speech directed toward adults to determine whether or not mothers vocally accommodate infants in similar ways across cultures.

Lastly, I conducted an experiment with adults in six cultures to determine whether the teaching behaviors proposed by Csibra and Gergely (2006) exist across human societies – a necessary feature of their theory. The overall goal of this dissertation was to examine three different forms of non-verbal behaviors in more traditional societies to determine whether a social learning system may be a human universal.

Background

Studying non-western cultures.

There are many reasons to use cross-cultural tools and methods to investigate psychological questions. First, in order to ensure that our understanding of human psychology is not restricted to a western, industrial population and that our research generalizes to humans, it is important to expand the focus of our research population. Second, if we are to understand brain mechanisms and possible selective evolutionary pressures, it is important to determine whether certain phenomena exist in human societies where people are living more traditionally in a manner more closely resembling our human ancestors. Third, recent reports have suggested that western and non-western populations differ in their responses on many behavioral experiments, indicating that some findings based on western populations may not be generalizable to the human population (Henrich, Heine, & Norenzayan, 2010). I would argue that exploring culturally diverse settings is central to expanding our understanding of human psychology.

Indigenous societies have largely been ignored by behavioral scientists (Henrich, et al., 2010; Hewlett & Lamb, 2005a). Further, systematic observations and empirical studies centered on children living in indigenous societies are rare to non-existent in developmental psychological research (Callaghan et al., 2011; Henrich, et al., 2010; Hewlett & Lamb, 2005a). Although not all questions warrant the study of children living in diverse cultural settings, it is important to explore development in traditional settings in order to claim that certain psychological phenomenon are *human* in nature. In addition, in order to produce findings that generalize beyond the urban, industrial population that comprises 16 percent of the world's population it is essential to examine other cultural settings (Henrich, et al., 2010; Population-Reference-Bureau, 2010).

It is unlikely that the majority of findings and conclusions stemming from western-centric literature is specific to the western population. However, recently Henrich and colleagues (2010) claim that, some of the behavioral research conducted with an undergraduate population at American and European universities, is specific to that population (Henrich, et al., 2010). In their report, they assessed the scientific literature on a variety of topics in the behavioral sciences in which both western and non-western studies have been systematically conducted. Their review of this literature indicates that western populations perform significantly different on several psychological tasks than other non-western populations (Henrich, et al., 2010; McCauley & Henrich, 2006). They refer to the sample populations which are typically studied in western psychology as W.E.I.R.D. – western, educated, industrial, rich and democratic. They argue that these social categories encompass the majority of participants in psychological experiments, when, in fact, this population is a minority in the world. They conclude by asking – what then, are we studying, if not a *human* psychology? (Henrich, et al., 2010). Although some may find their ideas radical and unrealistic, and question the practicality and necessity of conducting extensive cross cultural research as it is both costly and laborious, they argue that it is essential to broaden the participant pool to include more culturally diverse backgrounds.

Developmental studies in non-western societies.

Although anthropologists have been studying societies for over a century, child populations have largely been ignored (Hewlett & Lamb, 2005b; Hirschfeld, 2002; Super, Harkness, Barry, & Zeitlin, 2011). Not only are there few laboratory style studies conducted across diverse settings, there are also a limited number of ethnographic studies in which the environment of infant and children is documented in a systematic

quantifiable way. Nearly a decade ago, Lawrence Hirschfeld (2002) explicitly called upon anthropologists to incorporate more focal analysis of children in their work. He questions why anthropologists appear to 'not like children', claiming that there is a gap in the literature and a need for more systematic documentation of the environment of infancy and early childhood. However, detailed accounts of early childhood do exist and as a response to Hirschfeld's claim, Lancy provides a thorough review of the ethnographic literature on development across cultures (Lancy, 2008) It is through ethnographies and detailed accounts of naturally occurring behavior in diverse settings, such as those reviewed in Lancy's (2008) book on the anthropology of childhood, that we have become aware of significant differences in the social environment of infants and young children across the globe.

Margaret Mead, Beatrice and John Whiting and their student team, were pioneers in documenting a berth of topics related to differences and similarities across cultures in childrearing practices and development (Harkness & Super, 1983; LeVine et al., 1994; Mead, 1928; Super & Harkness, 1974, 1996; Whiting, 1963; Whiting & Edwards, 1988; Whiting & Whiting, 1975). They were the first to question western-centric ideas about child rearing and reject phenomena such as western models of adolescence and identity conflict, universality of infant sleep-wake cycles, and the function of multiple caregivers (Hewlett & Lamb, 2005b; Mead, 1928; Small, 1999).

Since the work of the Whitings' in the early sixties, work by Mary Ainsworth (1967) also suggested cultural differences in early social environments in children in the US and Uganda, as well as similarities in early social cognition, specifically Attachment (Ainsworth, 1967). A number of students of the Whitings' have continued to carefully

document early childhood environments in diverse settings (LeVine, et al., 1994; Super & Harkness, 2009). LeVine was one of the first to systematically investigate and report differences in parental mental models of child development and child rearing, exploring not only observable behavior, but bringing questions of how the mind and culture may shape development to the forefront (LeVine, et al., 1994). Through years of natural and structured observations of parents and children as well as through interviews and questionnaires, in the Gusii of Kenya, LeVine concludes that the goal of Gusii parents is to nurture and protect children, rather than the central goal of the west – psychosocial development (LeVine, 1994). He also examined Gusii mothers and infants interacting naturally and reports significant differences in mother infant interactions in this traditional society when compared to mothers and infant in the United States. In light of his observations, he questions western centered models of attachment suggesting that the current western model of attachment is inconsistent with his data collection and observations over the decades. (LeVine & Norman, 2001). In a recent review of the ethnographic literature on child development, he states that the relationship between our ethnographic understanding of children across cultures and developmental psychology remains problematic (LeVine, 2007).

There has been a recent increase in systematic observations of children across cultures by developmental psychologists. For example, Marc Bornstein, Heidi Keller, Ed Tronick, Tara Callaghan, Philippe Rochat, Melvin Konner, and Roger Bakemen - to name a few - have conducted empirical studies looking at the early social environment and the developing child across cultures (Bakeman, Adamson, Konner, & Barr, 1990; Bornstein et al., 1998; Callaghan, et al., 2011; Tronick, Morelli, & Winn, 1987).

Callaghan and colleagues (2011) report results using a battery tests investigating a selection of early socio-cognitive developmental milestones in three contrasted cultures – US, Peru and India. The authors report that children in each of the societies achieve certain developmental milestones, such as imitation, helping, gaze following, pointing, collaboration, joint attention, pretense and pictorial symbolic understanding, at more or less the same age (Callaghan, et al., 2011). They do report significant differences in the age of onset of development of symbolic understanding, claiming that the extensive reliance on and scaffolding of symbols in western cultures, facilitates the development of an early understanding of symbols, a milestone which was once believed to unfold in development without much parental scaffolding (Callaghan, et al., 2011). More recently, work by Clark Barrett, myself, Renee Baillargeon and colleagues (in preparation) explores social cognitive milestones of early theory of mind development in infancy across cultures, reporting universals in infants responses on experimental paradigm of false belief understanding (Barrett, et al., in preparation). Comprehensive experimental investigations such as these are rare, yet essential to understanding the role of culture and biology in development.

Many would expect the trajectory of motor development to be very similar across cultures and typically developing infants and children – with some variation in timing or, on occasion, the order of milestone achievement. However, in a recent review of the literature by Adolph and colleagues (2009), they point out that the ethnographic reports indicate widespread and significant variation in motor milestones in non-western cultures, yet the empirical evidence is non-existent in this field (Adolph, Karasik, & Tamis-LeMonda, 2009; Karasik et al., 2010). We know very little about how or why such

variation exists therefore our understanding of motor development in humans may be inaccurate or incomplete without exploring cultural variation in diverse environments. This is one example of how our western-centric perspective can give way to bias in our research. Exploring questions of development across cultures may, at first glance, appear to be a quest for 'replication', yet without examining our current model of development in more diverse settings our existing knowledge may be misleading.

There are many ways to define 'culture', making the quest of exploring development across 'cultures' a vague and foggy task. However, specific differences have been noted in what some refer to as 'industrial' versus 'small scale' or 'traditional' societies (Hewlett & Lamb, 2005a; Konner & Shostak, 1987; Whiting & Edwards, 1988). While recognizing that no social category is immune to within category distinctions, this categorical boundary is often acknowledged as encompassing social, economical, and political differences (for an exception see Hewlett et al., 2011 distinction between hunter-gatherer and traditional societies). I adopt this categorical distinction for the purpose of this research with the goal of examining cultures living more traditional or closer to that resembling our human ancestors and comparing to an urban, western, population. Throughout this paper I use the terms *western*, *urban,* and *industrial* synonymously referring to urban, industrialized centers, as well the terms *non-western*, *rural, non-industrial*, and *traditional* referring to cultures living in more traditional ways removed from significant influence of the industrialized west. I acknowledge that these distinctions may be gross over simplifications and I am guilty of making over generalizations about entire nationalities, for example, stating that 'Americans' respond in one way, when, in fact, I am examining only one sub-group of this population. However, for the purpose of

exploring *human* populations and examining whether the existing literature is reflective of the sample population tested or humans in general, this categorical distinction is sufficient for this level of investigation.

Human uniqueness.

Comparative psychologists and evolutionary scientists have explored questions of human specificity and the evolution of unique behaviors and the mechanisms underlying them. These questions are central to understanding evolutionary human psychology, but to a developmental psychologist, questions of evolution help us to understand precisely *how* the mind works in the present day modern human. Comparative and cross-cultural psychology can help us understand under what conditions were certain mechanisms selected for? What selective pressures contributed to the specificity or generality of the brains mechanisms and its flexibility and rigidity? Evolutionary psychology helps us understand which behaviors and mechanisms are intrinsically human and which ones may be a product of culture. In order to understand the psychological conditions under which our human ancestors lived, cross cultural methods of investigation are necessary. Therefore, if we are to fully understand human psychology, it is necessary to understand it in a variety of environments and contexts, but specifically small scale, non-industrial, traditional societies with little western influence. Although finding universal behaviors across cultures, it does not necessarily follow that the behavior was a product of selective pressures; however, it does enable the discussion and speculation of what the function and underlying mechanism of these behaviors may be.

Social learning.

One aspect of human uniqueness which has been explored and debated in great detail over the past century is the capacity for human social learning. Human infants

come into the world prepared to learn from others early in life (Csibra & Gergely, 2006). Without this ability to learn from others, many human cultural habits, forms, and lifestyles would not be possible (Csibra & Gergely, 2006). Adults are sensitive to this infant *preparedness* and they provide infants with the necessary information to learn their culture. How do they do this? The capacity for complex social learning has been claimed to be a uniquely human specific capacity. The topic of social learning in development began with the Russian psychologist Lev Vygotsky at the turn of the century (Vygotsky, 1930/78). Vygotsky's theory of social development claims that individual cognition is a product of social interaction – also known as the constructivist perspective. He proposes that the more 'expert' other adjusts his behavior to 'teach' or provide scaffolding to the novice learner, in what he termed, the 'zone of proximal development'. Although his theory can be thought of as central to the theme in this paper on human learning, he does not propose a mechanism by which knowledgeable others 'know' precisely how to detect and identify the 'zone' of potential learners as well as adjust their behavior (Vygotsky, 1930/78).

One theory suggests that the ability to detect a naïve learner and modify one's behavior in order to meet the needs of and transmit information to that learner is unique to humans and that this capacity has evolved to satisfy the function of transmitting knowledge and relevant information to others (Csibra & Gergely, 2006). Other theories emphasize the propensity for humans to selectively imitate, over-imitate, or engage in collaborative learning as possible mechanisms by which complex cultural forms are transmitted (Henrich & Gil-White, 2001; Horner, et al., 2006; Meltzoff & Moore, 1983, 1997; Tomasello, et al., 1993). Others have claimed that each of the social learning

mechanisms is a sufficient strategy for cumulative cultural evolution, suggesting that the capacity to appraise the effectiveness of the potential strategies is the necessary and unique component of human social learning (Caldwell & Millen, 2009).

In addition, the developmental literature provides evidence for a prepared learning system in infant (Sage & Baldwin, 2011; Topal, Gergely, Miklosi, Erdohegyi, & Csibra, 2008). Under this idea, infants are tuned into non-verbal communicative gestures and signals which enables them to interpret which aspects of information in the environment are relevant and important to attend to. Evidence exists for this 'prepared social learning' system in infants. For example, Topal and colleagues (2008) report that infants are particularly tuned into and utilize pedagogical signals to help navigate ambiguous situations (Topal, et al., 2008). Sage and Baldwin (2011) conducted an experiment with infants and report that pedagogical signals, as well as other social signals, were superior in facilitating the production of a sequence of actions associated with a particular tool, compared to non-social signals. The series of experimental evidence suggests that infants may have a prepared learning system which is particularly tuned into communicative social signals (Gergely, Egyed, & Kiraly, 2007; Sage & Baldwin, 2011; Topal, et al., 2008). This is of particular relevance for this paper as the goal of all three projects is to investigate the non-verbal communicative signals present across human societies to determine what features are common and possibly essential in human social life.

Project Goal

I examine Csibra and Gergely's (2006) theory of natural pedagogy as one possible account of social learning. Specifically, I measured the propensity of adults to modify their behavior in order to transmit information to a naïve learner in three different

projects. First, I examined emotional mirroring and maternal responsiveness of mothers in a communicative dyadic interaction with their infant. Second, I examined vocal modification (infant directed speech) by adults when addressing their young infants and compared it to vocalizations when addressing an adult in the same context. Last, I examined the propensity to produce non-verbal behavioral signals in the presence of a potential learner in an experimental paradigm and compared it to the signals produced during the presence of a passive observer. In all three studies, I am looking at *exaggerated* communicative behaviors by adults which serve the function of transmitting relevant information to a naïve learner – whether it is an infant or an adult. In both situations, the adult is motivated to communicate with the other individual, although the specific goal and function may be different across projects. These projects address questions central to cognitive and evolutionary psychology – exploring commonalities in human behavior across the globe enabling speculation regarding the mechanisms underlying them.

Summary of Evidence

I report empirical evidence from indigenous non-western societies – Fiji, Kenya, and also Bolivia – with minimal exposure to western culture, as well as urban western societies, Ukraine, Faroe Islands and the United States. To summarize, I found that mothers respond contingently to their infants behaviors within one second in all cultures to the same degree. I also report evidence for affect mirroring across all cultures, however, there is cultural variation in the *ways* mothers respond to their infants. Secondly, I examined parental vocalizations to their infants across cultures and found that parents increase and change their pitch in similar ways across societies when speaking to their infants compared to when they are speaking to an adult. There is a significant difference

in pitch across western and non-western mothers, with western (American) mothers having a significantly higher pitch than non-western (Fijian and Kenyan) mothers when addressing infants, however, closer inspection reveals that this difference is attributable to education and age differences. Lastly, I examined the propensity to produce pedagogical signals across cultures. In collaboration with three other primary researchers, I examined six cultures, Fiji, Kenya, USA, Bolivia, Ukraine and the Faroe Islands, for evidence of *teaching* or *pedagogical signals*. To summarize, I found evidence for universals in non-verbal behaviors such as reducing speed, pausing and pointing in the presence of a potential learner, but not in the presence of a passive observer.

Together these results suggest that there are universal non-verbal behavioral cues which are relied upon by adults across societies during a communicative interaction. Potential function of these behaviors is explored in the discussion.

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Manuscript 1: Universals in Mother-Infant Interactions across Cultures

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Abstract

Previous studies indicate that maternal responsiveness is an important factor in social emotional development in the first year of life (Bigelow & DeCoste, 2003; Gergely & Watson, 1996; Stern, 2001; Tronick, 1982). Research with caregivers and infants in western cultures has documented qualitative differences in the ways mothers respond to their infants, also indicating that infants are sensitive to and develop a preference for certain kinds of maternal responsiveness (Bigelow & Rochat, 2006). In the developmental literature, maternal responsiveness typically refers to the ways in which mothers respond to infants' behaviors in a dyadic interactive setting (Brazelton, Koslowski, & Main, 1974; Brody, 1956). Infants develop a sensitivity to and a preference for this contingent interactive style (Bigelow & Rochat, 2006; Rochat, 2001). In addition, parental mirroring of an infant's emotional expression is an important feature in the socialization of affect (Fonagy, Gergely, Jurist, & Target, 2002; Gergely & Watson, 1996). However, it may be the case that mother-infant interactions in non-western or traditional societies are quite different from those in the west and, in fact, anthropological literature supports this assumption (Hewlett & Lamb, 2005; Lancy, 1996, 2008; Whiting, 1963; Whiting & Edwards, 1988). Recent research on mothers and infants across cultures indicates that variation exists in the modalities of maternal expression and the maternal beliefs about infant cognition (Bornstein et al., 1998). In order to assess the validity of research conducted with western sample populations on contingency and affect mirroring, I examined mother-infant interactions in small-scale, traditional societies in Fiji and Kenya and compared them to an age-matched sample in the US. I measured the frequency and determined the modality of *contingent* responses and *affect mirroring* by the maternal caregiver during face-to-face episodes with their infants (aged 2-16 months).

I report evidence for universality of contingent responding and affect mirroring, however, the overall propensity to produce these behaviors was low. Cultural variations existed in the propensity to mirror a smile, with Kenyan mothers mirroring a smile more than Americans. Implications for the existing theories of social development are discussed.

Introduction

Many theoretical accounts of infant social and emotional development emphasize the importance of the mother-infant relationship in the first year of life (Ainsworth, 1967; Ainsworth, Blehar, Waters, & Wall, 1978; Bell & Ainsworth, 1972; Bowlby, 1988; Fogel, Diamond, Langhorst, & Demos, 1982; Fogel & Melson, 1986; Gergely & Watson, 1996; Stern, 1985; Tronick, 1982). These perspectives focus on specific features of the early caregiver-infant dyadic relationship which enable an infant to learn about the world, others, and the self and develop a healthy understanding of the social world within her cultural niche. Infants' process of discovery is partly through their developing awareness of the effect their actions have on the world and the impact of contingent stimulation on their development (Bigelow, 2001; Neisser, 1991). Some have claimed that infants first learn about the consequences of their actions on the world during face-to-face interactions in the first few months of life (Neisser, 1991).

From birth, infants are producing a wide array of behaviors – both involuntary reflexive behaviors and deliberate behaviors (Rochat & Hespos, 1997). Work by Rochat and Hespos (1997) indicates that newborn infants have already started to discriminate between themselves and external stimulation in the world. Rather than being born into a state of confusion between the self and the environment, newborns are already developing an awareness of the self in contrast to and in relation to external stimulation (Rochat & Hespos, 1997). According to Rochat and Hespos (1997), humans are born with the capacity to detect contingent responses in the environment.

Within the first few months of life, infants in western cultures are cared for primarily by their mothers – often being held, touched, carried and spoken to for much of their waking hours. Developmental psychologists have observed this intimate relationship

for decades and have suggested that infants are sensitive to the features of this first relationship (Stern, 1999, 2002). For example, maternal responsiveness and sensitivity is thought of as the response by a mother to an infant's action, enabling the infant to detect the effect she has on the mother – and, in general, the effect her actions have on the world. Not only do infants begin to learn that their behaviors can shape their social world – they also begin to form an expectation that the world functions in particular ways, and they begin to form social expectations about others (Neisser, 1991). It is through these social interactions that infants begin to form the social and emotional capacities to sustain healthy functioning in her society.

The developmental story may be different in non-western societies. It is possible that scientists are relying on an interactive style that is particular to western, industrialized, educated settings. Nearly a century of detailed ethnographic work by anthropologists indicates that the first year of an infant's social life looks quite different in different societies around the world (Chisholm, 1983; Hewlett & Lamb, 2005; Konner, 1977; Lancy, 2008; LeVine et al., 1994; Small, 1999; Tronick, Morelli, & Ivey, 1992; Whiting, 1963). Therefore, the goal of this paper is to investigate one aspect of a mother-centered model of the first relationship, to determine whether features thought to be significant in western literature, are present in non-western, traditional societies.

My central question of interest is the following: What does the interaction style of a mother and her infant *look* like in traditional societies? Does it resemble the western style, therefore validating much of the literature produced by observations of western mothers and infants, regardless of differences in childcare and parenting practices? Or, is it distinct with an interactive signature that is not reflected in urban research participants,

therefore suggesting that our western-centric model of the mother-infant relationship as fundamental to early socialization may be flawed?

If the *ways* of interacting with our young are universal in nature, specifically, if we see maternal contingent responding and affect mirroring, then what might the function of these behaviors be? Are they products of evolution or by-products of the necessary elements in which a human child finds herself? The data reported here do not directly address this question of function or adaptive significance however, the research is motivated in part by these questions and will therefore be revisited in the discussion - specifically focusing on Csibra and Gergely's pedagogical stance as one possible function.

Lastly, contemporary theories of infant psychological development must be taken beyond the artificial western scientific laboratory and observed in other diverse and more traditional settings if we are to fully understand the mechanisms underlying them.

Background

Emphasis is put on the facial and vocal responses of the primary caregiver to the infant as this has been observed and documented carefully for the past half century (Brody, 1956; Fogel, 1993; Stern, 2002). Theoretical accounts of attachment, social, emotional and cognitive development all stress the role of specific maternal facial and vocal patterns (typically face-to-face) during a mother-infant interaction – specifically emphasizing the importance of the *timing* and *kind* of responses (Bell & Ainsworth, 1972; Tronick, 1989, 1982; Tronick, Cohn, & Shea, 1986). In particular, it is widely accepted that maternal responding described by theories of *contingent responding, maternal attunement* and *affect mirroring* reflect behaviors that promote a healthy

relationship which encourages a successful social bond between an infant and caregiver (Fonagy, et al., 2002; Stern, 2001).

Research indicates that infants are sensitive to these contingencies in the environment early in life (Bigelow, 2001; Bigelow & Rochat, 2006; Neisser, 1991). Not only do infants begin to produce vocalizations, movements and facial expressions as a result of internal states, but they also become sensitive to the effect they have on the world and others (Bahrick & Watson, 1985; Gergely & Watson, 1999). By 'contingencies' I refer to an event that occurs in response to an infants' behavior, for example, moving a mobile by kicking (non-social) or soliciting the care or nurturance of an adult by crying or cooing (social). A contingent response by a caregiver is an elicited response by that caregiver within a detectable temporal sequence. For example, the infant exhibits a behavior (a smile) which elicits a behavior from the adult (a smile, touch, or vocalization) within a few seconds. Note that if the response occurs outside of a certain time window then the relationship to the onset behavior becomes unidentifiable and it becomes more difficult for the infant to detect the contingency between her actions and the action that followed (Gergely & Watson, 1996). According to Gergely and Watson (1996), the infant's ability to detect this stimulus-response event is referred to as the 'contingency detection mechanism'. Although theoretical and empirical work on infant development converges on the existence of such a mechanism, the debate lies in the extent to which this mechanism is affected or shaped by the external environment (Gergely & Watson, 1996).

Infants not only detect social contingencies in the environment, they also develop a preference for certain levels of contingency based on their experience (Bigelow, 1998;

Bigelow & Birch, 1999; Bigelow & Rochat, 2006). This developing social expectation is already present in infants by as early as two months of age. Bigelow and Rochat (2006) observed infants interacting with mothers and strangers and report that infants were more responsive to strangers that were similar to their mothers' level of 'contingent' responsiveness. They were less responsive to strangers who were either more or less contingent than their mothers (Bigelow, 1998; Bigelow & Birch, 1999; Bigelow & Rochat, 2006). One might think of this as a social responsiveness 'signature' of the mothers. If such a social 'signature' affects infants preferences in face-to-face interaction as early as the first few months of life, this may have implications for the effect that cross cultural variability in maternal responsiveness may have on human development.

In other work, Bigelow and Birch (1999) tested four- and five-month-olds' ability to remember the social contingency level of two strangers. They had two strangers interact simultaneously with an infant over a monitor, however, one was live and one was delayed. Six days later, they presented infants with the same strangers – both interacting live and with similar levels of contingency. The infants demonstrated a preference for the 'contingent'/live stranger, indicating that they not only detect differences in contingency levels, but they are also able to remember them, at least over a period of six days (Bigelow & Birch, 1999).

Others support the claim that specific features of mother-infant interaction are necessary for healthy development (Field, 1994; Field et al., 2005). In particular, Field observed depressed and non-depressed mothers interacting with their infants and she reports that depressed mothers had minimal contingency levels and, with age, infants began to adopt the depressed affect of the mothers (Field, 1994; Field, et al., 2005). These

findings suggest that maternal contingent responding is an important aspect of an infant's social world in the first year of life.

Recent cross cultural evidence investigating German and Cameroonian mothers, suggests that parental contingent responsiveness is a component of parenting which has been shaped by evolution and is a human universal (Kartner, Keller, & Yovsi, 2010). The authors find evidence for contingent responding by mothers within one second of an infants' behavior in both cultures, yet they report differences in the kinds of responses. German mothers respond with more visual contingent responsiveness (as infants increase in age from 4 to 12 weeks) and less tactile responsiveness (proximity) whereas the Cameroonian mothers display the reverse pattern. These findings have implications for the social communicative shaping that occurs at the group level already by four weeks of age. The authors draw a connection between the inter- and intra- dependant nature of the cultures and the contingency response patterns, however, the effect of such differences is not fully understood (Kartner, et al., 2010). To date, this is the only micro-analytic empirical investigation of a parental responsiveness in a traditional society. Although Levine and others investigated the early responsiveness of Gusii and Boston mothers with their infants, they did not have the temporal sensitivity to capture contingency responsiveness (LeVine, 1994). In order to understand how the communicative system is shaped by the early social environment I examined contingent responsiveness by mothers in three cultures.

Affect Mirroring

Parental mirroring of infant facial and vocal displays of emotion is one aspect of social contingent responsiveness. Parents have been observed imitating their infants' emotional displays and this has been the focus of several empirical investigations. One

interesting aspect of this behavior is that parents imitate both positive and negative expressions by an infant (Gergely & Watson, 1996). The tendency to reflect emotion back to the infant has been proposed to have two primary functions (Gergely & Watson, 1996). Minimally, it is has been proposed that such mirroring aids in the development of self-regulation of emotion, in what Gergely and Watson have termed, the 'social bio-feedback model' of emotion development. They propose that an infant produces a negative emotion display followed by the parental imitation of the emotion back in an exaggerated manner, which is then followed by a positive emotional expression, thereby encouraging the infant to return to a neutral or positive state. In addition, it is proposed that parental mirroring of emotion is the mechanism by which infants develop differential categories of emotion – specifically that an infant produces an emotional display and shortly thereafter witnesses the same, but distinct and exaggerated display on his or her parent, indicating that 'what I feel is what I see' on my social interactive partner, typically the parent (Gergely & Watson, 1996, 1999).

The contention lies in the speculated function of this behavior – ranging from emotion regulation (Gergely & Watson, 1999), emotion concept development (Gergely & Watson, 1996), attunement and attachment (Stern, 1985, 2002) and the 'like me' stance (Gopnik, Meltzoff, & Kuhl, 2001). Some studies suggest that mirroring an infants' behavior, which is a form of contingent responsiveness, leads to increased social responsiveness in infants (Bigelow & Rochat, 2006). Regardless of the debated function, parents' tendency to mirror their infants' affect is discussed as a unique aspect of parental behavior.

Caregiving across Cultures

Anthropologists have described a variety of ‘multiple’ caregiving environments suggesting that humans evolved as cooperative breeders and the model of one primary caregiver is a western, industrial invention (Hrdy, 2005, 2009; Konner, 2010; Munroe & Munroe, 1971; Seymour, 2004; Tronick, Morelli, & Winn, 1987; Weisner et al., 1977). Seymour (2004) argues for an urgent understanding of multiple caretaking worldwide, rejecting the assumption in western psychology that the mother-child relationship is the first, most important, or only intimate relationship of a young child’s life. In fact, in most cultures of the world, children are cared for by individuals other than the mother – both kin and non-kin (Seymour, 2004). In these societies, the notion of a strong attachment to only one primary caregiver is foreign and instead is replaced by a model of multiple social bonds. Infants are often nursed by several women – both lactating and non-lactating, and in some instances, the fathers, and cared for by others for as much as 50% of the time (Chisholm, 1983; Hewlett, Fouts, Boyette, & Hewlett, 2011). In addition, multiple caregiving is not restricted to small-scale hunter-gatherer societies. In fact, multiple caregiving is reported in several large-scale societies in India by Seymour (2004). Re-analysis of Ainsworth’s data in Uganda also indicates that a mother-centered model of attachment may be insufficient as children are cared for by multiple caretakers and siblings. Seymour argues for a new model of attachment, away from the mother-centered model, and instead incorporating multiple attachments into a theory of healthy social development (Seymour, 2004).

Looking into the eyes and cooing at a newborn infant may feel especially natural and biologically driven. However, there are several reports of societies in which face-to-face interaction with infants is rare or absent. Robert LeVine’s work with the Gusii in

Eastern Africa indicates that mothers are not encouraged to – and even discouraged to – speak directly to infants (LeVine, et al., 1994). This is a common belief in many societies of the world – specifically those relying on hierarchical relationships, making it taboo for adults to speak directly to children, yet there are others in which children are exempt from the status hierarchy making it okay for adults to engage in playful dialogue (Odden & Rochat, 2004; Rogoff, Mistry, Goncu, & Mosier, 1993). In many societies, it is not uncommon for an infant to spend most of her life in the first year carried on the mother's back. Hewlett's description of childhood and caregiving in a hunter-gatherer society in Central Africa indicates that 'weaning' from the back of caregivers is often more difficult for the infant than weaning from the breast (Hewlett & Lamb, 2005). In addition, Elinor Ochs describes the early caregiving environment in Western Samoa as one of indulgent physical care and sparse psychological interaction (Ochs & Schieffelin, 2001). After observing and interviewing caregivers, she reports that mothers tend to see infants as helpless and "having no understanding" and therefore do not engage in dyadic exchanges with them.

However, the majority of the research on infant psychological development is based on laboratory observations of mother-infant dyads in North American or European settings (referred to as the 'west' hereafter) which make up only 16 percent of the world's population (Population-Reference-Bureau, 2010). The results of these studies of typical, as well as depressed mothers and infants indicates that mutual eye gaze, imitative maternal behavior, as well as exaggerated facial and vocal expressions are all necessary features for healthy psychological development (Stern, 2001, 2002). In fact, mothers suffering from depression are considered as having 'interactive deficits' (Field, 1977).

Experimental interventions have manipulated these deficits through ‘interaction coaching’ where the mothers are instructed to increase the frequency and duration of mutual gazing, infant directed speech, and facial expressions (Field, 1977). The results are mixed however it is clear that such clinical interventions are heavily biased in their interpretation of what is ‘good’ social interaction between a mother and her child.

Not only are there few laboratory style studies conducted across diverse settings, but there are also a limited number of ethnographic studies in which the environment of infant and children is documented in a systematic quantifiable way. In fact, recently anthropologists Hewlett and Lamb (2005) have questioned why anthropologists appear to ‘not like children’, claiming that there is a need for more systematic documentation of the environment of infancy and early childhood. We do know from detailed ethnographies that there appears to be a significant difference in the social environment of infants in what some refer to as ‘industrial’ versus ‘small scale’ societies (Konner & Shostak, 1987). Although Konner describes a very different first year of life among the !Kung in the Kalahari, he describes a comparable amount and kind of face-to-face interaction (Konner, 2005).

While recognizing that no social category is immune to within category distinctions, this categorical boundary is often acknowledged as encompassing social, economical, and often political differences. With respect to this distinction, anthropologists and developmental psychologists have found significant differences in parenting styles and goals (Bornstein, 1991). In particular, they have found evidence for an emphasis on vocal, active, face-to-face social engagements in North American and European (industrial) societies, compared with an emphasis on physical responsiveness

and ‘passive’ engagements in non-Industrial small scale societies. Such variation in parenting styles may pose a significant problem for current theories of infant development which are based primarily on laboratory observations in Industrial societies. For example, psychologists have documented that cultures exist in which face-to-face interactions are not only discouraged, but viewed as harmful to infants (Dixon, Tronick, Keefer, & Brazelton, 1984). Differences in parental beliefs and goals, as well as the social, economic and political environment of a society may be reflected in caregiving styles and childrearing practices. The goal of this project is to examine specific aspects of maternal parenting behaviors – contingent responding and affect mirroring – which have been observed and documented in western cultures – in small scale traditional societies to determine whether these features are universal.

Two fundamental questions exist with respect to social contingency in early caregiver-infant interactions. If the ‘contingency detection mechanism’ is supported to a significant extent by early social interactions, then ‘contingency’ responding (parental responding within one second of infant behavior) must exist across diverse cultural environments. Secondly if infants develop a sense of control on the environment through this early proto-conversation with other social beings then differing amounts of contingent responding must shape different expectations (Bigelow, 1998). Therefore I expect group cultural differences in contingent responding to affect self-efficacy in that culture. Measuring self-efficacy is beyond the scope of this project, and, might be an ambitious leap to measure adult levels and presume they are causally linked to early interactions, however, as a starting point I decided to measure contingent responsiveness

in cultures that are minimally exposed to western culture and norms of parental behavior to investigate similarities and differences across cultures.

Hypothesis 1: Contingency

I expect that contingent responsiveness is a universal behavior enabling infants to learn about the world, their culture, and the effect they have in the world, therefore mothers in all cultures will display contingent responding to their infants' behavior (within one second). As ethnographic reports indicate significantly less face-to-face interaction and less focus on the psychological development of the infant in several non-western societies, I expect the proportion of mothers' contingent responses to be less in non-western cultures (Fiji, Kenya) compared to the western culture tested here (US).

Hypothesis 2: Affect Mirroring

I expect mothers to respond to their infants' emotional displays with 'affect mirroring' as defined in the literature – in each of the cultures, however I expect the proportion of mothers' affect mirroring responses to be less in non-western cultures (Fiji, Kenya) compared to the western culture tested here (US). It is unclear what the function of affect mirroring is making it difficult to produce ad hoc hypotheses regarding the any potential differences across cultures. To speculate, if affect mirroring is a mechanism for socializing emotions, then I would expect to see significantly less in Kenya compared to Fiji and the US as the literature suggests emotional expression is discouraged among Kenyans, even in infancy (LeVine, et al., 1994). In contrast, as Morton notes, South Pacific Islanders are expressive, therefore if 'socialization of emotion' is the function of affect mirroring, I would expect to see significantly more of it in Fiji compared to Kenya and the US (Morton, 1996). However, I suspect that the function of affect mirroring may

have more to do with 'mirroring' behaviors in general than emotion specifically, therefore I would expect to see comparable levels of affect mirroring across cultures.

Method

Design

The basic design was modeled on work done by Bigelow & Rochat (2006) with the goal of creating a natural *en face* interaction between the mother and infant for later coding and analysis of the mother and infant behaviors. I asked mothers to interact naturally with their infants for ten minutes (see Procedure).

Participants and Location

This study was conducted in three distinct locations – Fiji, Kenya and USA. The regions were selected based on previous contacts and opportunity for conducting behavioral research with adults and children. The primary experimenter spent a duration of time living and working in each region is familiar with the culture and customs of each (Fiji approximately one year over several visits, Kenya approximately one year over two visits, USA more than one year consecutively). Seventy-two infant and mother dyads participated in this study (30 Fijian, 24 American, and 18 Kenyan). The mean age of the infants was 7.8 months (SD 3.6 months, range 2-16 months). There was no significant difference in the age of infants across cultures, p=.415. The mean age of mothers was 27.7 years (SD 7.2 years, range 17-45 years), however I obtained age and education data from only 50 out of the 72 mothers, as I began data collection prior to full conception of the project. Age and education was not recorded for the first 22 mothers tested in Fiji and the US. There was a significant difference in the age of mothers across cultures, F=10.58, p<.001. Post hoc (LSD) comparison reveals that Kenyan mothers were approximately 6.6 years younger than Fijian mothers (p<.01) and 9.6 years younger than American mothers

(p<.001). Fijian and American mothers did not differ significantly in age. The number of years of formal schooling was also recorded for 44 of the mothers; the mean number of years of formal schooling (education) was 11.6 years (SD 4.1, range 5-20). There was a significant difference across cultures in the number of years of education obtained (p<.001) and post hoc (LSD) analysis reveals that American mothers had approximately 6 more years of education than Fijian mothers and 9 more years of education than Kenyan mothers; Fijian mothers had 3 more years of schooling than Kenyan mothers (all significant at p<.001). See Table 1.0. An additional five dyads were tested but are not reported in the analysis due to experimenter error (3) or fussiness (2).

Fiji.

The study was conducted in two distinct locations in Fiji – the Yasawa Island Group, located in the northwestern group of the Fiji Islands and the Lau Island Group, located in the southeastern group of the Fiji Islands. These two locations are similar in that they both rely on subsistence agriculture and marine foraging and fishing for livelihood (Henrich, 2004; Sahlins, 1962). From the Fijian mainland of Viti Levu, the villages on Yasawa Island are 1-2 days of travel by boat, with limited air access, and the villages of the Lau Island group are 5 days of travel by boat, with no other access (no air strip). Neither island had access to television or newspapers at the time of this study, with the exception of the medical station in the village of Tovu, Lau, which occasionally allowed public viewings of sports games on Sundays. This is of particular importance as the goal of this project was to examine universals in caregiving behaviors therefore it was important to include samples that were limited in western influence. Early childhood practices are similar in the two regions as children are taken care of primarily by the mother in the first few years of life with help from other females in the village, but no

significant amount of allo-parenting. Typically, the mother receives help in household domestic chores while she tends to her infant in the first 3-6 months of life. In addition, it is not uncommon for older siblings or cousins to help out with childcare but rarely in the first year of life (at least not in any significant amount). The mother was the self declared primary caregiver for all of the infant-mother dyads in this study. Each village is small, having a population of less than 150, with no secondary school on either of the island groups. All participants were recruited by word of mouth after obtaining consent from the village elders to conduct the study in these regions.

Kenya.

The study was conducted in the eastern region of Kenya near the rift valley in Bungoma district. Mothers in this study were recruited and tested in Chemwa Village, a small village having a population of 1220, comprising 198 households, located near a large town center (Bungoma town). Access to electricity is limited in this village and most households in this region rely on small income stores and labor on sugarcane and maize crops for a daily wage. All mothers in this sample were self-declared primary caregivers of the infants. A total of 18 mothers were recruited by word of mouth from a female adult member of the village.

USA.

The study was conducted at a laboratory in a city in the south eastern region of the United States. All mothers were recruited from a database comprised of families recruited by a variety of recruitment methods such as mailings, local daycare centers and birthing centers. All mothers were self-declared primary caregivers. Data from 24 mother-infant dyads are reported here.

Materials

In order to capture the head and torso view of the mother and the infant, two video cameras (Sony DCR-SR45) were used for this study. Following data collection, all videos were imported into *imovie* and edited so as to create single split screen video of each dyad for later coding. The videos were then coded using event recording software *Jwatcher.*

Procedure

Prior to testing, informed consent was obtained by a native speaker in each of the locations. After consent was obtained, mothers and their infants were brought to the testing location and seated in a quiet corner of the room or outdoor area. They were asked to interact naturally with their infant, with the goal of keeping the infant content for ten minutes (see Appendix A). Both the mother and infant were seated on the floor, with the infant facing the mother and within the mother's arms reach (see Figure 1.0). The mothers were asked not to pick up the infant however touching was allowed and was at the discretion of the mother. They were also told that if the infant cried we would stop the camera, but if the infant fussed, they could signal to us to stop and that we would only use the first few minutes of video and that would be sufficient for the study. Note that the mothers were not instructed to talk or play with their infants, rather, they were told to 'do whatever they preferred' given that the infant stayed within the view of the camera.

Coding

All videos were imported into a *macintosh* video editing software program *i-movie* and the first three minutes of uninterrupted interaction was extracted. An interruption was any event that disrupted the interaction which was not caused by either two members of the dyad. For example – a third party entering the testing space, talking

to the mother of infant, or the infant playing with a toy – were all considered interruptions. Twenty participants had interruptions within the first three minutes of video: US (5), Fiji (7), Kenya (8). These interruptions were removed with video editing software by inserting a two second black screen. The event recording software *Jwatcher* was used to code the behaviors for later analysis. After two independent coders trained on each of the coding categories and reliable agreement was achieved, each interaction was coded with seven passes for each of the separate categories – facial and vocal expressions of the mother and infant, gaze of the mother and infant and tactile responses of the mother (see Appendix B). First, mothers' vocalizations were coded for valence (positive, negative, neutral, or no vocalizations) Next, mothers' facial expressions were coded for valence (positive, negative, neutral, or no vocalizations). Tactile responses of the mother were also coded. I defined four categories of maternal tactile responses after watching a random selection of several videos from each of the cultures – reposition or vestibular movement, caressing, contact without movement, or tickling, poking or moving infant limbs. Gaze direction of the mother and the infant was also coded independently, specifically whether the one partner was gazing at the other (enabling us to potentially determine the presence or absence of mutual gaze in later analyses). Infant behaviors were also coded by watching each video several times and coding each behavioral category separately, as I did with the mothers. Infant coding categories were identical to mother categories with the exception of tactile responses which were only coded for mothers. Due to the camera angles, it was not possible to identify infant tactile behaviors. The overall goal was to obtain a quantitative record of the dyadic interaction for analysis

of the behaviors. The event codes were combined into one master data record for each interaction enabling the retention of temporal information in each interaction.

An independent coder was trained alongside the primary coder until reliability was achieved. Reliability consisted of coding 30% of the interactions independently and obtaining a score of 70% or higher agreement on each coding category. Agreement was declared for each code if the behaviors occurred in the same temporal order and within one second of each other. Errors included missed codes, erroneous codes, or time lags of more than one second. Percent agreement was calculated by dividing the number of agreed codes by the maximum number of behavioral codes for an interaction. Overall, the percent agreement of the two independent coders was greater than 70% on all of the categories.

Results

Descriptive Statistics

Infants.

Although the behaviors of interest for this project were the mothers' responses to her infant, I first examined each of the infant behaviors for any systematic differences in the frequency of behaviors across cultures or with age. Positive facial expressions (referred to hereafter as smiles) were produced by 87% of all infants and negative facial expressions (referred to hereafter as grimace) were produced by 51% of all infants. Positive vocal expressions were produced by 42% of all infants and negative vocal expressions were produced by 64% of all infants.

In order to determine if there were any significant differences in the amount of target behaviors produced by the infants (vocalizations and facial expressions), I conducted a multivariate analysis of variance (ANOVA) with infant behaviors (4) as the

dependent variable, country (3) as the between subjects factor and infant age, sex of infant, mother age and mother education as covariates in the model. Infant age was a significant predictor of infant smiles ($p<.05$) and a significant predictor of infant negative vocalizations ($p<.05$) with younger infants smiling more and producing fewer negative vocalizations. The number of grimaces ($p<.01$) and negative vocalizations ($p<.05$) produced was significantly different across cultures with pairwise comparisons revealing that the US produced fewer grimaces and negative vocalizations than Fiji and Kenya.

Mothers.

Next, I examined mothers' behaviors for any systematic differences across cultures using a multivariate ANOVA with mothers' behaviors as the dependent variables (8), country (3) as the between subjects factor and infant age, sex of infant, mother age and mother education as covariates in the model. There was a significant difference across cultures in the amount of smiles a mother produced ($p<.05$) and the number of times she rested her hand on the infant ($p<.001$). Pairwise comparisons revealed that American mothers smiled more and had a higher frequency of resting their hands on their infant than Kenyan and Fijian mothers. See Figure 2.0. The age of mother was a significant predictor of the number of times she smiled with older mothers smiling more across all three cultures.

Hypothesis Testing

First, in order to assess the degree to which the infants' target behavior was followed by the mothers' target behavior within one second (based on Bigelow & Rochat, 2006), I calculated the conditional probability of the mothers' behavior given that it was preceded by the infants behavior using the formula p(M given It), where M is the mothers target behavior, I is the infants target behavior and t is time (one second). The

Contingency Measure (CM) was the difference between the conditional probability of the mothers' target behavior and the unconditional probability of the mothers' behavior (e.g. the probability of the onset of a smile (Symons & Moran, 1994; Watson, 1979). The resulting conditional probability is referred to as a Contingency Measure (CM) and the formula for analysis is: CM = *p*(M given I*t*)-*p*(M). Each CM score was standardized (*z*-scores) and separate univariate ANOVA's were conducted on each of the standardized CM dependent variables. The rationale for not including all of the dependent variables in one mulitivariate ANOVA is that each mother did not produce behaviors for all variables therefore by including all variables reduces the sample size significantly, as it would only include mothers who produced all behaviors. Visual representations are based on the proportion of contingent responses divided by all of the opportunities for a response, rather than the z-scores. Infant age, sex of infant, mothers' age and education level were entered as covariates into the model. A window of one second was used because responsiveness typically occurs within one second (Bakeman & Adamson, 1984; Bigelow & Rochat, 2006).

Hypothesis 1: Contingency

Overall contingency.

A contingent response was defined as any change in mothers' behavior within one second of the onset of an infant behavior, as mothers typically respond within one second to an infant's behavior (see Bigelow & Rochat, 2006). The dependent variable, Overall Contingency Measure, was determined by calculating the difference between the conditional and unconditional probabilities of contingent responses. I conducted a univariate ANOVA with the standardized scores for Overall Contingency Measure as the dependent variable and country (3) as the between subjects factor and infant age, sex of

infant and mothers age and education level as covariates in the model. There was no significant difference in the level of contingent responding by culture $F(2,69)=.889$, $p=.416$, partial $\eta 2=.025$ however, there was a marginally significant increase in contingent responding with increasing age of the infants $F(2,69)=3.56$, $p=.063$.

Contingency by modality.

In order to determine whether mothers are responding to infants using different modalities (facial, vocal or tactile), I calculated the standardized Contingency Measure for each of the modalities. I analyzed these using a multivariate ANOVA with the standardized Contingency Measure for each modality as the dependent variable (3) and country (3) as the dependent variable. Infant age, sex of infant, mother age and education level were all entered as covariates in the model. There was no significant difference in the modality of the contingent response by culture, $F(2,69)=.081$, $p=.967$. Overall, within-subjects contrasts indicates that mothers responded more with contingent vocalizations than any other modality $F(2,69)=4.539$, $p<.05$.

Contingency to infant target behaviors.

There are 12 possible behaviors that each mother could produce as a contingent response to an infant behavior. In order to determine whether mothers are responding differently across cultures in the frequency of contingent responses, I generated four separate contingency scores – one for each infant behavior. The proportion of contingent responses (number of contingent responses divided by the number of opportunities for a response) was calculated by summing the number of responses by the mother (12) and dividing that by the frequency of the infant target behavior. I conducted a multivariate ANOVA with contingent response as the dependent variable (4), country (3) as the

between subjects factor, and infant age, sex of infant, mothers' age and education level as covariates in the model. Each dependent variable is reported separately below.

Contingency to an infant smile.

There was no main effect of country on the proportion of contingent responses to a smile (p=.742). In a separate multivariate ANOVA, I examined whether mothers' contingent responses differ by behavior and modality. I entered mothers' contingent responses by behavior as the dependent variables (12 – mother facial positive, negative, neutral. mother vocal positive, negative, no vocal, neutral and mother touch vestibular, caress, tap, resting hand and no touch). Neutral behavior and the absence of behavior are included in these analyses because they indicate a change in the mothers' behavior as a response to an infants' behavior, indicating a contingent response. Once again, all dependent variables are within one second of the onset of an infant behavior. Country (3) was entered as a between subjects factor and infant age, sex of infant, mothers age and education level were covariates in the model. There was a significant difference across cultures in the proportion of positive vocal responses to an infants' smile, with the US responding with more positive vocal responses than Fijian mothers (p<.001) or Kenyan mothers (p<.001), as indicated by post hoc analysis (LSD).

Contingency to an infant grimace.

There was a main effect of country on the proportion of contingent responding to a negative facial expression (grimace), $F(2,71)=4.36$, p<.05, with Fijians responding more contingently overall to an infant negative facial expression than Americans (p<.001) or Kenyans (p<.05). A separate multivariate ANOVA examining mothers' contingent responses to an infant frown by behavior and modality revealed no cultural differences (p=.265).

Contingency to an infant positive vocalization.

There was a marginally significant main effect of country on the proportion of contingent responses to a positive vocalization ($p<.10$), with Americans responding more contingently to a positive vocalization than Fijians ($p<.05$). A separate multivariate ANOVA examining mothers' contingent responses to an infant positive vocalization by behavior and modality revealed no cultural differences ($p=.145$).

Contingency to an infant negative vocalization.

There was no overall main effect of country on the proportion of contingent responses to a negative vocalization ($p=.354$). A separate multivariate ANOVA examining mothers' contingent responses to an infant negative vocalization by behavior and modality revealed no cultural differences ($p=.184$).

Hypothesis 2: Affect Mirroring

Affect mirroring (smile).

I conducted a univariate analysis of variance with the standardized scores for the Contingency Measure (CM) of smiling as the dependent variable (the difference between the conditional probability of the mothers smile given the infants smile within one second, and the unconditional probability of the mothers smile) and country as the between subjects factor and age and sex of the infant as covariates in the model. Nine infants did not produce any smiles during the interaction and were therefore excluded from the analysis. There was a significant overall main effect of culture, $F(2,60)=4.292$, $p<.05$, partial $\eta 2=.125$ (moderate effect). Post hoc (LSD) analysis reveals that Kenyan mothers produced more affect mirroring of smiles than did American mothers.

Affect mirroring (grimace).

There were only two mothers (Fijian) who grimaced back at their infants grimace within one second therefore no analyses were conducted for contingent responding to infant grimace.

Affect mirroring (positive vocalization).

I conducted a univariate analysis of variance with the standardized scores for the Contingency Measure (CM) of positive vocalizations as the dependent variable and country as the between subjects factor and age and sex of the infant as covariates in the model. There was a significant main effect of culture $F(2, 39)=4.18$, $p=.05$, partial $\eta 2=.177$ (moderate effect). Post hoc (LSD) analysis reveals that Kenyan mothers produced more affect mirroring of positive vocalizations than did American mothers.

Affect mirroring (negative vocalization).

I conducted a univariate analysis of variance with the standardized scores for the Contingency Measure (CM) of negative vocalizations as the dependent variable and country as the between subjects factor and age and sex of the infant as covariates in the model. There was a no significant main effect of culture.

Discussion

The goal of this study was to examine maternal contingent responsiveness and affect mirroring across diverse cultural settings to determine whether they are universal features of maternal behavior. To summarize, I report significant cultural differences in the level of affect mirroring produced by mothers. Kenyan mothers mirrored their infants' positive emotions (both facial and vocal) more than American mothers. There were no significant differences across cultures for negative affect mirroring. There are many possible interpretations of this difference. I suspect this difference reflects the lower frequency of Kenyan positive expressions of emotion overall – although this is factored

into the analysis statistically, it may be reflective of a conservative tendency of the Kenyan mothers with their positive affective expressions. Kenyan mothers produced significantly fewer for smiles than American mothers and fewer (although not significant) positive vocalizations than American and Fijian mothers. I interpret this conservative response to potentially reflect a 'sensitivity' in the Kenyan mothers, whereas American mothers are producing higher frequency, but less 'contingent' affect mirroring responses. The general interpretation that Kenyan mothers are more reserved in their affective expressions of emotion is consistent with other reports (LeVine, et al., 1994) indicating that mothers discourage too much emotion or excited play in infants. When a Kenyan infant begins to laugh, mothers to avert their gaze from the infant (LeVine, et al., 1994). This project does not address these particular questions of the socialization of emotion. Further studies are needed to provide an understanding of how emotion is socialized early in infancy. For example, in order to examine LeVine's claim that infants are socialized not to express heightened levels of emotion or excited play, one might ask mothers to induce laughter in their infants and examine the behaviors before and after the infant laughs. Such microanalyses of mother-infant interactions in natural yet structured observation settings will be a significant contribution to the developmental literature on cognition, socialization and emotion.

With respect to contingency data, there was no difference in the overall amount or kind (modality) of contingent responding across cultures. All mothers responded more contingently to infants with vocalization compared to tactile or facial responses. However, when an infant produces a smile, American mothers respond with more positive vocalizations than the other two cultures, as well as respond more contingently to infant

positive vocalizations than Fijians. The tendency for American mothers to respond to infant positive expressions of emotion with positive vocalizations is not surprising. Some have classified the US as an *in*-dependent versus an *inter*-dependent culture, also referred to as *individualist* compared to *collectivist* (Singelis, Triandis, Bhawuk, & Gelfand, 1995). In an individualistic culture in which education is highly valued, and nuclear families are the norm, one might expect a reward for the use of verbal modalities.

There were few significant effects caused by an increase in age of infants. First, there was a significant increase in contingent responsiveness with increasing infant age. In general, however, mothers respond more contingently to a negative vocalization and less to a smile as infants increase in age. These age effects were consistent in all cultures. It is likely that mothers are responding to the increased mobility of the infant in this restrictive environment and it is unclear whether this age effect would exist outside of this setting.

Lastly, I also report group differences in the general behaviors of each of the dyadic partners. First of all, as infants get older they are smiling less and producing more negative vocalizations. Again, this is likely due to the restrictive nature of the set up for increasingly mobile infants. In general, older mothers smiled more, and, American mothers smiled more. Note that these two predictor variables are confounded as American mothers tended to be older in this sample. One could speculate on why American mothers (or, older mothers) appear to be significantly ‘happier’ in this context. One low level explanation for American mothers is that they are familiar with the general scientific inquiry into human behavior and may be more at ease with respect to being ‘tested’. Another explanation is that they are hyper-aware of being evaluated and

therefore producing more smiling behaviors than would otherwise be natural. Alternatively, I may be capturing a real group difference in the socialization of emotion.

Another interesting group difference is that American mothers rested their hands more on their infants compared to the Fijian and Kenyan mothers. This difference was surprising as I expected the modality of 'touch' to be utilized more in non-western cultures as western cultures are known for relying on face-to-face and vocalizations with infants. However, it could be that Kenyan and Fijian mothers in this sample rely on a different *kind* of touch. According to ethnographic reports, and my personal observations, mothers in both regions are in physical contact with their infants more than American mothers. Kenyans are 'wearing' their infants for much of the day, while Fijian mothers are holding or cuddling their infants in the home for much of the day. Therefore, I would speculate that the difference in the frequency of touch may be an artifact of the somewhat artificial dyadic situation.

Interestingly, there is a low frequency of occurrence of these behaviors throughout the sample. My data are inconsistent with previous reports of contingency and affect mirroring in the literature. Bigelow and Rochat (2006) report more than 80% of contingent responses by mothers, yet I report contingency levels less than 30%. There are several possible explanations for the lower contingency scores in my sample. I expect that the low scores are due to methodological differences (specifically coding) and are not intrinsic to the sample itself. In particular, I did not code for a change in the magnitude of an expression as Bigelow and Rochat (2006) report. Due to logistical problems which arose – such as poor lighting as there was no electricity in the Kenyan or Fijian setting, as well as difficulty obtaining reliability on a culturally diverse sample, it is

possible that my coding criteria were more stringent than in other reports. Regardless of why my contingency levels were lower than what is typically reported in the literature, they are valid reflections of the coded behaviors of dyadic interactions between mothers and their infants across cultures. Therefore, these lower than expected contingency levels led me to further question the function of this behavior.

I propose two alternative explanations for the function of these maternal behaviors. First, if mothers are responding to their infants' smiles with a smile less than 30% of the time, what effect does this have on the infant? If, as Gergely and Watson, Bigelow and others have suggested, infants are calculating a 'magnitude' of responsiveness, or, as I like to think of it, a *social signature* then one would expect the frequency of occurrence to be above chance. It is not above chance in my sample. Therefore, I propose that these behaviors are more about developing a connection or recognition with the dyadic partner than they are about the magnitude of response. The infant needs to know that he is recognized by the other, therefore the response must be contingent (for the response to be recognized as a result of the infant's behavior). If contingency and affect mirroring are about more than calculating probabilities and frequencies in the social environment, then the frequency of occurrence becomes less important. What becomes relevant is the fact that they *do* occur at all. Perhaps all the infant needs is someone to imitate his behavior once per day, or to respond contingently (when I do something, they do something back) for a very small portion of the day, to enable him or her to learn that others in the social environment recognize him. In addition, one might argue that there is nothing special about the 'affect' in affect mirroring as is suggested by Gergely and Watson, and, in fact, infants prefer contingent responding and

general imitation for forming a bond or connection with the other. Although demonstrating emotional expressions and cultural displays are significant and important in the life of a developing infant, they may not be the necessary or critical feature of this maternal behavior. Affect mirroring has been regarded as a curious behavior by scientists as it is especially odd to imitate a negative behavior back at an infant. I propose that if we look at the broader communicative context, we may find that mothers are imitating a wide range of behaviors, not restricted to emotion, therefore removing the affect out of affect mirroring. The critical element in this behavior may be imitation. Simply connecting with another through shared experiences may be the necessary feature of responsiveness – and that need not be through facial expressions.

Another alternative explanation for these behaviors is that infants need not develop an understanding that they 'have an effect on *people*' in the environment. As the literature points to a developing social expectation and preference for a social style of responding, it is possible that social contingency serves an entirely separate function from learning about contingencies in the environment. Every individual encounters countless individuals in one's life. Determining the 'effect' one might have on another may have less to do with contingencies and more to do with a connection, shared experience, shared expressions or values. Contingent responding may be another way of recognizing your dyadic partner. Stern refers to this dyadic interaction as a 'dance' and it is possible that the function is to identify the rhythm of the other individual. Some evolutionary perspectives suggest that certain features of increased maternal care may be behaviors that were adaptive as keeping an infant in close proximity may have enabled those infants to survive (Falk, 2004). One 'proximity-ensuring' mechanism may be the contingent

response ‘social signature’. If an infant comes to recognize the social dance of her mother, even in the absence of sight and sound, one could imagine such an ability might be beneficial to survival. Although this idea does not align perfectly with Bigelow’s report that infants prefer a level of contingency that is similar to their mothers, it is not in contrast to it. Infants are developing a social expectation for how others respond. Although contingent responding may be infrequent, the important aspect is that when it does occur, it is reliable and stable.

At this point, limitations with coding and the procedure must be acknowledged. First, the coder was a female adult whose eye may be particularly familiar and tuned in to the expressions of infants and mothers in western cultures – therefore potentially leading to the cultural difference in behaviors observed. In addition, the procedure itself may elicit different responses from infants across cultures. For example, one could imagine a Kenyan infant who expects to be held or carried with little opportunity for face-to-face interaction with her mother, is suddenly placed onto the floor or ground, facing the mother. Typically mothers set their infants down to breastfeed therefore the act of stopping may be leading to an expectation for a feeding. Not only is this a limitation of the study, but it is interesting, in and of itself – with infants as young as the first year of life, forming strong social expectations that are significantly different across cultures.

In addition, the wide age range and small number of infants tested is a limiting factor in this study. As noted, there were significant age effects in this study. As different developmental issues arise with increasing age, mothers are more than likely responding differently. Due to a small sample size and low power such differential responses, if present, may not have been detectable in this study.

Lastly, I defined affect mirroring as the mother matching the affective facial and vocal behaviors of her infant, however, affect mirroring is typically reported as having a 'marked' exaggerated component, enabling the infant to identify the imitated expression as distinct from her own. Although this is a critical aspect of the definition, my data do not capture 'exaggeration'. After several personal discussions with Gergely and Bigelow and failed attempts to reliably identify a 'marked' (exaggerated) response, I decided that it would be problematic to interpret the facial expressions of a culture in which I was not an 'expert' in the non-verbal communicative system. In future, in order to capture a 'marked' expression of emotion in the mothers, one might capture video of mothers engaging in dialogue with other adults in order to determine the baseline expressions from which to compare an 'exaggerated' expression.

In order to address these limitations, and to expand on this data, I propose three potential modifications and further coding and analyses on this dataset. First, in order to fully assess the level of affect mirroring in the data a more qualitative coding scheme must be developed and implemented. As mentioned previously, one would need to code for specific marked expressions of emotion in the mothers. In addition, a more general, qualitative, episodic coding system would contribute to the data. For example, there are many qualitative differences which I observed watching the videos which are not captured in the current coding scheme such as differentiating between an inattentive gaze and a playful gaze away (peek a boo). Perhaps more 'qualitative' coding of specific targeted behaviors during the interaction would better capture such episodes.

Second, in order to develop a complete understanding of the dyadic interaction it would be important to expand the existing definition of contingency from a one second

window to a longer, possibly three second window. The existing definition is based on observations of mothers and infants in western laboratories; therefore it is possible that contingent responding may have a different lag sequence in other cultures.

Third, in order to complete a comprehensive analysis of the interaction, it would be essential to examine the mutual gaze behavior of mothers and infants. It is possible that gaze behavior is one modality that provides significant information to the infants – for example, mothers may respond with a gaze, an eyebrow raise, or an episode of gaze aversion – but without future coding, these episodes are missed and the data may be misinterpreted.

Despite the limitations, these data provide the first evidence of contingent responding and affect mirroring at the micro-analytic level in non-western, traditional societies.

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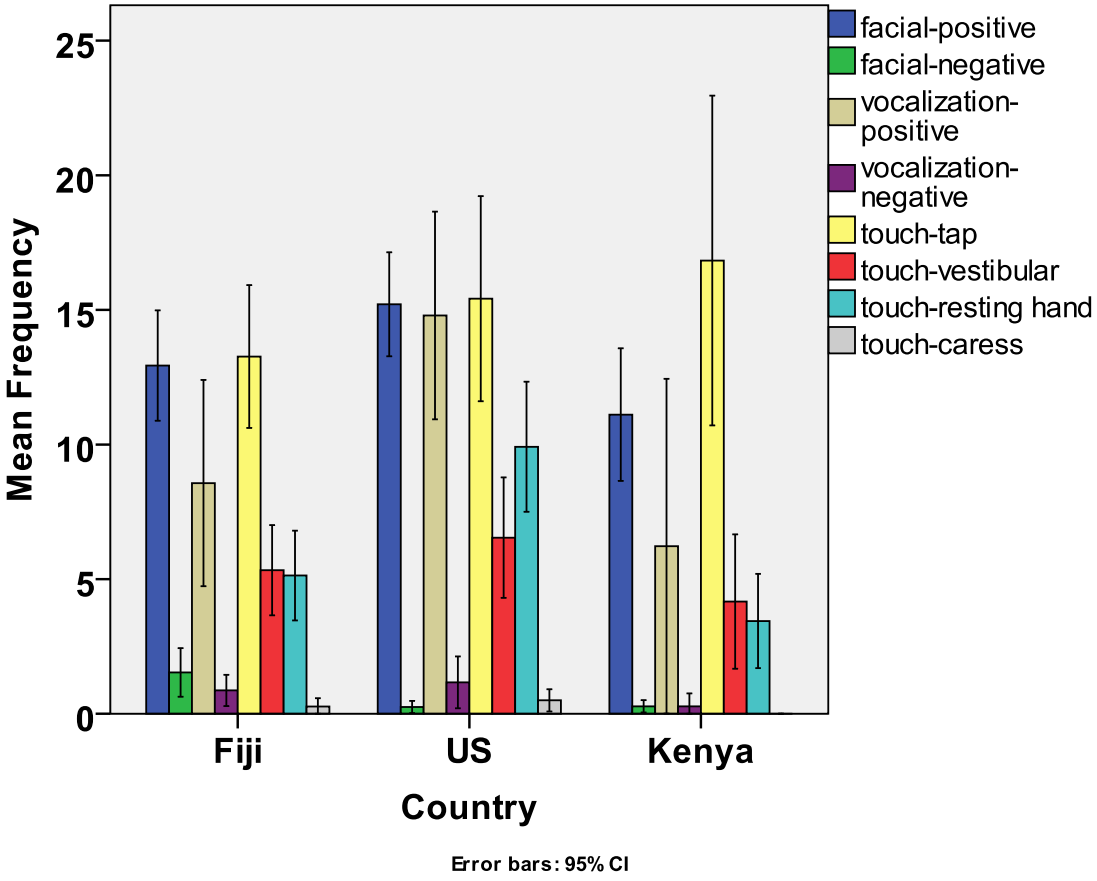
Tables and Figures

Table 1.0: Participant age and education by culture (mean, *SD*, *n*)

Country	Mother age (yrs)	Mother edu. (yrs)	Infant age (mos)
All Countries	27.7(7.2), *n*=50	11.6(4.1), *n*=44	7.8(3.7), *n*=72
Fiji	29.3(7.9), *n*=18	10.7(1.8), *n*=12	7.7(4.0), *n*=30
US	32.2(5.2), *n*=14	16.8(1.7), *n*=14	7.3(2.9), *n*=24
Kenya	22.7(4.5), *n*=18	8.06(1.7), *n*=18	8.8(3.9), *n*=18

Figure 1.0: Fijian mother interacts with her six month old infant.

Figure 2.0. Mean frequency of behaviors produced by mothers.



Appendix

Appendix A (script)

ENGLISH

We will be videotaping you interacting with your infant. Please just do whatever you normally do with your infant to keep him or her engaged. We will be videotaping and ask that you continue to interact with your child/infant for 10 minutes. Please do not lift up your infant at anytime as we have the camera on the infant. Please do not use any props. Thank you very much.

SWAHILI

Tutakuwa tukichukua video yako ukihusiana na mtoto wako. Tafadhali fanya jinsi wewe hufanya kwa kawaida ili kumfanya angalau awe anafanya jambo, yani, asisubae .Tutakuwa tukichukua video na tunakuhimiza kuendelea kucheza na mtotowako kwa dakika 10. Tafadhali usimuinue mwanako kwasababu tumeangalisha kamera kwake. Tafahdhali usitumievihimili vyovyote.
Asante sana.

FIJIAN/BAUAN:

O keitou na tabaka tiko na nomudrau veimaliwai kei na levumu. Keitou na qai kerea kevaka o rawa ni o cakava ga na ka o dau cakava e na veisiga me dau vakawelei koya kina. Keitou na tabaka me 10 na miniti na nomudrau tiko vata. Keitou kerea talega me o kakua ni o keveta na luvemu ka ni na tabaki tiko. E kerei talega me o kakua ni vakyagataka e dua na vakawele. Vinaka vakalevu.

Appendix B (coding scheme)

*General coding instructions***:** Each behavior category may overlap, but the 'states' or 'events' within each coding category are mutually exclusive and exhaustive. One behavior must occur within a given category at all times. A behavior is coded when there is a distinct change in behavior. By change in behavior I refer to clear pauses between the same behavior or a change in the behavior itself. For example, a rapid vocalization without a pause of greater than .5 seconds between each utterance (e.g. ah, ah, ah)is coded as one behavior. If, however, there are clear pauses between each vocalization (e.g. ah, pause, ah, pause, ah) then these would be considered distinct utterances and a separate key press occurs for each. Specifically, a change that occurs within ½ second and is fleeting is coded as continuous and receives one key press, however, if the change is distinct and longer than ½ second then the behavior is coded as a change in behavior. See definitions below. When coding the infant behavior, maximize screen so that the infant is showing in the largest possible image. Do the same for the mother, however, for mother-touch category, keep both images on the screen.

Interruptions: If either dyadic partner is responding to something else in the environment (i.e. – infant turns to camera and smiles at the camera rather than at the adult) than this is <u>not</u> coded. Any interruptions such as this which are longer than a few seconds have been removed from the video data you are coding and a black screen is inserted with an explanation of the interruption. Note that there is a separate key press for 'black screen interruption'.

Repetitive key strokes indicate a change (in some way) of the event/state. For example, if an infant is crying (negative vocalization) and they start to cry in a different way (change in intensity or volume) then another key stroke is pressed (negative vocalization). The goal is to capture the changes in behavior that are produced (in order to determine how each partner is affecting and responding to the other)

Vocalizations: Vocalizations include any sound coming from the mouth including singing, except digestive sounds or sneezes, coughs, etc.. Includes clucking and 'shhhhhing' for mothers. For infants, cries and frets are included in vocalizations (negative vocalization). Positive vocalizations refer to any vocalization having a clear and distinct upward intonation. Negative vocalizations refer to any vocalization having a clear and distinct downward vocalization. Neutral vocalizations refer to any vocalization not having a clear distinct upward or downward intonation (also includes 'shhhing' or 'clucking'). No vocalization is coded if there is a bout of 3 seconds or more of no vocalizations. This is not used as an 'end' code for the previous vocalization.

Facial expressions: Facial expressions include any clear change in the facial movements of the mother or infant that are recognizable as a change to any observer. Do not code a change in intensity for facial expressions as it is too subjective. This was attempted but

reliability was too low, therefore we are only coding a change in the category of expression.

Touch: A touch is any change in the touch category. For example, flailing and caressing would be different categories of touch. Only code a change in touch within the same category if the change is clear and distinct - for example, if the mother produces a different *kind* of touch within the same category such as puppeting and then ticklng, then code this as 'e,e'. If there is tickling, clear pause with contact, tickling, then code this as 'e,r,e'. However, if there is a little tickling and then more intense tickling, just code this as 'e'. Mother touch reposition/vestibular refers to rocking child back and forth using hands on child while child is lying on floor. Includes rocking child side to side with mothers finger in mouth (rocking head). Also includes holding a pillow or blanket to rock the infant.

Gaze: The current coding scheme does not differentiate between an uninterested gaze away (unattentive) and a 'peek-a-boo' gaze away. Perhaps more 'qualitative' coding of specific targeted behaviors during the interaction would better capture such things.

Ethogram:

z mother vocal positive
x mother vocal negative
c mother vocal neutral
v mother vocal no vocalization.
b infant vocal positive
n infant vocal negative
m infant vocal neutral
/ infant vocal no vocalization.
a mother facial positive
s mother facial negative
d mother facial neutral
g infant facial positive
h infant facial negative
j infant facial neutral
q mother touch reposition/vestibular
w mother touch caress
e mother touch tap/poke/flailing /puppeting/tickling
r mother touch contact but no movement
t mother touch no contact
u mother gaze on – gaze directed at the infant (does not have to be in the eyes or mutual gaze; if infant is crawling around, gaze on is coded if mother is looking in direction of infant)
I mother gaze off – gaze directed away or not on the infant
o infant gaze on – gaze directed at the adult
p infant gaze off – gaze directed away from the adult
1 Press '1' every two seconds if a black screen appears. When video begins again, resume coding.

Manuscript 2: Infant Directed Speech in Three Cultures: Evidence for Universals

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Abstract

When speaking to infants, adults typically alter the acoustic properties of their speech (Ferguson, 1964, 1978). They do so in a variety of ways, specifically - previous research has found that adults use higher pitch, increased pitch range, and more pitch variability when addressing infants and small children (Ferguson, 1977; Fernald, 1992). In addition, adults also simplify and shorten words to accommodate young children and infants. To date, however, no studies have thoroughly examined basic acoustic properties of infant-directed speech (IDS) in traditional societies. Some scholars have suggested that infant directed speech does not exist in some non-industrial societies (Ochs, 1982; Pye, 1986; Ratner & Pye, 1984), claiming that adults in these societies do not alter their speech, or, in some instances they claim that they even reduce the pitch when addressing infants and young children (Ratner & Pye, 1984). However, if we are to understand the form and function of infant directed speech, we must determine whether such speech modification is a product of western culture or a human universal – and specify which features are culturally variant and which ones are found across societies. In addition, one would expect vocal communication with prelinguistic infants to rely heavily on acoustic information rather than linguistic, therefore I expected universality in speech modification across cultures. I examined pitch production (measured as fundamental frequency/F0 in hertz units) in mothers speaking to both infants (IDS) and adults (ADS) in three cultures: Fiji, Kenya, and US. Recordings were obtained from videotaped caregiver-infant dyadic interactions and interviews with adults. In all three cultures, speakers used higher pitch when speaking to infants relative to adults, and also used significantly greater pitch variation (F0 SD) and pitch range (F0 max – F0 min). I additionally analyzed recordings in which I only had IDS, and these caregivers had very

similar pitch profiles. However, I did find that American mothers used marginally higher pitch than Kenyan and Fijian mothers, suggesting that IDS might be more exaggerated in the US. Although – this difference may be attributable to education and age but we do not have this information for enough of the participants in this sample to determine whether it is a culture effect or an education or age effect. Interestingly, when I analyzed an additional 30 recordings of which I only have recordings for infant directed speech (and not adult directed speech), there was a main effect of culture (west/non-west) that disappears when you add education and age of mother as covariates in the model. Therefore, in this analysis, it appears that education and age, but not culture, are significant predictors of changes in pitch and pitch range. Specifically, increasing maternal age correlated with increase in elevated IDS pitch and increased education level correlated with a decrease in elevated IDS pitch. This is the first research systematically comparing spontaneous IDS and ADS in traditional societies, and is consistent with a large body of evidence showing universal patterns in IDS across industrialized populations. Implications for the evolution of prepared learning mechanisms in infants and a prepared 'teaching' mechanism in adults will be discussed.

Introduction

Research Question

Mother's modify the ways in which they communicate with infants and young children, specifically by adjusting their speech patterns and simplifying their speech register (Ferguson, 1977; Schieffelin & Ochs, 1986). Features of this modified speech can be broken into two categories – linguistic and acoustic. The linguistic features refer to a series of linguistic properties such as: the repetition of words and phrases, simplified speech, exaggerated pronunciation, clarification by means of synonyms and paraphrasing, and a special 'grammar' which utilizes all of these features (Ferguson, 1977). Ferguson claims that infant directed speech, also referred to as babytalk or motherese, is restricted in scope and structure, compared to adult directed speech, having a limited grammar and sound sequences (Ferguson, 1964, 1977).

Research comparing the acoustic properties of speech directed at infants to speech directed at adults indicates that infant directed speech (IDS) has a higher pitch, slower speed, and a smooth exaggerated prosody, unlike the choppy, fast adult directed speech (Ferguson, 1977). Several possible functions of IDS have been explored with some evidence indicating that infants are drawn to the acoustic qualities of IDS, preferring it over adult directed speech. Other evidence suggests that it relates to the communicative goals of the speaker, communicating intentions through the acoustic properties. It has also been suggested that IDS aids in language learning by acoustically highlighting vowel categories with the exaggerated quality of the vowel space. Some have suggested that IDS may serve all of these functions, but that the function may change as different developmental needs arise (Fernald, 1992).

The first reports of the acoustic features of infant directed speech noted that adult speech was higher pitched when addressing children and infants compared to when they were addressing adults (Ferguson, 1977, 1978). Analysis of these properties revealed that infant directed speech was composed of a higher mean fundamental frequency (F0) (corresponds to perceived pitch) and a wider pitch range. In addition, an exaggeration in the physical production of speech has been observed – for example, exaggerated movement of the lips (Ferguson, 1977).

Infant directed speech has been deemed a human universal, although the evidence to date is insufficient to make this conclusion. Evidence exists for IDS in several industrial cultures and urban centers, yet no empirical evidence has sufficiently documented the acoustic features in more traditional, small scale societies. IDS is not specific to English speaking mothers. There is cross linguistic evidence for infant directed speech in several societies such as Australia, Japan, Thailand, Syria, Middle East, India, Native American, Russia, France, Bangkok, Germany, Mexico, US, Canada, Great Britain, among other cultures (Ferguson, 1964, 1977; Fernald, 1992; Fernald et al., 1989; Kitamura, Thanavishuth, Burnham, & Luksaneeyanawin, 2002).

In contrast to this evidence, ethnographic reports, and few systematic observations, suggest that certain acoustic and linguistic features of infant directed speech do not exist in some cultures (Ochs, 1982; Pye, 1986; Ratner & Pye, 1984). Specifically, observations in the South Pacific (Samoa) and Central America (Guatamala) indicate an absence of modified speech to infants as well as no modification of the prosody of the mother when found addressing a child (Ochs, 1982; Ochs & Schieffelin, 2001; Pye, 1986; Ratner & Pye, 1984). Ratner and Pye (1984) and Pye (1986) report data collected during

observations of mothers engaging with their children during an interview context in Guatamala and indicating that these mothers do not increase their pitch when addressing children (Ratner & Pye, 1984). In contrast, they report that the mothers decrease their pitch slightly when addressing infants. The data collected by Ratner and Pye, although interesting, are difficult to interpret due to a small sample size (three) and other methodological problems. For example, we know from previous linguistic work that specific kinds of speech use different 'prosodic signatures' with, for example, mothers decreasing their pitch when uttering prohibitives to children. Therefore, it is plausible that, given the unconstrained context of the data collection, that the three mothers were uttering prohibitives to their children during the interview-like situation, so as not to be interrupted by the children during the interview. We know from ethnographic reports of childcare practices in the South Pacific, that children are expected to be seen and not heard, therefore this explanation is not only plausible, but likely (H. Morton, 1996; Rogoff, Mistry, Goncu, & Mosier, 1993). Although the work by Ratner and Pye (1984) has been ignored by many due to methodological uncertainty, several ethnographic observations also suggest infant directed speech may be a western phenomenon. Therefore, it is essential to examine the features of infant directed speech in non-western cultures.

Face-to-face dyadic conversations with infants are less common in non-western cultures (LeVine et al., 1994; Rogoff, et al., 1993; Tronick, Morelli, & Ivey, 1992; Whiting & Edwards, 1988). For example, LeVine reports that when he instructed Gusii mothers in Kenya to talk to their baby he reports,

"…they said it was of course silly to talk to a baby" p. 210 (LeVine, et al., 1994).

LeVine reports that the most frequent behaviors observed in the Gusii mothers were holding and touching an infant of nine months whereas for Boston mothers, looking, and talking to infants were most frequent at this age. Rogoff also summarizes differences in cultures in which the children are often, but not always, separated from adult activities, claiming that it is not culturally appropriate to speak to a young child or infant, but rather emphasis is put on gazes and postures,

> "Western researchers' emphasis on talking as the appropriate means of adult-child interaction may reflect a cultural bias that overlooks the information provided by silence, gaze, postural and timing changes, smells, and touch." p. 11 (Rogoff, et al., 1993).

However, research on language development indicates that children's linguistic skills depends upon direct linguistic input from the social environment (Kuhl et al., 1997). What is unclear is whether it is necessary to talk to infants directly, specifically by modifying the properties of our speech to accommodate the infant – as observed in western cultures – or is it sufficient to be a passive observer of adult-adult interactions early in life? Adult-adult vocalizations would presumably not consist of vocal modification noted in IDS. Although the data reported in this project does not directly address this question, it explores one aspect – specifically, whether 'vocal accommodation' directed at infants occurs in more traditional cultures.

It is important to determine whether modifying speech style when addressing infants is specific to western (or industrialized) cultures or whether it is also observed in small-scale, traditional societies. Demonstrating that such speech modification is

universal when addressing infants and young children would enable further speculation about the present function of this behavior. In addition, it would enable speculation about the origin of this behavior and the possible evolutionary pressures that may have facilitated the emergence of IDS. Although some (see Fernald 1992) have speculated that IDS is a product of natural selection, satisfying certain requirements for solving age old evolutionary problems, such as mother-infant bonding, language learning, or communication, these speculations fall short without evidence from indigenous societies. Although evidence across a wide range of cultural environments, including those which are closer to our hominid ancestors, does not allow us to conclude that the behavior is a product of evolution, the lack of evidence allows us to speculate that it may be a behavior that is constructed by culture. We know that universal behaviors may be the result of universal experiences, or evolutionary adaptations, and although this data does not address this question, it enables us to engage in dialogue and speculation regarding the function and origin of the behavior.

Possible Functions of IDS

Language acquisition.

It was originally thought that infant directed speech taught syntax and grammatical structure to young children who are beginning to learn language (Snow, 1977). However we know that mothers modify their speech even when addressing very young infants (Ferguson, 1964), suggesting that it may serve prelinguistic functions, such as communicating intentions or other non-linguistic features of communication (Bryant & Barrett, 2007). However, others make the claim that, in fact, the primary function of IDS is for native language learning (Kuhl, Williams, Lacerda, Stevens, & Lindblom, 1992; Saffran, 1996; Werker & Tees, 1984). We know that infants prefer the acoustic features

of IDS as early as the first month of life (Cooper, 1990). Werker finds that IDS facilitates learning of native vowel-consonant combinations. She has demonstrated this with synthesized as well as natural speech– specifically that infants are able to learn and make vowel-consonant distinctions when trained in infant directed speech (Werker et al., 2007). Kuhl and colleagues (1997) examined the acoustic properties of maternal speech (specifically vowel categories) to infants across 3 distinct languages – Russian, Swedish and English – and compared it to speech directed at adults. They report that in each language, mothers use more extreme vowel categories when addressing infants but not adults. They argue that language input directed at infants facilitates language learning at even this early age (Kuhl, et al., 1997).

Werker and colleagues report evidence that IDS aids in phonetic category learning in the first year of life (Werker, et al., 2007). In a series of studies, they found that infants change their sound categories based on the properties of the speech input (Werker, et al., 2007). Acoustic analysis of Japanese and American mothers teaching words to their infants indicates that the distributional properties of their speech is language specific – that they emphasize vowels differently in each language and that infant directed speech actually facilitates the ability to establish our native phonemic categories. What would happen in the absence of exposure to infant directed speech?

Socialization.

Infant directed speech is one among many tools for language socialization (Ochs, 1986b). Ochs and Sheiffelin (2001) view language socialization as the process by which a child is exposed (whether intentionally or not) to the interaction styles of their culture (Ochs, 1986b; Ochs & Schieffelin, 2001). They argue that sociocultural information is actually embedded in the conversations that adults and other members of society have

with children. Therefore, their perspective is to view and examine language socialization as the process by which children learn the sociocultural information of their culture. They argue that not only is linguistic information embedded in conversations, there is also a 'world view' (p.3), which children learn *as* they are learning language (Ochs & Schieffelin, 2001). Their perspective is relevant to this project as the goal is to examine whether vocal accommodation occurs when addressing infants, in all cultures. If vocal modification of speech is culturally determined, what is it that we are communicating to infants with this speech form?

Function changes with developmental needs.

Fernald argues that as different developmental problems arise, the function of IDS likely changes (Fernald, 1992). She suggests that infant directed speech does not facilitate language learning until it is directed at older children (Fernald, 1992; Sachs, 1977). Directed at young infants, the function is to communicate intention and emotional meaning (Fernald, 1992). She proposes a model (1992) of development in the first year, suggesting that mothers change their prosody (i.e. prosody refers to the rhythm, stress and intonation of speech) when addressing very young infants (less than 18 months), however the speech modification later becomes focused on simplification and repetition of speech. She argues that at first, young infants are drawn to the perceptual features of IDS (Fernald, 1992; Sachs, 1977). Later, it serves to direct attention as well as modulate arousal and the affective quality of the vocalizations serves to communicate intention and emotion – the first sound-meaning correspondences for the infant, according to Fernald (1992). Lastly, as infants are beginning to learn language, the developmental function of IDS helps infants learn words, specifically it highlights certain aspects or features of words in sentences and this enables words to emerge more easily from the string of

sounds. She claims that IDS is an adaptive mechanism (for a review, see ‘The Adapted Mind’ as she provides us with a summary of the empirical support for satisfying the developmental function at each of these developmental stages).

Specifically, Fernald provides an abundance of evidence which suggests that the primary function of IDS is to communicate intention and/or emotional meaning (Fernald, 1989). For example, Fernald (1989) presented filtered infant- and adult-directed speech to individuals and asked them to determine the intentional category of each of the utterances. Students were better at determining intentionality when presented with infant directed speech, suggesting that the prosodic modification of speech by adults when speaking to infants provides meaningful information about intention. In addition, Fernald and colleagues report that mothers use a specific form of IDS, or a prosodic signature, when engaging with an infant for a specific purpose (1992). In other words, mothers have one way of vocalizing with the intent of soothing an infant who is distressed, versus an already calm infant. Fernald’s data provide evidence for differential vocalizations accompanied by different intentions or motivations of the speaker. One possible explanation that they put forth is that the mothers are merely expressing affect vocally (Fernald, 1992). Another possible explanation is that the mothers are simply resonating the emotion of the infant and not communicating any intention. Perhaps this speaking style enables them to first draw the attention of the interactive partner (the infant) to the fact that they are ‘like each other’ and then aim to ‘repair’ the distress. We know that infants prefer those who not only have temporal congruency with their actions (act when they act) but also those who act in a similar manner (Meltzoff refers to this as structural

congruency). Infant directed speech may also satisfy the function of acting ‘like’ the other, facilitating the social bond between a mother and infant (Meltzoff & Moore, 1999).

In tandem with the evidence presented by Fernald, others have investigated the behavioral effects of different kinds of IDS on infants – in order to help elucidate the question of the function of IDS. Papousek and colleagues (1990) presented infants with different kinds of IDS speech – specifically disapproving and approving, devoid of linguistic content, and they found that approving intonation actually increased the attention of the infants whereas disapproving served to decrease attention (Papousek, Bornstein, Nuzzo, Papousek, & Symmes, 1990).

In addition, the features of IDS prosody have been shown to have differential effects on infant behavior – with adult directed vocalization accelerating heart rate, eye closing and withdrawal and infant directed vocalizations leading to eye opening and head orienting of the infant (Fernald, 1992). This suggests that the prosodic acoustic qualities may be particularly effective at getting infants’ attention – more evidence suggesting that this behavior may be an evolutionary adaptation.

Decades of research has documented the specific form, acoustic properties, as well as social properties of infant directed speech, however, if we are to fully understand the function of IDS, it is essential to determine whether it exists in societies more closely resembling that of our ancestors. Newborn infants are able to identify differences in sounds presented to them very early on, possibly even in utero (DeCasper & Fifer, 1980). Although we know that IDS contains affective information, as well as highlights linguistic features specific to the native language (Werker, et al., 2007), it is not clear what the primary function of IDS is, or if it is an adaptive mechanism for language

learning – or for communication – or moderating arousal, to name just a few of the functions that have been proposed (see discussion section for more). In order to understand the function, we first must establish if it is a feature of all human societies.

Universality of IDS

Vocal modification when addressing infants and young children has been observed in many European, Asian, and African cultures and appears to be a human universal (Ferguson, 1964, 1977; Fernald, 1992). Although there are many anecdotal and ethnographic reports of infant directed speech across cultures, there is very little empirical evidence supporting this assertion.

Over three decades ago, Jacqueline Sachs (1977) argued for more research on infant directed speech to infants, specifically calling for more cross cultural evidence to determine whether this behavior is universal, and possibly has adaptive significance. She claims that mothers' tendency to modify their speech when talking to infants and children has its roots in evolution. As she notes, much of the research up until that point (1977) had been focused on the child learning to talk and the simplified speech that mothers used when talking to older infants and toddlers. This simplified speech register has been observed and reported in several cultures around the world (Ferguson, 1964). However, she argues that mothers do not simplify their speech when talking to prelinguistic infants, rather they adjust the acoustic (prosody and rhythm) properties of their speech. She argues that they do so to match the infant's abilities - that like IDS, the infant produces high pitch, smooth rhythmic sounds, and exaggerated intonation patterns. Although she argues that IDS is an adaptive mechanism, she claims that cross-cultural evidence for universality is necessary.

IDS across cultures.

Some of the most detailed ethnographic observations and linguistic analysis of caregiver-infant interaction in a small scale, indigenous society has come from the work of Elinor Ochs and Bambi Scheifflin. Ochs examines the socialization of child language by observing and systematically reporting caregiver-child verbal interaction in Western Samoa and in middle class Americans in order to examine the ways in which children are socialized into learning the implicit cultural rules and norms of their language. She reports significant differences in the way in which toddlers produce language in the two cultures and also differences in the ways in which parents are speaking to their children (Ochs, 1982). Ochs also notes that caregivers in Western Samoa do not 'communicate' with their infants in the typical way that is observed and described in the west. In particular, western observations of mothers and infants indicates that mothers of infants even a few days old engage in face to face interaction and speak directly to infants, often interpreting movements and behaviors as intentional. This is in sharp contrast to what is observed in Samoan parent-child interactions.

> "This assumption about the capacity of infants and young children to control and direct their behaviors to social ends is not shared by traditional Samoan adult and sibling caregivers. While infants and caregivers have considerable social contact with one another, they do not engage in the communicative-like interactions to the extent described by Trevarthen and others. Infants are sung to and cooed over to distract them from their hunger or to put them asleep or simply to amuse them; they are not "greeted" (Stern, 1974, 1977) nor are their vocalizations or gestures typically treated as social acts" p. 89 (Ochs, 1982).

In addition, she reports that the often non-conscious ways of speaking to children has a strong impact on their language acquisition. She explores the linguistic differences between the two populations in great detail, as well as the differences in interaction style. She notes Samoan mothers' speech to children and infants has an emphasis on emotion and she reports linguistic features of the speech in dialogue examples (Ochs, 1986a). Schieffelin and Ochs (1986) report differences in the ways Samoan mothers socialize language, with western mothers having an emphasis on ensuring an *understanding* of an utterance, whereas Samoan mothers encourage repetition of utterances that they do not comprehend (Schieffelin & Ochs, 1986). However, no report of acoustic analysis of speech has been reported from their work in Western Samoa – leaving open the question of whether or not linguistic modification is universal.

There is reason to think that a modified speech register when talking to young children is universal (Kuhl, et al., 1997). Harkness studied first language acquisition and socialization in the rural western highlands of Kenya where she observed toddlers (2-3 years) with their mothers and other children and adults. She measured mean length utterances (MLU) of the participants, older children who were caretaking, as well as the mothers and she found that mean length utterance correlated with the amount of time spent talking. Children who spent more time talking were more advanced with their language than their same age counterparts who were less talkative. Of direct relevance to my research on IDS is the fact that although Harkness does not report acoustic analysis on the mothers speech, she does report variables in both mothers' and older children's speech to participants and finds that they adjust the complexity and mean length utterance of their speech to participants (young children beginning to learn language – not infants).

Ferguson (1977) summarizes evidence for adult vocal modification in 15 different languages and 23 different societies (Ferguson, 1977). He reports a difference in 'speech register' when addressing children, which may refer to a change in any linguistic feature of speech, such as vocabulary or syntax. In addition, the literature cited consists of self reports, ethnographic natural observations and interviews *about* infant directed speech. Although this is a starting point, the problem with this kind of evidence is that a similar argument exists against the universality of IDS. Again – several anthropologists have reported that mothers do not alter their speech when talking to children (Ochs, 1982; Pye, 1986; Ratner & Pye, 1984).

In addition, work by Watson-Gegeo and Gegeo (1986) suggests that the Kwara'ae (Melanesian group of the Solomon Islands) caregivers modify their speech register in similar ways to 'babytalk' found in other societies (Watson-Gegeo & Gegeo, 1986). Although the authors report linguistic variation (simplification of speech) when talking to young children, they do not provide any systematic analysis of the speech in that culture.

In addition to the ethnographic observations of speech modification directed at infants in small scale societies, mothers have also been noted to sing lullabies to infants across a wide variety of cultures (Trehub, Unyk, & Trainor, 1993). Although the lullabies tend to vary in their acoustic properties, many contain linguistic content about cultural values. Trehub, Unyk and Trainer (1993) investigated mothers singing in the presence and absence of their infants in an urban center in India and Canada. Although they do not report acoustic analysis of the vocalizations, they find that mothers in both cultural settings sing to their infants in a distinctive and recognizable way – different than songs sung in the absence of an infant. In their experiment, they recorded mothers in both

cultures singing to their infants, as well as singing in the absence of anyone. Later, they played the songs for participants in a lab setting and they were reliable in their ability to identify the infant versus adult directed song in both cultures (Trehub, et al., 1993). We also know that the musical qualities of infant directed song modulates arousal of infants (Trehub, 2001).

Cross-language evidence for IDS

In addition, evidence exists for a vocal prosodic 'signature' for different affective communicative contexts across several contrasted languages (Ferguson, 1964). For example, Fernald and colleagues (1989) recorded mothers speaking to their infants in German, French, Italian, and Mandarin and acoustically analyzed the prosodic contours of the speech (Fernald, et al., 1989). They found that different communicative contexts elicit a similar prosodic form – for example, the acoustic properties of a mother comforting, prohibiting, approving, or getting the attention of a young child across these languages are distinctly different across these intention categories and similar across languages. When participants are presented with only the prosodic contour of speech languages that they are unfamiliar with, they are significantly better at determining the intention when the speech is infant directed, versus adult directed (Fernald, 1989).

Such cross-language similarity suggests that there may be universal features of infant directed speech which are language-independent and potentially universal. These findings were also supported by cross cultural evidence conduted with a South American hunter-horticulturalist group known as the Shuar in Ecuador (Bryant & Barrett, 2007). Bryant and Barrett recorded English speaking mothers talking to infants as well as adults and extracted the intentional categories (prohibition, approval, comfort and attention) for both kinds of speech. They played this speech to adult Shuar participants and found that

they were able to distinguish adult from infant directed speech as well as identify the intention categories of both kinds of speech, but they performed significantly better at identifying the intention categories when presented with infant directed speech (Bryant & Barrett, 2007).

Evidence for culture specific forms of IDS

Although there appears to be a convergence of evidence for the universality of infant directed speech, some have argued against the universality of this behavior, suggesting that vocal modification is a phenomenon of western or industrialized cultures who have a strong emphasis on formal education and language learning (Pye, 1986; Ratner & Pye, 1984). Ratner and Pye gathered speech samples from three Mayan mothers and two American mothers speaking to their infants and compared it to their speech directed toward an adult. They analyzed the acoustic properties of the speech and concluded that the mean fundamental frequency (F0 or pitch) was not raised in the same manner as with American mothers (Ratner & Pye, 1984). Specifically, they report that two out of three Mayan mothers actually decrease their pitch when addressing infants compared to addressing adults, with the third participant only raising their pitch marginally (6 Hz) (Ratner & Pye, 1984). In addition, Pye analyzed this data further in 1986, specifically looking for the prosodic modification features suggested by Ferguson in 1978 (Ferguson, 1978; Pye, 1986). He reports that Mayan mothers also do not increase their pitch range (a feature proposed by Ferguson to be a human universal), nor do they speak at a slower rate when addressing children (Pye, 1986). However, it is difficult to interpret these findings as they report data from only three subjects and the utterances they analyzed for infant directed speech may have been primarily prohibitive, which we know to have a decrease in pitch and increase in speech rate (Bryant & Barrett, 2007).

Pye gathered this data while conducting an interview with the Mayan mothers and reports that the nature of the mothers infant directed speech was primarily to encourage the child to comply with his, or the mother's requests (Pye, 1986). To summarize, they claim that vocal modification when speaking to an infant is a cultural and linguistic specific phenomenon, serving different functions for different languages, and is therefore not a universal and evolved mechanism.

Hypotheses

In order to understand the function and origin of infant directed speech I explored maternal speech to infants and adults in three cultures. Given the vast amount of ethnographic literature indicating that mothers modify their speech when addressing infants, I expect the specific acoustic properties of infant directed speech to be present across all societies, with mothers increasing their pitch, pitch range, and variation of their pitch when speaking to infants compared to when speaking with adults. Although my data do not directly address the question of the function of IDS, they provide a common ground for discussion of the speculation of this behavior as a species-specific product of evolution.

Method

Design

This project is a mixed design with each mother-infant dyadic observation producing two acoustic recordings (repeated measures): speech directed at an infant and speech directed at an adult. Data was collected from three cultures, Fiji, Kenya and US.

Participants and Location

A total of 43 mothers were recorded producing both IDS and ADS. These paired samples included 12 mothers from Fiji, 3 from Kenya, and 28 from the US. The pitch profiles of the Kenyan and Fijian mothers were highly similar, so due to the small Kenyan sample (3), they were included with the Fijian mothers to comprise a non-western group. Results without the Kenyan mothers included did not differ. The mean age of the infants was 8.3 months (*SD* 3.6 months, range 2-16 months) and there was no significant difference between the non-western (mean age 8.6 months, *SD* 4.5) and western groups (mean age 8.1 months, *SD* = 2.9) (*t*-test, *p*=.673) in the age of the infants. Note, however, that infant age information is missing for 3 infants. The mean age of the mothers was 31.3 years (*SD* = 6.1 years, range 21-45 years) and there was no significant difference between the two cultural groups (western and nonwestern) (*t*-test, *p*>.05) (western mothers mean age =32 years, *SD* = 4.9 years; non-western = 29 years, *SD*= 7.2 years). The average number of years of education achieved by the mothers was 14 years (*SD* = 4.2 years, range 7-22). There was a significant difference in the number of years of formal education achieved by the mothers (independent samples *t*-test *p*<.001) with non-western mothers obtaining on average 9.5 years (*SD* = 2.0) and western mothers achieiving17.0 years (*SD* = 2.1), however, education was not a significant predictor of any of the dependent variables and was therefore not included in the analysis model, however, we had education information for 25/43 participants (10 non-western, 15 western).

An additional thirty participants were analyzed for infant directed speech only, as we did not have recordings for both infant and adult directed speech for these participants. The mean age of the infants was 8.5 months (*SD* = 3.9 months).These

participants were nine Kenyan (mean age 9.7 months, *SD* = 3.4), 4 US (mean age 7.3 months, *SD* = 4.2) and 17 Fijian (mean age 7.9, *SD* = 4.2). We analyzed these 30 participants together with the 43 reported above – comprising a total sample size of 73 for a separate analysis of infant directed speech.

Fiji.

The study was conducted in two distinct locations in Fiji – the Yasawa Island Group, located in the northwestern group of Fiji Islands and the Lau Island Group, located in the southeastern group of Fiji Islands. These two locations are similar in that they both rely on subsistence agriculture and marine foraging and fishing for livelihood (Henrich, 2004; Sahlins, 1962). From the Fijian mainland of Viti Levu, the villages on Yasawa Island are 1-2 days of travel by boat, with air access, and the villages of the Lau Island group are 5 days by boat, with no other access (no air strip). Neither island had access to television or newspapers at the time of this study, with the exception of the medical station in the village of Tovu, Lau, which occasionally allowed public viewings of sports games on Sundays. This is of particular importance as the goal of this project was to examine universals therefore it was important to include samples that were devoid of significant western influence. Early childhood practices are similar in the two regions as children are taken care of primarily by the mother in the first few years of life with help from other females in the village, but no significant allo-parenting. Typically, the mother receives help in household domestic chores while she tends to her infant in the first 3-6 months of life. In addition, it is not uncommon for older siblings or cousins to help out with childcare but rarely in the first year of life (at least not in any significant amount). The mother was the self declared primary caregivers for all of the infant-mother dyads in this study. Each village has population of less than 150 and there is no

secondary school on either of the island groups.. All participants were recruited by word of mouth after obtaining consent from the village elders to conduct the study in these regions.

Kenya.

The study was conducted in the eastern region of Kenya near the rift valley in Bungoma district. Mothers in this study were recruited and tested in Chemwa Village, a small village having a population of 1220, comprising 198 households, located near a large town center (Bungoma town). Access to electricity is limited in this village and most households in this region rely on small income stores and labor on sugarcane and maize crops for a daily wage. All mothers in this sample were self-declared primary caregivers.

USA.

The study was conducted at a laboratory in a city in the south eastern region of the United States. All mothers were recruited from a database comprised of families recruited by a variety of recruitment methods such as mailings, local daycare centers and birthing centers. All mothers were self-declared primary caregivers.

Material

The equipment and materials used for this study were a video camera (Sony DCR-SR45), video editing software (*i-movie*), acoustic analysis software (*pratt*).

Procedure

Prior to testing, informed consent was obtained by a native speaker in each of the locations. After consent was obtained, mothers and their infants were brought to the testing location and seated in a quiet corner of the room or outdoor area. They were asked to interact naturally with their infant, with the goal of keeping the infant content for ten

minutes (see Appendix A). Both the mother and infant were seated on the floor, with the infant facing the mother and within the mother's arms reach. The mothers were asked not to pick up the infant however touching was allowed and was at the discretion of the mother. They were also told that if the infant cried we would stop the camera, but if the infant fussed, they could signal to us to stop and that we would only use the first few minutes of video and that would be sufficient for the study. Note that the mothers were not instructed to talk or play with their infants, rather, they were told to 'do whatever they preferred' given that the infant stayed within the view of the camera. In order to obtain adult directed speech, mothers were asked questions at the beginning and end of the interaction with her infant. She was asked general descriptive questions such as the age and sex of the infant as well as a few questions about her thoughts of the interaction. All samples were recorded digitally using a video camera (Sony DCR-SR45).

Coding & Analysis

Extraction of audio clips.

The first ten seconds of uninterrupted vocalization directed toward the infant (and toward the adult for adult directed speech) was selected and extracted for the speech sample. Note that a vocalization was any utterance or sound coming from the adult while engaging with the infant (or adult), but did not include sounds derived from only lip movements (raspberries). These vocalizations were extracted using i-movie software and exported as uncompressed waveform audio files (44.1 kHz, 16 bit, Mono). As the primary goal of the original design was to capture episodes of free interaction between the mothers and infants, some mothers had very little or very short episodes of adult directed speech. In instances where adult directed speech was less than 10 seconds, we captured any instance of adult directed speech (at times this occurred over multiple

vocalizations). Background and infant noise was not edited out at this stage, rather it was removed during the acoustic analysis. However, if the infant vocalized consistently for more than three seconds, then it was considered an interruption and the next ten seconds were captured instead.

Acoustic analyses.

The clips were analyzed using acoustic analysis software, Praat 5.2.21. We calculated the fundamental frequency (F0) values which corresponds perceptually to the 'pitch' that we hear in vocalizations. Fundamental frequency is extracted from the vibration rate of the vocal cords and the result is the highest common denominator of the harmonic series (need more here and reference). These were calculated using an autocorrelation method which is a statistical procedure used to determine the similarity and patterns between multiple observations as a function of the time (highest common denominator of the average frequency during a vocalization). Octave errors and other analytical errors were removed by hand, or fixed through pitch setting adjustment. Default pitch settings suggested by Praat were used for women (120 Hz – 600 Hz) but changes to these settings were done on a case-by-case basis after visual inspection of the F0 values, never exceeding +/- 20 Hz adjustment in the lower limit, and +/- 60 Hz in the higher limit. F0 standard deviation (F0 SD) and F0 range were used as measures of pitch variation. F0 range was measured by subtracting the minimum F0 from the maximum F0 value for each speaker.

Because of the spontaneous nature of the recordings, many sounds in addition to the mothers vocalizing were present, and had to be edited out. All parts of the recording that included non-target vocalizations (e.g., other people talking, crying babies, overlapping speech, animals, etc) were removed prior to analysis, and some recorded

clips were not able to be analyzed (n=5) due to excessive non-target vocalizations. Overall, in the IDS clips 75% of the original recordings were retained on average. For adult-directed speech (ADS) recordings, clips were shorter and more variable in length, however, 76% of the recordings were retained in the analyses, comparable to the IDS samples.

Results

A repeated measures ANOVA was conducted, with speech type (IDS or ADS) as a within subjects factor, country (western and non-western) as a between subjects factor, and the fundamental frequency (pitch or F0), pitch SD, and pitch range as the dependent variables. All main effects of speech type were significant. Both western and non-western mothers used higher pitch (F0) when speaking to infants than when speaking to adults, $F(1, 41) = 16.47$, $p < .001$, partial $\eta 2 = 0.29$ (medium effect). See Figure 1.0. Both groups also had greater pitch variation (F0 SD), $F(1, 41) = 16.38$, $p < .001$, partial $\eta 2 = 0.29$ (medium effect), see Figure 2.0, as well as greater pitch range in their speech (max F0 – min F0), $F(1, 41) = 19.79$, $p < .001$, partial $\eta 2 = 0.33$ (medium effect), see Figure 3.0. Western and non-western mothers did not differ significantly on any of the pitch dimensions, other than a marginal difference in overall pitch in infant directed speech, with western mothers using higher overall pitch, $F(1, 41) = 3.19$, $p = .08$, partial $\eta 2 = 0.07$ (small effect). Recorded clips varied in the percentage of usable sound for acoustic analysis and this was included in the model as a covariate, but was not significant ($F < 1$). See Table 1 for pitch data of all speech in paired samples.

Thirty additional mothers (26 western; 4 non-western) were recorded only producing IDS, therefore I conducted a separate analysis examining only the pitch

profiles of infant directed speech (and not adult directed) of all 73 mothers. Again, there were no significant differences between Fiji and Kenya therefore I am including both countries as one non-western group for comparison with the western group (US). I conducted a multivariate linear regression analysis with country (western or non-western) as the fixed factor and pitch (F0), pitch variation (F0 SD), and pitch range (F0 R) as the dependent measures and infant age, sex of infant, mother's age and education level as covariates in the model. There was a significant main effect of country for the dependant variable pitch, $F(1, 71) = 9.38$, $p < .01$, partial $\eta 2 = .117$ (small effect) and pitch range, $F(1, 71) = 4.212$, $p < .05$, partial $\eta 2 = .056$ (very small effect), however, this effect disappears when we enter the covariates education and age into the model. Maternal age was a significant predictor of overall pitch, $F(1,71) = 7.15$, $p < .05$, partial $\eta 2 = .273$ (medium effect) – see Figure 4.0 - and the number of years of education achieved was a significant predictor of overall pitch, $F(1,71) = 6.40$, $p < .05$, partial $\eta 2 = .252$ (moderate effect – note that this trend exists for the data of the 43 mothers) and pitch variation (F0 SD), $F(1,71) = 5.32$, $p < .05$, partial $\eta 2 = .219$ (medium effect). See Figure 5.0 and 8.0. As mothers increase in age, the degree to which they increase their pitch decreases, when speaking to an infant. However, as the number of years of education achieved by mothers increases, the degree to which they increase their pitch and pitch variation during infant directed speech increases.

Although I did not have adult directed speech recordings for these additional thirty mothers, after finding that age and education are significant predictors of infant directed speech, one might wonder if these variables are also significant predictors of adult directed speech (43 mothers). In other words, is infant directed speech shaped by

mothers' age and education, or is their general speech affected by these two variables? In order to examine this question, I conducted additional analysis of adult directed speech and there were no significant findings to report. Age and education levels have an impact on the degree to which infant directed speech changes, however, they do not impact adult directed speech. See Figure 6.0 and 7.0.

Also, the sex of the infant was a significant predictor of pitch variation $F(1, 71) = 5.67$, $p<.05$, partial $\eta 2 = .230$ (medium effect), with mothers producing more variation (pitch standard deviation) with males than with females.

Lastly, to further explore the data, I examined the difference between the mean fundamental frequencies (pitch) of adult directed and infant directed speech for each individual participant pair in order to determine whether each individual pair had an increase in their pitch when addressing infants. Out of the 43 mothers, seven mothers showed the reverse trend for pitch, with their mean F0 for adult directed speech exceeding the mean F0 for infant directed speech. Six were from the US and one was from Fiji.

Discussion

Universality of IDS

The question of the universality of infant directed speech is not trivial; it is central to questions of the evolution of human sociality. Many have speculated on the function of infant directed speech - ranging from perceptual word segmentation and language learning to the communication of intention and emotion. Although my data do not directly address these questions, they do provide a solid framework for discussion rather than speculation based on selective observations. I provide the first comparative analysis of the acoustic properties of infant and adult directed speech in a small scale society.

To briefly summarize, the data provide evidence of common acoustic features of infant directed speech in three culturally distinct societies, demonstrating that the behavior is not specific to industrial or western societies. I report a cross cultural difference in pitch which disappears when I factor age and education into the model as predictors. As mothers increase in age, the degree to which they raise their pitch when talking to an infant decreases. In addition, as the level of formal education obtained increases, the degree to which mothers raise their pitch also increases. However, age and education are not significant predictors of any of the three dependent variables in adult directed speech. This suggests that age and education have an impact on mothers' infant directed speech – however, it is not clear whether 'culture' is, in fact, producing this difference. Specifically, we see a higher level of education and age of mothers in the US, yet it is unclear whether being American or simply the number of years of education and age are driving this difference. Although the variance is explained by the predictor variables age and education, it is unclear what is explaining the predictor variables. It may be number of years of education and age, for example, or a value and belief system which is acquired with age and education. Without data from a more homogeneous sample (with respect to age and education) from all cultures, it is not possible to determine this.

When comparing the performance of each individual dyad for adult and infant directed speech, I discovered that seven out of 43 mothers show the reverse trend – speaking in a higher pitch to adults than to the infants. I can only speculate on why this is the case. Upon closer inspection, I noticed that six of these mothers were from the US and one from Fiji. I suspect that the US mothers may be nervous, and possibly hyper-

aware of being evaluated for their parenting skills, therefore, when speaking to the experimenter they were possibly embarrassed because of the difficulty or fussiness of the infant. In contrast, it was not uncommon for Fijian mothers to scold or punish their children during the experiment. Although it is merely an impression based on observations, this is how I would interpret the data from the US mothers showing the reverse trend.

IDS as an Adaptation

Unlike breastfeeding and attending to physical needs of an infant, vocal adjustment while addressing an infant is not observed in other primates (Fernald, 1992). Other mammals nurse, hold, and rock their infants, but none have been observed altering their vocalizations in the ways that humans do. Although some modified gestures have been observed in chimpanzee mothers with their infants, no vocalization resembling the properties of infant directed speech has been observed or documented (Falk, 2004). Dean Falk has speculated at length regarding the evolutionary history of this universal and species-specific behavior (2004). She argues that an increased juvenile dependency period led to a selection shift to mothers who were particularly skilled at maintaining close proximity to their infants through gestures and vocalizations.

Others have proposed that infant directed speech facilitates emotion development in infants (Trainor, Austin, & Desjardins, 2000). Under perspective, the unique characteristic of infant directed speech is the emotional expression in the speech. Trainor and colleagues (2000) compared adult and infant directed speech on emotion terms and report that the infant-adult directed speech modification disappears when we examine emotion terms only. The striking thing about our speech to infants is how emotionally laden it is compared to our ‘emotion restricted’ adult speech, however, I would argue

against this idea, suggesting that we would then expect to find cultural differences as there are significant differences across cultures in the display rules regarding emotions. In addition, although we did not investigate specific speech terms individually, the pattern of ids speech appears to hold even for speech on 'non-emotional' or non-social topics such as object orientation (Trainor, et al., 2000).

Some have argued that the cross linguistic consistency that we see in vocal modification when addressing an infant reflects expressions of affect that are associated with the physical response to the current situation – and thereby providing important information about the current situation. For example, many studies suggest that an increase in pitch and pitch range correlate with happiness and positive emotional expressions, whereas negative expressions typically correlate with a decrease in pitch and a smaller pitch range (Cosmides, 1983). Some biologists have found a similar correlation in animal vocalizations (E. S. Morton, 1977). Such evidence provides a framework for an evolutionary story about the modification of speech for communication of emotion and intention.

Limitations

For decades, linguists have reported the richness of infant directed speech in great detail – from altering the prosody of speech, to adjusting the content and vocabulary to accommodate the infant. My findings are limited in that they explore only one aspect of a complex behavior. In order to fully understand the function of infant directed speech, it would be important to examine the different communicative contexts in which it is used. For example, one might examine different speech samples in different cultural contexts - across different communicative situations between a mother and infant, specifically examining the acoustic properties of different *kinds* of infant directed speech. If we see

universality in the acoustic properties of speech by communicative context, it might be that this vocal modification evolved for communicating intention, and is not specific to language learning. On the other hand, in order to determine if the acoustic properties (not the simplified speech register) of IDS is a specific mechanism for facilitating language acquisition, it would be necessary to determine *if* it facilitates in language acquisition across languages, as demonstrated with infants in western societies with English and computer generated speech sounds. If the specific properties of infant directed speech facilitate language learning, then a different functional explanation would arise.

There are many different features of infant directed speech that were beyond the scope of this project. IDS is a rich and complex phenomenon of which I analyzed one aspect of the acoustic elements. Although cross-language analysis exists (Ferguson, 1978) in the linguistic content of infant directed speech, many of these are descriptive in nature and not a systematic analysis of the speech. Exceptions exist, however, the focus is typically on speech to toddlers and older children whereas, if we are to explore Fernald's argument that the function of IDS changes as different developmental problems arise, then it would be important to look at speech directed to very young children and infants. Therefore, one possibility would be to examine the speech utterances in this sample and compare it to that directed at adults – to look at the linguistic properties of the speech to adults and infants. The literature on the linguistic features of IDS is extensive, but not exhaustive and more needs to be done in small scale societies to understand universal elements to this simplified speech – in order to speculate on the function and origin.

Specific to mothers?

In Helen Morton's ethnography of Tongan life and specifically the care of infants, is that no matter what age, sex, or status the individual, everyone engages in playful

exchanges with infants (H. Morton, 1996). In my experiences in Fiji, I also observed this and found it to be distinct from other cultures that I had lived and worked in. I developed an interest in the role of fathers and the emotional exchanges that are commonplace to Fijian households. Morton speculates that the infant is outside of the status system, making the showing of affection and play as having no shame or danger in compromising the status of the individual. After observing these 'indulgent' interactions with men and children, I decided to capture some father-infant interactions with the goal of comparing this to cultures in which fathers are less involved in playtime with young infants.

Ten fathers also provided IDS and ADS speech recordings, seven from the US, and three from Fiji. This sample is too small for inferential analysis, but US fathers showed a similar pattern of IDS changes relative to ADS. When using IDS, US fathers used higher pitch (*M* = 148 Hz, *SD* = 13.2) then when using ADS (*M* = 135 Hz, *SD* = 37.8). Their pitch variation was only slightly higher in IDS (*M* = 40 Hz, *SD* = 14.4) than ADS (*M* = 37 Hz, *SD* = 21.7), but their pitch range was reasonably higher in IDS (*M* = 181 Hz, *SD* = 84.3) than ADS (*M* = 165 Hz, *SD* = 88.2). Conversely, the three Fijian fathers showed a reverse pattern when averaged. When speaking to infants, their overall pitch was lower in IDS (*M* = 151 Hz, *SD* = 13.2), than ADS (*M* = 159 Hz, *SD* = 5.45), as was their pitch variation (IDS: *M* = 21 Hz, *SD* = 10.6; ADS: *M* = 57 Hz, *SD* = 52.0), and their pitch range (IDS: *M* = 110 Hz, *SD* = 50.1; ADS: *M* = 167 Hz, *SD* = 113.1). This data is not conclusive, and suggests that further analysis is needed to determine whether IDS is specific to mothers.

Overall, the data presented in this project suggest that infant directed speech is a universal feature of maternal behavior and, given the preliminary analysis of the father-

infant speech, it appears not to be specific to mothers. Although several functional explanations have been proposed, more data is needed to determine what function this universal behavior satisfies.

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Tables and Figures

Table 1.0: Means and standard deviations of three pitch measurements in infant-directed and adult-directed speech across non-western and western cultural groups (*N*=43).

Speech Type	Non-Western			Western		
	F0	F0 SD	F0 Range	F0	F0 SD	F0 Range
Infant-directed	252(35.2)	55(22.4)	243(83.2)	287(57.4)	68(24.0)	302(91.7)
Adult-directed	231(39.7)	32(22.9)	121(100.0)	234(37.5)	50(21.5)	224(107.0)

Note: All F0 values in Hertz. Standard deviations in parentheses.

Figure 1.0: Mean fundamental frequency (F0) by speech type (IDS/ADS) and culture.

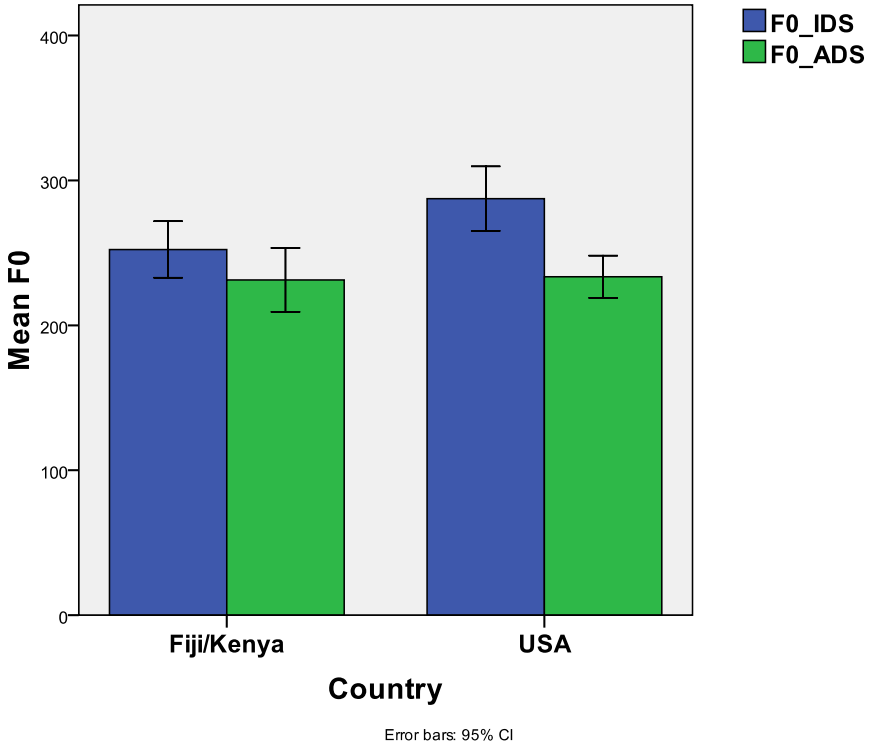


Figure 2.0: Standard deviation of fundamental frequency (F0) by speech type (IDS/ADS) and culture.

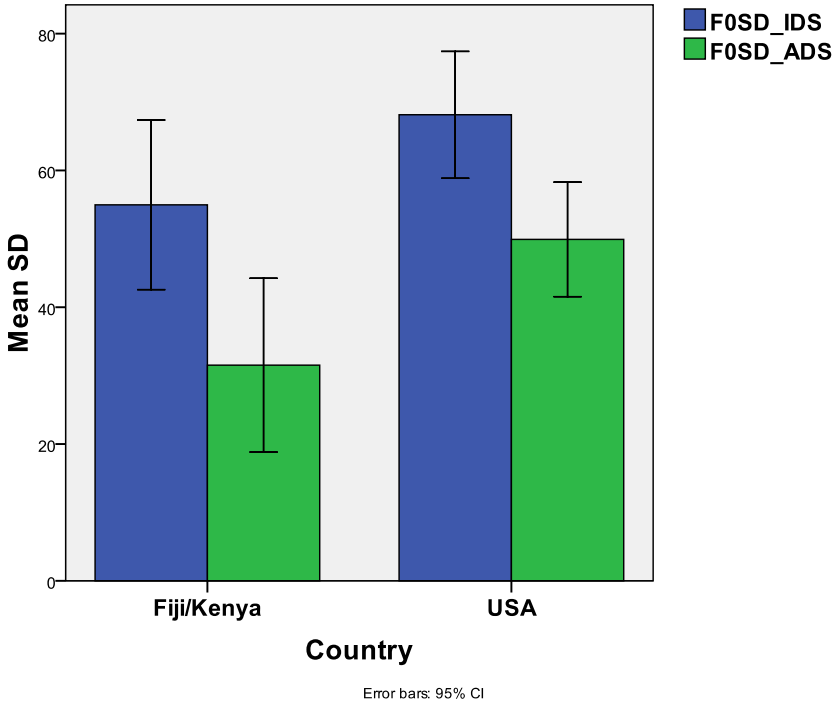


Figure 3.0: Average range of fundamental frequency (F0) by speech type (IDS/ADS) and culture.

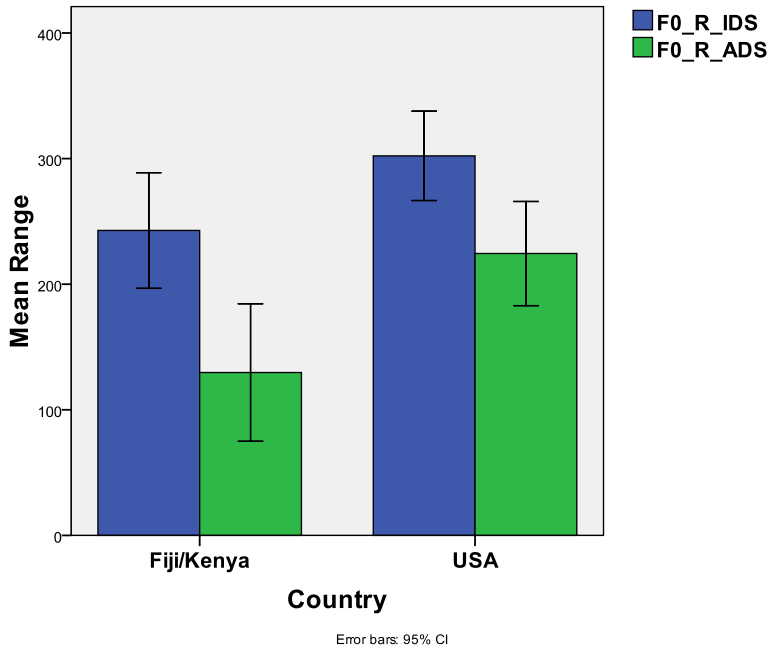


Figure 4.0: Mean fundamental frequency (F0) of infant directed speech and mothers' age in years (*n*=73).

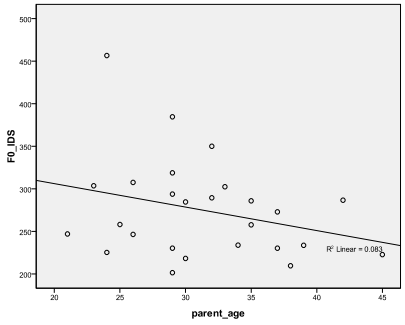


Figure 5.0: Mean fundamental frequency (F0) of infant directed speech and mothers' education in years (*n*=73).

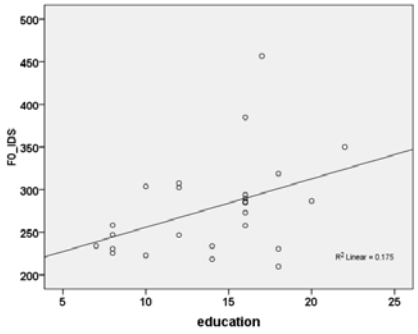


Figure 6.0: Mean fundamental frequency (F0) of adult directed speech and mothers' age in years (*n*=43).

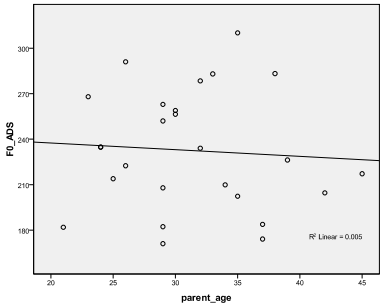


Figure 7.0: Mean fundamental frequency (F0) of adult directed speech and mothers' education in years (*n*=43).

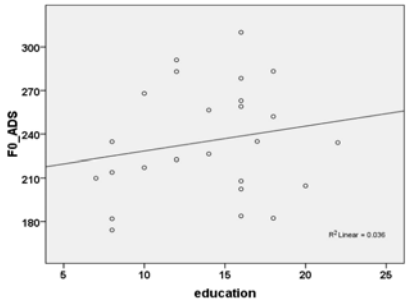
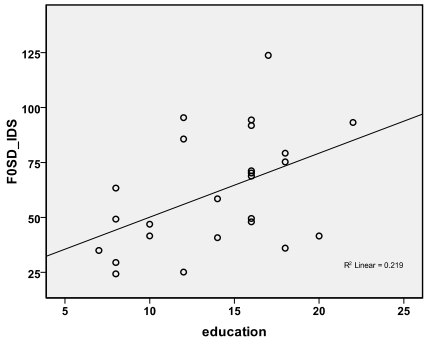


Figure 8.0: Standard deviation of fundamental frequency (F0) of infant directed speech and mothers' education (*n*=73).



Appendix

Appendix A (script)

ENGLISH

We will be videotaping you interacting with your infant. Please just do whatever you normally do with your infant to keep him or her engaged. We will be videotaping and ask that you continue to interact with your child/infant for 10 minutes. Please do not lift up your infant at anytime as we have the camera on the infant. Please do not use any props. Thank you very much.

SWAHILI

Tutakuwa tukichukua video yako ukihusiana na mtoto wako. Tafadhali fanya jinsi wewe hufanya kwa kawaida ili kumfanya angalau awe anafanya jambo, yani, asisubae .Tutakuwa tukichukua video na tunakuhimiza kuendelea kucheza na mtotowako kwa dakika 10. Tafadhali usimuinue mwanako kwasababu tumeangalisha kamera kwake. Tafahdhali usitumievihimili vyovyote. Asante sana.

FIJIAN/BAUAN:

O keitou na tabaka tiko na nomudrau veimaliwai kei na levumu. Keitou na qai kerea kevaka o rawa ni o cakava ga na ka o dau cakava e na veisiga me dau vakawelei koya kina. Keitou na tabaka me 10 na miniti na nomudrau tiko vata. Keitou kerea talega me o kakua ni o keveta na luvemu ka ni na tabaki tiko. E kerei talega me o kakua ni vakyagataka e dua na vakawele. Vinaka vakalevu.

Manuscript 3: Pedagogy in Six Cultures: Evidence for Universals

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Abstract

Humans are unique in their propensity to transmit complex culture forms with high fidelity. The debate regarding the mechanism underlying this ability is ongoing. Recently, a theory was proposed by Csibra and Gergely (2006) suggesting that the capacity to 'teach' by producing social communicative signals may be the driving force behind all other uniquely human abilities, such as the ability to use a symbolic system such as language and a sophisticated theory of mind. Ethnographers have challenged this theory with detailed observations taken over a number of years indicating an absence of teaching and instead, a reliance on observational learning in some cultures (Lancy, 1996, 2008). The argument, however, rests on careful observations rather than empirical evidence. To my knowledge, no empirical investigation for pedagogical signals across cultures exists. In order to examine the plausibility of Csibra and Gergely's theory of natural pedagogy, I examined 104 adult pairs in Bolivia, Faroe Islands, Fiji, Kenya, Ukraine and USA in an experiment in which one adult was motivated (but not explicitly instructed) to teach another adult how to make an origami figure. In the control condition, the adult made one fox in the presence of a potential learner, but was not motivated to teach the skill. According to the theory of natural pedagogy, I expected to find evidence of pedagogical signals in the experimental but not control condition. Videos were coded for eye gazes, hand movements, head movements, durations to complete one fox and the sequence of the steps produced. Results indicate that adults in all six societies produced pedagogical signals during the experimental but not control condition. Variability exists in the frequency and preferred category of signals in each society. These findings provide a common ground for discussion of the universality of pedagogical signals and further speculation into the uniquely human propensity to teach.

Introduction

Social Learning

Human infants come into the world prepared to learn from others early in life (Csibra & Gergely, 2006). Without this ability to learn from others, many human cultural habits, forms, and lifestyles would not be possible (Csibra & Gergely, 2006). Adults are sensitive to this infant *preparedness* and they provide them with the necessary information to learn their culture. How do they do this? The capacity for complex social learning via communication has been proposed to be a uniquely human and universal capacity (Csibra & Gergely, 2009, 2011).

The topic of social learning in development was first explored by the Russian psychologist Lev Vygotsky at the turn of the century (Bruner, 1990; Vygotsky, 1930/78). Vygotsky's theory of social learning states that individual cognition and language skills are a product of social interaction – also known as the constructivist perspective. He claims that a developing child attains certain cognitive milestones through interaction with others. He proposed that the more 'expert' other adjusts his behavior to 'teach' or provide scaffolding to the novice learner, in what he termed, the 'zone of proximal development' (Tharp & Gallimore, 1988). He states that adults or older siblings are sensitive to the capacities of a child (or zone) and they adjust their demonstrations and behavior to meet the needs of the child – demonstrating those skills which are attainable, but not yet mastered by the child (Tharp & Gallimore, 1988). There has been a convergence of thinking regarding the importance social learning in development however debates exist regarding the underlying cognitive mechanism that enables this kind of social learning and the transmission of cultural knowledge (Boyd & Richerson, 1985; Bruner, 1990; Gergely, Egyed, & Kiraly, 2007; Horner, Whiten, Flynn, & de Waal,

2006; Odden & Rochat, 2004; Rogoff, 1990; Tharp & Gallimore, 1988; Tomasello, 1999; Vygotsky, 1930/78; Whiten, McGuigan, Marshall-Pescini, & Hopper, 2009).

Debates surrounding the uniquely human capacity for social learning span the fields of neuroscience, psychology, anthropology and philosophy (Chaminade, Meltzoff, & Decety, 2002; Henrich, 2004; Meltzoff & Moore, 1983, 1997; Tomasello, 1999; Tomasello, Kruger, & Ratner, 1993). The argument has a long history among developmental and comparative psychologists – exploring the human tendency to transfer cultural knowledge forms to others through mechanisms such as teaching, imitation and other forms of learning (Boyd & Richerson, 1988; Tomasello, 1999). The propensity to transfer knowledge or information through generations while retaining the complexity is believed to be a species-specific trait (Gergely & Csibra, 2006; Tomasello, 2008). Although evidence exists indicating that other species have the *capacity* to transmit skills and information while retaining the complexity, humans utilize this capacity in ways that are unreachable to other species (Tomasello, 1999; Whiten & Ham, 1992; Whiten, Horner, & de Waal, 2005). What then, enables humans to transmit complex, opaque forms of cultural knowledge in great detail, over generations, while retaining the information that was created or added through cumulative modification?

Natural Pedagogy

Several theories have been proposed regarding what makes humans unique in their ability to generate and transmit cultural forms – the ability to create and use a symbolic system such as language, theory of mind, cooperation and empathy, self-consciousness, and social learning (de Waal, 2009; Henrich & Gil-White, 2001; Horner, et al., 2006; Premack, 2004; Rochat, 2009; Tomasello, 1999). A recent theory proposed

by Csibra and Gergly (2006) claims that humans are adapted to spontaneously transfer relevant cultural knowledge to others as well as to learn cultural knowledge from others. They authors refer to this mechanism as ‘natural pedagogy’ and they pose an evolutionary story suggesting that selection pressures for the transmission of accurate and complex information resulted in universal teaching behaviors that allow a teacher to provide specific information to a learner about which aspects of a situation are relevant and which ones are irrelevant. They refer to this social learning mechanism as ‘teaching’ or ‘pedagogy’ and the theory in general as ‘Natural Pedagogy’ or the ‘Pedagogical Stance’(Csibra & Gergely, 2006) and they claim that the capacity to teach others is what enables cumulative cultural transmission in humans and not other species. Teaching is defined by Csibra and Gergely as the ability to transmit information or skills through costly modification of behavior which would not otherwise occur in the absence of the learner (Csibra, 2007). They argue that this system enables a learner to selectively imitate only those features of a situation that are necessary and relevant - resulting in fewer errors and high fidelity in the transmission of information (Csibra & Gergely, 2006). Specifically, the authors suggest that humans, but not other species, evolved the capacity for producing ostensive communicative signals when motivated to transmit information to a leaner (Csibra, 2007). These pedagogical signals provide information to a learner – indicating that the event is a potential learning event, therefore enabling the learner to omit the imitation of irrelevant behaviors or steps (Csibra & Gergely, 2006). They specify that pedagogical signals are non-verbal behaviors which draw attention to and enable careful observation of an action or skill. Specifically, teachers provide these signals by making eye contact, repeating steps, providing communicative gestures such

as pointing, and performing slow exaggerated movements promoting the rapid transfer of complex information in learners who are adapted to detect these teaching signals (Csibra & Gergely, 2006). In the absence of such signals, the learner would be unable to discriminate between relevant and irrelevant steps and therefore imitate all behaviors indiscriminately. They claim that the imitation mechanism alone is insufficient to explain the process of cultural transmission of complex, cognitively opaque forms of knowledge (Gergely & Csibra, 2006). The emergence of this specialized communication system may form the basis for other uniquely human abilities such as the use of a complex symbol system and language and a sophisticated theory of mind ability (Csibra & Gergely, 2006).

The authors cite evidence for this theory in a review of the developmental literature, suggesting that many developmental phenomenon (such as gaze following, face preference in newborns, and imitation of novel acts) can be framed with respect to their new social learning mechanism – that the drive to learn from and teach others may facilitate a number of different infant social cognition phenomenon (Csibra & Gergely, 2006). Under their theory of natural pedagogy, it is this drive to learn from others that creates a 'pedagogical stance' in humans – with infants having an innate bias toward 'teachers' in the social environment and adults having an innate propensity to engage in 'teaching' behaviors (Csibra & Gergely, 2006). For example, the authors argue that the current functional explanations for face preference in newborns, gaze following in infants, and the imitation of novel acts in toddlers are insufficient. The preference for upright faces is suboptimal as newborns often see faces in a variety of orientations; therefore it is unclear why a preference for upright faces would have evolved. In addition, the tendency to imitate novel acts, even when it is clear that there is a simpler solution, has an

insufficient explanation, according to Csibra and Gergely (2006). The explanation offered is that imitation allows us to learn how to produce actions to achieve goals, yet, in many examples (see Meltzoff 1988) the goal could have been achieved by other, often simpler more efficient means (Csibra & Gergely, 2006). Lastly, gaze following is assumed to facilitate theory of mind – we follow the gaze of another in order to 'see what they see', yet often gaze cues do not result in accurate search tasks by infants (Csibra & Gergely, 2006). The authors propose that this social learning system precedes other forms of infant social cognitive abilities and can account for the array of behaviors observed in infant cognition (Csibra & Gergely, 2006).

The developmental literature provides evidence for a prepared learning system in infant (Sage & Baldwin, 2011; Topal, Gergely, Miklosi, Erdohegyi, & Csibra, 2008). Gergely and colleagues (2007) argue that the pedagogical signals enable an infant to interpret which aspect of information in the environment is relevant and important to attend to. Topal and colleagues (2008) report that infants are particularly tuned into and utilize pedagogical signals to help navigate ambiguous situations (Topal, et al., 2008). Sage and Baldwin (2011) conducted an experiment with infants and report that pedagogical signals, as well as other social signals, were superior in facilitating the production of a sequence of actions associated with a particular tool, compared to non-social signals. The series of experimental evidence suggests that infants may have a prepared learning system which is particularly tuned into communicative social signals (Gergely, et al., 2007; Sage & Baldwin, 2011; Topal, et al., 2008).

Alternative Theories of Social Learning

Others have proposed alternative explanations and there is a long history of the debate regarding the mechanism underlying this ability (Boyd & Richerson, 1985; Henrich & Gil-White, 2001; Horner & Whiten, 2005; Tomasello, et al., 1993; Whiten & Ham, 1992; Whiten, et al., 2005). Specifically, Tomasello and colleagues suggest that the human tendency to imitate other humans, in combination with other forms of social learning strategies are the essential features of social learning and cultural transmission (Tomasello, 1999, 2008). They provide support for their theory with a series of experimental social learning tasks comparing humans to non-human primates and conclude that the propensity for humans to imitate, work collaboratively, and as well as modify one's behavior to instruct another individual are the critical aspects of human unique social learning (Ashley & Tomasello, 1998; Tomasello, Carpenter, Call, Behne, & Moll, 2005).

They suggest that the propensity, not the capacity, to imitate is uniquely human and that the drive to model others is unmatched in chimpanzees and other non-human primate (Call & Tomasello, 1994). Specifically, they argue that chimpanzees rely on emulation whereas humans rely on imitation (Call & Tomasello, 1994). In short, imitation requires the learner to model the actions, whereas emulation requires the learner to learn about the end state – focusing on the environment, rather than the model. As imitation itself is insufficient to transmit opaque forms of complex knowledge with high fidelity; Tomasello and colleagues (1993) propose that three forms of cultural learning the propensity for humans to imitate, work collaboratively, and modify one's behavior to accommodate another individual – are the necessary features of cultural transmission (Ashley & Tomasello, 1998; Tomasello, et al., 2005; Tomasello, et al., 1993).

Whiten and colleagues provide evidence that non-human primates are capable of transmitting information through both imitation and emulation while retaining the features of the information being transmitted with high fidelity (Whiten & Ham, 1992). They suggest that humans ability to be 'flexible' in their social learning strategies, compared to chimpanzees who appear to be more conservative, enables this human unique ability (Horner & Whiten, 2005; Horner, et al., 2006; Whiten & Ham, 1992; Whiten, et al., 2005). The propensity for humans to imitate is the central feature of human social learning that distinguishes humans apart from other non-human primates and other species (Horner & Whiten, 2005; Horner, et al., 2006). Support for this perspective exists in literature examining human children and non-human primates engaging in a variety of social learning tasks, indicating that non-human primates have the capacity to engage in a range of social learning behaviors – including emulation and imitation and the transmission of behaviors through generations. This literature also demonstrates that human children have a tendency to over-imitate at the expense of efficiency whereas chimpanzees, although capable of both imitation and emulation, are more conservative in imitation, and instead, typically emulate (Horner & Whiten, 2005; Horner, et al., 2006). The authors of this research claim that this difference in the degree to which they utilize their social learning tool, is the central feature of human social learning that distinguishes humans apart from other non-human primates and other species (Horner & Whiten, 2005; Horner, et al., 2006).

Another theory of cultural transmission has been proposed by Boyd and Richerson (1985) and expanded upon by Henrich and Gil-White (2001). Boyd and Richerson proposed several possible mechanisms by which information is transmitted –

conformist transmission, success-bias and prestige-bias, suggesting that we copy those who have prestige or success and also follow the traditions and methods adopted by the majority in a group. Henrich and Gil-White expanded their theory, arguing that humans are equipped with a 'prestige-bias' mechanism which drives them to observe and imitate prestigious individuals and provide evidence from ethnographic records (Henrich & Gil-White, 2001; Henrich & McElreath, 2003). Specifically, they propose that the 'selection' occurs at the level of the model, not the actions being imitated. They provide evidence demonstrating that potential learners over-generalize the knowledge of prestigious individuals and selectively imitate those with prestige over others making it unnecessary for learners to identify irrelevant from relevant behaviors; instead, the selection process occurs at the forefront when deciding *who* not *what* to imitate (Chudek, Heller, Birch, & Henrich, submitted for publication; Foulsham, Cheng, Tracy, Henrich, & Kingstone, 2010; Henrich & Gil-White, 2001). In addition, developmental studies demonstrate that children not only selectively imitate knowledgeable individuals, but they also generalize and over-attribute the skills and knowledge of the individual (Brosseau-Liard & Birch, 2010). Other support for this theory comes from social network analysis examining who people go to for advice about learning valued skills in Fiji (Henrich & Broesch, 2011), as well as experimental simulations demonstrating that people prefer to copy successful individuals as a cultural learning strategy (Mesoudi, 2008).

Others have argued for different uniquely human capacities, other than social learning, as the driving force that sets us apart from other primates (Premack, 2004; Preston & de Waal, 2002; Rochat, 2009, 2010). For example, Rochat (2009) claims that the capacity for self-consciousness – the ability to reflect upon the self as an entity in the

minds of others is what makes us uniquely human. Many others have argued that the capacity to utilize a symbolic system, including language, and the social cognitive faculties which support it such as theory of mind, are the driving force behind human uniqueness (Premack, 2004). Some have claimed that the increased reliance on others leading to interdependency and the evolution of social cognitive capacities such as empathy and cooperation are the evolutionary driving force underlying human specificity (de Waal, 2009; de Waal & Tyack, 2003; Plotnik, 2010; Preston & de Waal, 2002).

Other scientists have put forth an argument stating that each of the potential social learning mechanisms is a sufficient strategy for cumulative cultural evolution (Caldwell & Millen, 2009). Caldwell and Millen (2009) conducted an experiment in which they manipulated the possibility for imitation, emulation, and teaching and found that all three strategies were successful in transmitting complex knowledge through the 'generations'. They speculate that the ability to transmit culture in a human unique way may rest on the capacity appraise the effectiveness of the potential strategies (Caldwell & Millen, 2009; Laland, 2004).

Absence of Teaching across Cultures

Lastly, many social anthropologists and few cultural psychologists have argued against the theory of natural pedagogy and participatory learning in dyadic interactions, as the central mechanisms of learning, suggesting that they are western-centric ideas proposed by scientists having a bias toward models of formal education (Lancy, 1996, 2008; Lancy & Grove, 2010; MacDonald, 2007; Paradise & Rogoff, 2009; Rogoff, 1990, 2003; Rogoff, Matusov, & White, 1996). A long list of ethnographic reports and detailed observations across cultures suggests that societies exist in which there is no teaching and instead, there is an exclusive reliance on passive, observational learning (Lancy, 1996,

2008; Lancy & Grove, 2010; Morton, 1996; Odden & Rochat, 2004; Paradise & Rogoff, 2009; Rogoff, 1990, 2003; Rogoff, et al., 1996).

Odden and Rochat (2004) have claimed that observational learning is the central mechanism of cultural transmission some non-western cultures, specifically Western Samoa (Odden & Rochat, 2004). Although the authors recognize that participatory learning may exist in this society, they claim that observation is the primary means by which cultural information – such as information regarding status and hierarchy, household chores, and livelihood skills - is passed on from adults to children (Rogoff, 2003). There may be multiple, complementary mechanisms which are utilized differently in different contexts and with no dominant universal mechanism (Odden & Rochat, 2004). Support for this claim exists through extensive reports from two years of ethnographic work as well as interviews, experiments and questionnaires (Odden & Rochat, 2004) indicating that the responsibility to learn is on the child in Samoa, rather than the adult's responsibility to teach them (Odden & Rochat, 2004). In addition, there is a reliance on observation rather than teaching, as indicated by self-reports and a number of observations by the authors of children gathered around adults while performing a task for multiple children to observe (Odden & Rochat, 2004).

In many non-western cultures, anthropologists have reported a complete absence of teaching, stating that the responsibility to learn is upon the learner, the child, and not the adult or knowledgeable other (Lancy & Grove, 2010). Ethnographic reports and careful observations of children living in diverse cultural settings indicate that children are expected to observe and learn culturally relevant skills and knowledge without assistance from others (Lancy, 2010; Lancy, Bock, & Gaskins, 2010; Lancy & Grove,

2010). This is in stark contrast to what is observed in the developmental lives of children in western cultures.

In order to examine questions about the learning process of a traditional hunter-gatherer society, Hewlett (1986) examined how the Aka pygmies of Central Africa learn a variety of life skills and cultural knowledge, including taboos, hunting, food gathering, and childcare practices (Hewlett, 1986). They presented a list of fifty skills to the Aka and asked them if they possessed each particular skill and if anyone had shown them how to do the skill. Overall, parents were reported as the largest contributor of knowledge and skills to children. This is in contrast to more recent work which claims that peers and others are the primary source by which information is transmitted in traditional farming societies (Harris, 1998; MacDonald, 2007). Interestingly, 'watching others' is reported as the next most important source for some skill knowledge, although this is primarily for group behaviors such as dancing (Hewlett, 1986). In addition, most skills were acquired by the age of ten years and all skills were acquired by the age of 15 years. This research is a significant contribution to the literature on cultural transmission, yet questions regarding the underlying mechanism of transmission remain. Recently, the authors expanded upon this work by exploring whether teaching exists in Aka hunter-gathers (Hewlett, Fouts, Boyette, & Hewlett, 2011). They report evidence for teaching with questionnaires, self reports, interviews and observations during field work (Hewlett, et al., 2011). This research is a significant milestone in the debate on teaching across cultures, however, it is yet unclear that what is meant by 'teaching' by these authors, constitutes the same non-verbal pedagogical cues indicated by Csibra and Gergely (2006). For example, Hewlett and colleagues give an example of pedagogy as the

following. They observed an Aka mother tying a sling around both toddler girls and boys and then placing a bottle in it to represent a baby (Hewlett, et al., 2011). Although observational data like this is rare, difficult to obtain, and rich, it is a subjective report and therefore open to interpretation with respect to the search for these very specific signals.

In earlier work, Rogoff and colleagues (1993) examined caregivers and toddlers engaging in collaborative activities in four different cultures (Rogoff, Mistry, Goncu, & Mosier, 1993). They examined the 'guided participation', specifically the guidance, support and challenge of caregivers and adults in each of the communities during culturally structured activities. They report marked cultural differences in the extent which the child is considered responsible for her learning – specifically between the middle class and non-middle class societies, and they attribute this difference to the societal structure and the segregation of children from adult activities (Rogoff, et al., 1993). Rogoff and colleagues (1993) report that there is more instructional teaching in middle class socioeconomic groups in which the child and adult are separated for much of the adult activities, whereas in the non-middle class groups, she reports more reliance on gestures, gazes and non-verbal signals. According to the findings of Rogoff and colleagues, one would expect to see more non-verbal pedagogical signals in communities in which the adult and child are not separated for most of their activities, such as the traditional and rural societies reported here compared to the western, industrial societies. To summarize, the essential characteristic in guided participation is that the child and adult engage in joint activities and that the adult accommodates and supports the goals of the child (Rogoff, et al., 1993). In a series of ethnographic descriptions, interviews and

natural observations in four societies– Guatamala, US, Turkey and India – she reports significant cultural variations across cultures in the ways in which the participants engage in guided participation (Rogoff, et al., 1993). Although this lends general support for the theory of Natural Pedagogy, Rogoff and colleagues (1993) coded for participation at a macro level without sufficient detail to determine whether pedagogical signals were actually present (e.g. 'Caregivers' demonstration – during child participation' p. 40). For example, one could imagine a situation where a category such as 'demonstration' may include passive observation of learners without the teacher altering his behavior in anyway.

In addition, my own observations working in Fiji agreed with the literature on observational learning as the primary process by which knowledge and skills are passed on and acquired. I conducted field research in Fiji over five consecutive summers and, although I observed many teaching opportunities (matt weaving, cooking, food and stick gathering, primarily with mothers and daughters), I did not see any specific episodes of teaching.

Although these accounts do indicate that there is a dominant reliance on observation in non-western societies and teaching in western societies, they are not entirely irreconcilable observations. Under the assumptions of the theory of Natural Pedagogy, the 'teacher' alters his behavior in some way in the presence of the learner – in a way that he would not otherwise do in the absence of the learner (Csibra, 2007). Therefore, it may be that the teacher in these ethnographic descriptions was, in fact, modifying his behavior by slowing down, or adjusting the way he or she fishes or weaves, to enable the learner to witness certain important features of the skill. In order to

determine whether this may be the case, and whether or not the theory of Natural Pedagogy is one plausible explanation into the uniquely human capacity to transmit cultural knowledge, experimental evidence is needed.

Method

Design

This was a mixed design with condition (experimental and control) as a between subjects factor and phase (baseline and transmission) as a within subjects factor.

Participants and Location

The data presented below are from six societies: Bolivia, Faroe Islands, Fiji, Kenya, Ukraine and United States. I collected data from three societies (Fiji, Kenya and USA) and my collaborators collected data from Bolivia (M. Gurvin, C. Von Reuden), Faroe Islands (M. Schug, R. McElreath) and the Ukraine (M. Kanovsky). This project was part of a larger project investigating questions pertaining to philosophical questions of culture and mind, supported by the Arts and Humanities Research Council in the UK. The Culture and the Mind project recruited anthropologists, economists, philosophers and psychologists to address questions with an interdisciplinary approach. I was invited to participate in the discussion at the earliest stages of questions pertaining to social learning and pedagogy and was instrumental in the design and therefore invited to lead the project. I was responsible for every aspect of synthesizing the data, coding, analysis and writing. The cultures were selected based on the individual expertise of the researchers recruited for the project. However, it was important to have a small-scale society which has had little influence from western culture, in the sample. The field sites in Fiji and the Tsimane in Bolivia satisfy this requirement, therefore enabling us to better examine the question from the perspective of how our human ancestors may have lived.

Bolivia.

The Tsimane make up approximately 9000 people in the region east of the Andes and the average village size is approximately 100 people, although more than half have fewer than 50 people. The Tsimane forager-horticulturalist group live in a region of Bolivia which is only accessible by dirt road or by river, however, seasonal flooding often makes access difficult. Tsimane is the primary language, but Spanish is spoken by many. Although integration into the market economy has increased the amount of contact with urban centers in this region, they daily life of most individuals in this region consists of minimal western exposure, with no electricity or media. In a study conducted in 2001, 64% of the population in this region reported no schooling, 29% had fewer than three years of primary school, 5% had completed the fourth or fifth grades and 1% had some secondary education (Reyes-Garcia, 2001).

Faroe Islands.

Situated between Norway and Iceland, the Faroe Islands are primarily inhabited by people of Norwegian decent. The population is 40,000 with most people living in villages of fewer than 500 people. Most villages are along narrow coasts with steep mountains behind them. The main forms of economic activity are fishing and sheep herding, with people in the large towns having office jobs. Most people have achieved high school education. The 24 dyads from the Faroe Islands were tested in the largest town on the island Tórshavn (pop. 19,000), however, the majority were from smaller towns and villages (rural).

Fiji.

This study was conducted in two villages in the northwestern part of the Fijian islands – the Yasawa Island Group. Villagers in this region rely on subsistence

agriculture and marine foraging and fishing for livelihood. They are quite far from the Fijian mainland (1-2 days by boat to Yasawa) and did not have access to television or newspapers at the time of this study. This is of particular importance as the goal of this project was to examine universals therefore it was important to include samples that were devoid of significant western influence. Each village has a population of less than 150. All participants were recruited by word of mouth after obtaining consent from the village elders to conduct the study in these regions.

Kenya.

The study was conducted in the eastern region of Kenya near the rift valley in Bungoma district. Participants were recruited by word of mouth from villages near Bungoma town, and tested in the center of Bungoma town. The population of the villages is approximately 2000-3000 and is led by one village headman or head woman. The villages did not have electricity at the time of this study. Most households in this region rely on income from small scale businesses or small scale agricultural activity (cash crops). In addition, most rely on small scale kitchen farms to support the needs of the family. Swahili is spoken by all participants, in the villages surrounding Bungoma, and English is spoken by many, however, Luhya is the primary spoken language in the region. The urban centers consist of all the tribes of Kenya, whereas the rural areas surrounding Bungoma consist primarily of Bukusu which is a sub tribe of the Luhya tribe of western Province of Kenya. I did not test participants in a control condition at this site. Time and electricity limited my sample size to seven dyads.

Ukraine.

The study was conducted in the region of Storozhnitsa, western Ukraine, south-west of the town of Uzhgorod in the district Transcarpathia. Agricultural economic

activities play a central role in this region with most people, including professionals, earning some income directly from agriculture. There was no control condition at this site.

USA.

The study was conducted at a laboratory in a city in the south eastern region of the United States. All participants were recruited from classes on a university campus and were from middle to upper class of American society.

Participant descriptives.

Data from 104 dyads is presented below (see Table 1.0 and Table 2.0), however 13 additional dyads were tested but unusable due to experimenter error (5), video malfunction (3), the learner knew the task already (3) or the dyad did not complete the task (2).

Age difference.

Participants were recruited by random selection of available individuals in each society. They were paired by the primary researcher at each site with the goal of pairing individuals of the same sex and approximate age. All dyads were same-sex, however the age difference between the two paired individuals varied but was not significantly different across cultures, or condition as indicated by a univariate analysis of variance with age difference as the dependent variable and culture and condition as the between subjects factor, $F(5,103)=.374$, $p=.865$.

Age of teacher.

The mean age of teacher participants across all of the sites and conditions was 29.5 years (*SD* 11.5). There was significant difference in the age of the teachers across cultures, $F(5,103)=7.321$, $p<.001$, as indicated by a univariate ANOVA with teacher age as the dependent variable and culture and condition as the between subjects factors. Post hoc (LSD) analysis indicates that the age of teacher participants in the US was significantly different from all other cultures except Kenya; Bolivia was significantly different from all other cultures except Kenya; Kenya was significantly different from Fiji and Ukraine; Fiji was significantly different from Bolivia, Kenya and the US; Ukraine was significantly different from Bolivia, Kenya and US. There was no clear West/non-West difference in the significant difference in the age of the teacher, however, due to the significant difference across cultures, age of teacher was factored into the analysis as a covariate in the model at each step but was removed because it was not a significant predictor of any of the dependent measures.

Age of learner.

The mean age of the learner participants across all of the sites and conditions was 28.2 years (*SD* 12.6). There was significant difference in the age of the learners across cultures, $F(5,103)=4.706$, $p<.001$, as indicated by a univariate ANOVA with learner age as the dependent variable and culture and condition as the between subjects factors. There was also a significant difference in learner age by condition, $F(5,103)=10.054$, $p<.01$, with participants in the experimental condition being on average 8.3 years older than participants in the control condition. There was no culture by condition interaction. Post hoc (LSD) analysis reveals that there was no clear West/non-West difference in the significant difference in the age of the learner with the largest difference being between

the US and the Ukraine. The US learner participants were on average 18 years older than Ukraine learner participants. The age of the learner was factored into the analysis as a covariate in the model at each step but was removed because it was not a significant predictor of any of the dependent measures.

Teacher education.

I conducted a univariate ANOVA on the maximum number of years of formal education reported by teachers with culture and condition as the between subjects factors. There was a significant difference across cultures in the education levels reported by teachers, $F(5,103)=45.19$, $p<.001$, as well as a culture by condition interaction, $F(5,103)=2.74$, $p<.05$. Post Hoc (LSD) comparisons reveal that the US had significantly more formal education than all other cultures except for the Faroes who had significantly more than the US. The Faroes had significantly more education than all other cultures. Bolivia had the least amount of education than all the other cultures. Based on this, I would expect to see significantly more pedagogical behaviors with increasing education level in the teacher participants, specifically the Faroe and the US. See Table 2.0 for teacher age and education levels by culture and condition.

Learner education.

I conducted an analysis of variance on the maximum number of years of formal education reported by learners with culture and condition as the between subjects factors. There was a significant difference across cultures in the education levels reported by learners, $F(5,103)=31.9$, $p<.001$, as well as a culture by condition interaction, $F(5,103)=.040$, $p<.05$. Post Hoc comparisons (LSD) reveal that Bolivian learners had attained the least amount of formal education, significantly fewer years than all other

cultures. The US and Faroes had more education than all other cultural groups. The Ukraine was not significantly different from Fiji and Kenya.

Procedure

The primary researchers for each site were familiar with the culture and had lived there for at least six months (two summer field seasons). Data collection was led by the primary researcher, but delivered by an individual fluent in the local language. All scripts were translated from English into the local language and then translated by a separate research assistant back into English. Any discrepancies between the original English document and the final English document were addressed with additional translations. Participants were recruited to the testing location – an isolated, partitioned section of a room in a local dwelling. The entire session was video recorded. Prior to obtaining informed consent, the experimenter explained the basic design. This was a mixed design with a within subjects comparison as well as two conditions. The conditions are described in detail below.

Experimental Condition

Two participants were recruited to the testing location and the general procedure of the study was explained. The experimenter requested that one participant volunteer to be the first to participate. One participant volunteered and remained in the testing location (referred to hereafter as ‘teacher’) while the second participant (referred to hereafter as ‘learner’) moved to another location, unable to hear or see inside the testing area. The teacher learned a new skill – how to make an origami fox - by watching a video on a laptop computer. The goal of this phase of the experiment was to enable a baseline or within subjects comparison of the production of one fox without a learner compared to the production of one fox with a learner present. After the teacher demonstrated that she

mastered the skill by making one origami fox alone, without the video as a guide, the learner was brought back into the testing location and seated directly beside the teacher, with both participants facing the video camera. See Figure 1.0. The dyad was told that they will be given a fixed duration of time to practice together and that after the practice time the learner will be asked to produce as many as she can (alone) during a fixed amount of time for a 'test' phase. This is the critical phase of the experiment and referred to as the 'transmission opportunity' phase. It is explained that the dyad will be compensated (ten percent of a daily wage per fox) for each fox she produces in this test phase. The amount of money and duration of this phase varied per site, but the goal was to enable each dyad to produce 5 fox, equaling approximately ten percent of one days wage to be split between the two participants (See Table 3.0). The experimenter would decide if each fox was sufficient (to ensure that they were motivated to teach the steps rather than produce a few folds). After this phase, the dyad was compensated and thanked for their time. They were asked not to talk to anyone about the experiment and, instead, go directly about their daily activities. The participants were not instructed to teach and the word 'teach' is never used during the experiment. See Appendix A for full script.

Control Condition

The control condition was the same as the experimental condition except that there was no motivation for the teacher to 'teach' the learner the new skill. The learner was an observer and played no role in producing any fox during the experiment. The teacher was compensated for the number of fox that she produced while the learner observed. The instructions were modified to reflect this difference.

The entire experiment was conducted over a relatively short period at each location (less than one week in all locations) to ensure that the details were not discussed

with other community members and the primary experimenters at each location took measures to ensure this was the case. Participants were instructed not to talk to each other during the experiment.

Materials

The procedure was video recorded with a video camera (Sony DCR-SR45) and the stimuli were presented to the participants on a laptop (model and screen size varied moderately). The paper used was origami paper (7 x 7 inch). Two stimuli videos were recorded in the US and consisted of an adult female experimenter producing an origami fox without pauses or any deliberate demonstration (in other words – she made the origami fox in real time without any gestures or pauses for demonstration). The videos differed slightly in the steps used to produce the target origami piece, in order to track the fidelity of the steps produced during transmission of the skill. Both videos were comparable in speed and angle. The video was factored into the analysis at each step and was not a significant predictor of any of the behaviors and will therefore not be discussed further. See Figure 2.0 for illustration of the video.

Coding

The full duration of the experiment was video recorded for later analysis. Each of the videos was edited using *MacIntosh* video editing software *i*movie in order to extract the necessary phases for coding. As each society produced a variable number of fox in the 'transmission opportunity' phase, I coded the first fox produced by the teacher in order to compare across societies. Two phases of each video were extracted and coded for the behaviors produced – the production of one fox by the teacher alone (baseline) and the production of one fox by the teacher in the transmission opportunity phase (with the learner). The behaviors were coded using an event recorder (*Jwatcher* event recording

software) and I divided each behavior by the duration to produce one fox, resulting in a per minute metric for comparison.

There were four coding categories – hands, eyes, head, and steps – with several behaviors in each category (see Appendix B for coding scheme and Appendix C for ethogram). Behaviors produced by the teacher and the learner were coded for the transmission phase, and for the teacher in the baseline phase. The category 'hands' consisted of coding all hand movements such as manipulating own origami, manipulating other's origami, pause, gesture directing attention (e.g. point), gesture directing behavior (e.g. stop). Eye gaze consisted of coding the gazes to the individual's own work, gaze to the other's work, gaze at exemplar, gaze at other's eyes, or gaze away (anywhere other than previously mentioned). Head movements consisted of nodding, shaking, and no head movement. Steps consisted of the sequence of paper folds to produce the origami fox.

In order to develop a reliable coding system, two independent coders were trained on a random selection of videos. Once agreement was achieved on each of the behaviors, a new random selection of 30% of the videos was coded by all. Reliability was determined if the temporal sequence of codes was retained, as well as a time lag of one second. Reliability of greater than 70 percent agreement was achieved. See Appendix A.

Hypotheses

Although a substantial amount of literature exists on observational learning as the primary mode of social learning in non-western cultures, I expect to find evidence for pedagogical signals across cultures. I suspect that the pedagogical signals in western cultures may be more prominent and more exaggerated than in non-western cultures due to the emphasis on formal education. In addition, the literature reported by

anthropologists on observational learning is gathered primarily by western academics who may have an eye tuned into specific kinds of 'teaching' – more exaggerated and verbal, rather than the subtle non-verbal cues that may exist across cultures. To summarize, I expect to find evidence for the pedagogical signals, such as slowing down, producing more exaggerated movements to draw attention to certain features as defined by the Natural Pedagogy theory across all six cultures. I expect cultural variation to exist in the frequency of pedagogical behaviors with western cultures producing more cues due to the emphasis on formal education.

Hypothesis 1: Pedagogical signals across conditions and cultures.

I expect pedagogical signals to be present across all six cultures with significantly more pedagogical signals in the experimental versus the control condition in all of the cultures, with more referential gestures, gestures directing attention, more pauses, more manipulating the learner's origami, as well as more eye contact with the learner and more repetition of steps. We should also see more communicative head movements such as nodding or head shaking in the experimental versus the control. With respect to cultural variability, I expect the frequency of pedagogical signals to be greater in western cultures (US, Ukraine, Faroe) compared to non-western cultures (Fiji, Bolivia, Kenya) in the experimental but not control conditions.

Hypothesis 2: Pedagogical signals within-subjects control.

I expect there to be significantly more pedagogical signals in the transmission versus the baseline phase of the experimental condition, but not the control. I also expect no significant difference in the frequency of pedagogical signals in the baseline of the experimental condition and the transmission phase for the control condition.

Hypothesis 3: Duration to produce one origami fox across conditions and phases.

I expect the duration of the transmission phase to be significantly longer than the baseline phase in the experimental but not the control condition as well as no difference in the duration of the baseline phase of the experimental and the transmission phase of the control condition.

Hypothesis 4: Covariates as predictor variables of frequency of pedagogical signals.

I expect more education to be correlated with a higher frequency of pedagogical signals.

Results

I analyzed the frequency of behaviors produced by the teacher during the production of one origami fox. In addition, the duration of each phase was also compared across conditions and phases. The independent variables of age (teacher, learner, and age difference between the teacher and learner), education (teacher, learner and education difference between the teacher and learner) and sex of dyad were entered into each equation. Although some cultures differed significantly in the age and education level of participants, these were not significant predictors in any of the models, therefore they were removed from the analysis and will not be discussed further.

Hypothesis 1: Pedagogical Signals across Conditions and Cultures.

In order to determine whether people engage in pedagogical signals across diverse cultural settings, I examined the frequency of pedagogical signals in all cultures, expecting to find significantly more signals in the experimental transmission phase (opportunity to transmit the skill) than the baseline (making one alone) or the control phase (making one while another watches with no motivation to transmit). First, in order

to determine whether a significant difference exists in the signals during experimental versus control, I examined each category of dependent variables (hands, eyes, steps, head movements) separately in four separate multivariate analysis of variance's with culture (6) and condition (2) as the between subjects factors. Age and education of the teacher and learner and age and education difference between the pairs, and sex of the dyad, were entered as covariates in the model. Each separate ANOVA is reported below. Note that the assumption of independence of variables is debatable however I conducted a general linear model regression analysis on each of the dependent variables and found no difference in the results for each of the dependent variables.

Hands.

Four separate dependent variables were entered into the equation – manipulating the learner's origami, pauses, gesture directing attention (e.g. pointing) and gesture directing behavior (e.g. stop). There was an overall main effect of condition, $F(4,86)=8.33$, $p<.001$, partial $\eta 2=.279$ (large effect), observed power .998, with teachers' producing more 'pauses' $F(1,103)=28.58$, $p<.001$, partial $\eta 2=.243$(medium effect), and 'gestures directing attention' $F(1,103)=7.22$, $p<.01$, partial $\eta 2=.075$ (small effect) significantly more in the experimental than the control condition. See Figure 3.0.

Eyes.

I entered two of the five possible eye gaze behaviors produced by the teacher into a multivariate analysis of variance. The two target dependent variables were 'gaze at learner's origami' and 'gaze at learner's eyes or face'. Other behaviors coded but not included in this analysis were 'gaze at exemplar', 'gaze at own work' and 'gaze away'. There was an overall main effect of condition, $F(1,103)=53.35$, $p<.001$, partial $\eta 2=.551$ (large effect) with teachers' gazing more at the learner's hands in the experimental versus

the control condition, $F(1,103)=103.45$, $p<.001$, partial $\eta 2=.540$ (large effect), although this result is not necessarily a meaningful comparison given that the learner was not manipulating any object in the control.

Head.

Three different head movements by the teacher were coded for: 'nodding', 'shaking the head from side to side', and 'no head movements'. I entered the target variables nodding and shaking into a multivariate analysis of variance as dependent variables, with culture (6) and condition (2) as between subjects factors. Covariates are listed above. There was a main effect of culture $F(5, 99)=2.91$, $p<.01$, partial $\eta 2=.140$ (medium effect), and condition $F(2,102)=11.81$, $p<.001$, partial $\eta 2=.212$ (large effect). Overall, teachers nodded more in the experimental condition compared to the control $F(1,103)=23.01$, $p<.001$, partial $\eta 2=.205$ (small to medium effect). There was a culture by condition interaction $F(2,102)=6.34$, $p<.001$, partial $\eta 2=.176$ (medium effect) with some cultures shaking their heads more in the experimental than the control (US, Faroe) whereas Fiji had more head shaking in the control than the experimental (there was almost no head shaking in Bolivia, and there was no control group for Kenya or Ukraine).

Steps.

The number of steps demonstrated in video demonstration to produce one origami fox in version 1 was 9. The number of steps demonstrated in video demonstration version 2 was 8. In order to determine how many additional steps were produced (indicating repetitive steps), I subtracted the total number of steps for each version from the number of steps in the demo video for each version. The resulting variable is the number of additional steps each teacher produced, regardless of version. I conducted a univariate analysis of variance on the dependent variable extra number of steps produced by the

teacher during the transmission phase, with culture (6), condition (2) and version (2) as the between subjects factors. Covariates listed above were entered into the model. There was a significant overall main effect of condition with more extra steps being produced in the experimental group than the control $F(1,79)=13.01$, $p<.01$, partial $\eta 2=.141$ (small effect). See Figure 4.0. There was no significant difference by culture.

Hypothesis 2: Pedagogical Signals Within-Subjects Control.

I expect there to be significantly more pedagogical signals in the transmission (making one origami fox in the presence of the learner) versus the baseline phase (making one origami fox alone), in the experimental condition but not the control condition. I also expect no significant difference in the frequency of pedagogical cues in the baseline of the experimental condition and the transmission phase for the control condition. I conducted a repeated measures analysis of variance with all of the pedagogical signals (8) as the dependent variables and phase (2) as the within-subjects variable and culture (6) and condition (2) as the between subjects factors. Teacher and learner age, education and the difference in age and education of each dyad and the sex of the dyad were all entered as covariates in the model. There was an overall main effect of condition $F(8,77)=14.22$, $p<.001$, partial $\eta 2=.596$ (large effect) with more pedagogical signals produced overall in the experimental compared to the control condition. There was a significant within subjects contrast with the variables ‘gaze to learners hand’ and ‘gaze at learner’s face’, however this is not a meaningful comparison as there was no learner in the baseline phase. There was a significant within subjects interaction between

phase and condition $F(8,77)=13.70$, $p<.001$, partial $\eta 2=.587$ (large effect). Tests of within subjects contrasts between phase and condition reveal that teachers produced more head nodding $F(1,102)=10.43$, $p<.01$, partial $\eta 2=.110$ (small effect), pauses $F(1,102)=34.48$, $p<.001$, partial $\eta 2=.291$ (medium effect), and pointing $F(1,102)=6.84$, $p<.05$, partial $\eta 2=.075$ (small effect) in the experimental transmission phase than the baseline experimental or control, or the control transmission phase. This indicates that there were significantly more pedagogical signals in the presence of a potential learner when motivated to teach, compared to when producing one alone or with another individual observing.

Hypothesis 3: Duration to Produce one Fox across Conditions and Phases.

In order to test the hypothesis that the duration to complete one origami fox in the transmission phase of the experimental condition would be significantly longer than the transmission phase of the control condition or the baseline phase of either the experimental or control, I examined the dependent variable 'duration to complete one origami fox by the teacher' by entering it as a dependent variable in a repeated measures analysis of variance with condition (2) and culture (6) as the between subjects factors and phase (2) as the within subjects variable. There was a significant effect of condition $F(1,85)=8.52$, $p<.01$, partial $\eta 2=.091$ (small effect), indicating that teachers took longer in the experimental condition. Teachers took almost a minute longer to produce a fox in the transmission phase of the experimental condition, compared to transmission phase in the control condition. Within subjects contrasts indicate that participants took significantly longer to produce one fox in the transmission opportunity phase in the experimental condition than in the control condition or the baseline for the experimental or control condition (see Figure 5.0). This suggests that teachers are slowing down in the

presence of a potential learner, but not in the presence of an observer. There was no culture by condition interaction, indicating that this effect is valid for each culture.

There was also a main effect of culture $F(5,85)=3.29$, $p<.01$, partial $\eta 2=.16$ (moderate effect), indicating that some cultures were faster than others (see Figure 6.0). Specifically, when compared to the duration of the participants in the US, Bolivian's were more than 2 minutes slower to produce one fox on average (136 seconds) whereas Fijians were 80 seconds slower and Kenyans were 121 seconds slower to produce one fox in the transmission phase. Supporting my hypothesis, there was a within subjects interaction between phase and condition.

Hypothesis 4: Covariates as Predictor Variables of Frequency of Pedagogical Signals.

I expected more education to be correlated with a higher frequency of pedagogical cues, however, there was no significant effect of any of the covariates in the analysis.

Discussion

The overall goal of this project was to determine whether pedagogical signals exist in traditional, non-western societies. Csibra and Gergely (2006) suggest that humans have a unique capacity to teach and learn which enables the transmission of knowledge with high fidelity. They argue for a specialized mechanism enabling humans to transmit as well as receive knowledge. Although the debate regarding the mechanism underlying knowledge transmission is ongoing, the new component of this theory is the proposed mechanism for enabling selective imitation. Csibra and Gergely suggest that the ability to teach and draw attention to certain features of a skill or knowledge set enables transmission of relevant and not irrelevant information. As they provide an evolutionary story for this behavior, one essential component of this theory is that these signals must

exist in all human societies. The absence of such signals would make their theory falsifiable. However, a current debate exists between psychologists and anthropologists regarding the plausibility of this theory across human societies. Whereas psychologists claim that teaching must exist across societies, anthropologists have argued for an absence of this behavior and instead, a reliance on observational learning. In order to shed light on this debate, we designed an experimental procedure in which we motivated individuals to transmit a skill to another individual and coded the behaviors to determine whether there was a presence or absence of teaching cues.

To summarize, I found evidence for pedagogical signals across cultures. In support of my hypotheses, I report more pedagogical signals in the experimental compared to the control condition as well as fewer in the baseline phase of the experimental condition. Specifically, the teachers produced significantly more of the following behaviors (pedagogical signals) in the experimental versus the control condition of the transmission phase: *pause, gesture directing attention (e.g. point), nodding, head shaking, repeating steps,* as well as an increase in the *duration* to produce one origami fox. There was no significant difference in the following behaviors between the two conditions: *referential gestures (e.g. gesture indicating 'stop')* and *gaze at the learner's face.* The behaviors 'manipulate other's origami' and 'gaze at the learner's origami' will not be discussed as they are invalid comparisons across conditions as the learner did not have an origami in the control condition. The significant difference in these six pedagogical signals across conditions indicates the presence of 'teaching' signals across cultures.

I report only three cross cultural differences in the target dependent variables. First, there was a significant difference in head shaking across cultures with the US and Faroe Islands producing more in the experimental than the control, whereas Fiji produced more head shaking in the control condition compared to the experimental. There were no instances of head shaking in Bolivia. As Fijian teachers produced more head shaking in the presence of an observer compared to the presence of a potential learner, this leads me to question our interpretation of the dependent variables as pedagogical signals. Although we operationally defined a series of pedagogical signals according to Gergely and Csibra's theory, one might speculate on the function and meaning of each of the behaviors and further analyses may help shed light on these speculations. For example, we might examine what happens prior to and following a head shake. Does the learner produce an error? Is the teacher responding to the learner's behaviors or to their own? Such careful analysis of the data will enable a deeper understanding of the signals that we are measuring.

Further analyses of the pedagogical behaviors produced during baseline indicate that only 3 of the 8 pedagogical behaviors were produced significantly more in the experimental transmission phase than the experimental baseline or the control transmission phase. As expected, *nodding*, *pauses* and *gestures directing attention (e.g. point)* were produced significantly less frequently in the experimental baseline phase. *Referential gestures*, *gaze at learners face*, *head shaking, extra steps,* and *no head movements* were not significantly different at baseline compared to control. I interpret this to indicate that some behaviors are relied upon more than others for this specific skill of origami making.

Although less relevant to the central question of interest, there were cultural differences in the duration to produce one origami fox with Bolivians, Fijians and Kenyans taking significantly longer to produce one fox compared to Americans.

To summarize, I report evidence for specific pedagogical signals in six cultures. Although the data lend support for the Natural Pedagogy theory, other plausible explanations exist for the presence of pedagogical behaviors across societies. To be explicit with this logic, if I report that humans in every society demonstrate the capacity to laugh or deceive, this does not lead to the conclusion that laughing or deceiving are the universal mechanisms driving the evolution of our species. There are many other theories regarding the transmission of knowledge, as outlined in the introduction – from the propensity to imitate, to connect with others, the capacity for theory of mind, language development, the drive to collaborate, the capacity for empathy – to the prestige or success bias theory. In order to further explore the plausibility of these different theories more experimental analysis in combination with ethnographic reports must be done.

How do we reconcile these findings with the ethnographic reports suggesting an absence of teaching? There are three possible explanations for this discrepancy.

1. Teaching may look different. First, the absence of teaching observed by anthropologists might be due to the lens in which they are looking. Typically, the anthropologists carefully observing and reporting these differences are western, educated individuals who have developed an expectation for certain *kinds* of behaviors that classify as teaching. It may be the case that 'teaching' in other cultures is more implicit and non-verbal, as was measured in this project, not what formally educated individuals think of when they look for teaching. Typically, the concept of teaching elicits a mental model of

formal instruction – one teacher and many students, or explicit, verbal, unambiguous instruction. These behaviors may be products of a western educated model, therefore the claim that there is ‘no teaching’ in some societies may actually mean that there is no ‘western model’ of teaching.

2. Teaching is rare. Second, it is possible that ethnographers are actually ‘tuned into’ all forms of teaching, but rather teaching of any kind is rare in many societies and therefore the low frequency leads to the misinterpretation that it does not occur.

3.What constitutes ‘teaching’? Third, it is possible that some ethnographers would agree that teaching in this subtle form, can and does exist in some cultures. They are making the claim, rather that explicit instruction does not occur, not implicit teaching.

There seems to be an agreement among ethnographers that teaching is either absent or rare in many non-western, more traditional societies. Although this data provide evidence for the existence of teaching or pedagogical signals across societies - why are the reports of the frequency of these behaviors in natural settings so low? Some have argued that the more rapid the social change, the more reliant on pedagogy (Premack & Premack, 1998).We might speculate that in isolated communities with less reliance on technology or industrial advancements, there is less of a need for pedagogy, therefore in our natural observations, we see very little.

In order to fully explore the plausibility of this theory in light of ethnographic reports, let us return to the definition of teaching. Teaching is defined as the ability to transmit information or skills through *costly modification* of behavior which would not otherwise occur in the absence of the learner (Csibra, 2007). This definition encompasses any behavior facilitating transmission that is produced in the presence of the learner,

which would not otherwise be produced in their absence, including adjusting body posture to enable a better ‘view’ of a skill. Under this definition, the ethnographic reports of observational learning may fall into the category of ‘pedagogy’. If the teacher modifies her behavior in the presence of the learner, for example, placing the target skill or item of interest in better view of the learner, this behavior is so subtle that it may be impossible to detect without comparing to the teacher’s behavior in the absence of a learner. Such comparison, under controlled conditions, is not only difficult, but may be impossible to observe carefully and reliably during natural observations. What anthropologists are referring to as observational learning, may actually be a form of teaching under the Natural Pedagogy theory.

As with many experimental paradigms, there may be little direct external validity to this project as it is narrow in scope with respect to questions of teaching and social learning. The goal was to examine whether these behaviors were present or absent across societies and we succeeded in demonstrating that they do exist. However, there are many additional deeply interesting questions with respect to *how* cultural transmission occurs and which mechanisms of social learning are relied upon. The next step in investigating how information is passed on would be to conduct a more naturalistic observation in one of these societies, specifically examining patterns of transmission. For example, one might observe and record adults with their children during times of possible transmission, such as going on a hunt or a fishing expedition, weaving, cooking or gathering to examine which social learning mechanism is relied upon. Cross cultural projects such as these will help shed light on questions of what it means to be human.

Several other limitations exist with this project. First, formal schools are present in each of these societies and the influence of formal education is one potential (yet, unlikely) explanation for our universal results. In order to address this, one would need data from a non-western society with no exposure to formal schooling. The ideal culture for examining the universality of pedagogy would be a hunter-gatherer society with no exposure to western education. Although Barry Hewlett reports very little reliance on teaching with the Aka hunter-gatherer group in Central Africa, it was not examined at the same level of analysis as is required for this theory. However, we are currently collecting data with the Hadza hunter-gatherer group in Tanzania. Hopefully this data will further support the hypotheses of this project.

Second, problems existed with the design of the control condition. In this condition, a second participant is sitting next to the teacher, observing them, with no explanation given to the teacher regarding their presence. In addition, there were several pedagogical behaviors that could not be compared across the control and experimental conditions because of a lack of comparability. For example, we coded for the behavior *manipulate the learner's origami* and *gaze at the learner's origami* but these comparisons are invalid as the learner did not have an origami paper in the control. Therefore, we added a new control condition in collaboration with Gyorgy Gergely's laboratory at the Central European University in Budapest, as well as ran the original experiment with the original control. The critical features of this new control condition are the following: rather than have a passive observer as the learner in the control condition, the learner is also making an origami figure (not a fox) beside the teacher and the teacher is provided with an explanation for why they are making the origami side by

side. The teacher is told that the learner is also a teacher and that they are ‘short on space’ therefore they will share a table. This enables a valid comparison of the behaviors a teacher produces in the presence of another when motivated to teach compared to no motivation to teach. This data is in the final stages of coding and I will analyze it to determine if any differences exist in the original and new control and compare it to the experimental group.

Lastly, another limitation of this study is that the coders were not blind to the hypothesis, therefore a third coder was trained and coded 30% of all of the data as a blind coder. He was not familiar with the goal of the project, or the experimental design. In order to reduce the curiosity regarding the hypothesis and experimental design, he coded the experimental group first, and later, after he was led to believe that the coding was complete, he was recruited to code a ‘similar’ experiment using the same coding scheme.

In addition, the data recorded and coded provide a rich data set for further analyses. As the temporal sequence was recorded for each behavior, we can examine the interaction and how the teacher and learner respond to one another. Also, I report only data from the production of one fox in the transmission phase. As the experiment lasted several minutes, it is possible that the teacher may have demonstrated the first one and moved on to produce more teaching signals for the second or the third. In addition, I would expect more interesting interactions to occur after the production of the first fox – after which both participants are aware of what is happening and possibly more focused on their mutual goal. Future analyses may include coding further into the data to provide a more rich comparison across the cultures. It is possible that we are capturing a low level baseline for pedagogical behaviors.

The debate regarding the uniquely human mechanism underlying the transmission of cultural knowledge is ongoing. The data here lend support to the Natural Pedagogy theory, however more evidence is need to resolve the current debate. Specifically more comparative, cross cultural and cross disciplinary evidence is needed.

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Tables and Figures

Table 1.0: Pedagogy participants by society and condition (*N*=104).

Culture	*n*	Experimental	Control
Bolivia	20	9	11
Fiji	19	15	4
Faroe	23	11	12
Kenya	7	7	0
Ukraine	9	9	0
USA	26	14	12

Table 2.0: Age and education level achieved of pedagogy teacher participants by society and condition.

	Age (SD)		Education (SD)	
Culture	Experimental	Control	Experimental	Control
All cultures	30.5(12.6)	27.6(9.1)	11.5(4.1)	11.8(5.9)
Bolivia	23.8(6.8)	29.0(11.6)	6.3(2.8)	3.7(2.6)
Fiji	39.3(14.1)	26.0(14.6)	9.1(2.9)	11.0(2.0)
Faroe	33.9(7.6)	34.3(6.9)	15.5(2.6)	16.9(3.3)
Kenya	27.1(7.7)	-	10.3(3.5)	-
Ukraine	37.2(16.7)	-	12.1(1.3)	-
USA	20.3(3.8)	20.3(1.1)	14.6(2.8)	14.4(1.2)

Table 3.0: Duration of phases and monetary compensation by culture (*N*=104).

	Duration		Compensation	
Culture	Practice Phase	Test Phase	USD/fox	USD/5 fox
Bolivia	10	5	0.57	2.85
Fiji	10	5	1.11	5.55
Faroe	5	3	4.64	23.20
Kenya	5	5	1.19	5.95
Ukraine	to produce 3	to produce 5	10% daily wage	50% daily wage
USA	4	3	2.00	10.00

Figure 1.0: Learner and teacher during pedagogy experiment in Fiji.

Figure 2.0: Still image of video demonstration of origami fox.

Figure 3.0: Hand movements by teacher across conditions during transmission phase (p<.001)

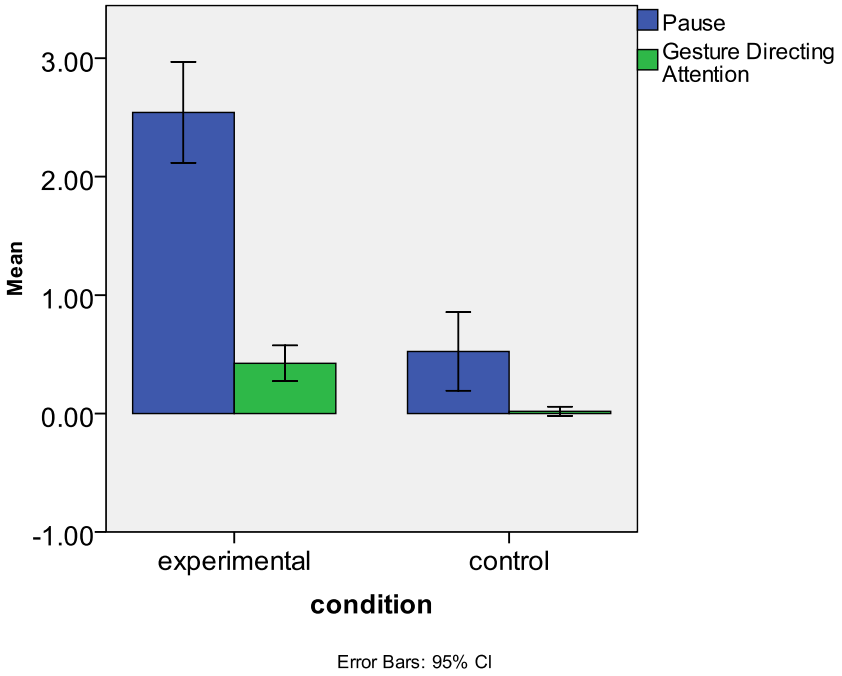


Figure 4.0: Extra steps and skipped steps (fidelity of transmission) produced by teacher across conditions during the transmission phase (n.s. by culture).

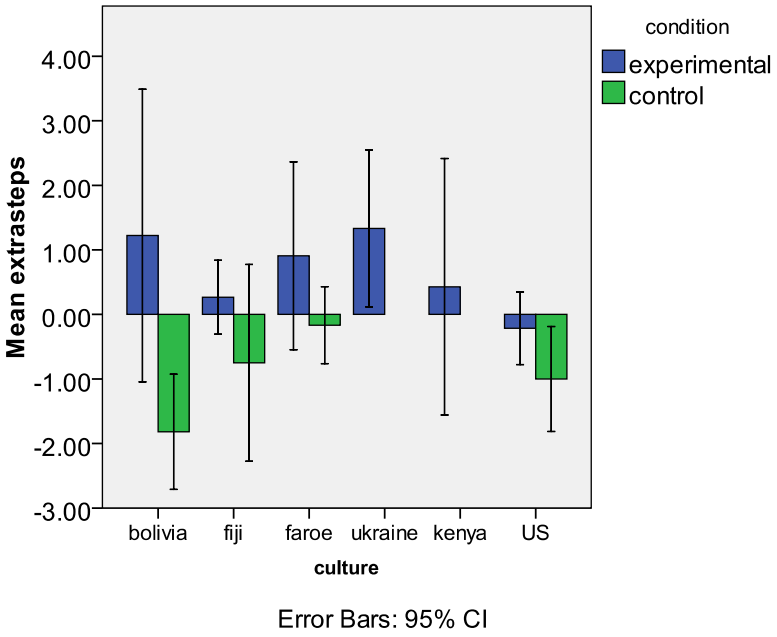


Figure 5.0: Mean duration in seconds in baseline and transmission phase by condition.

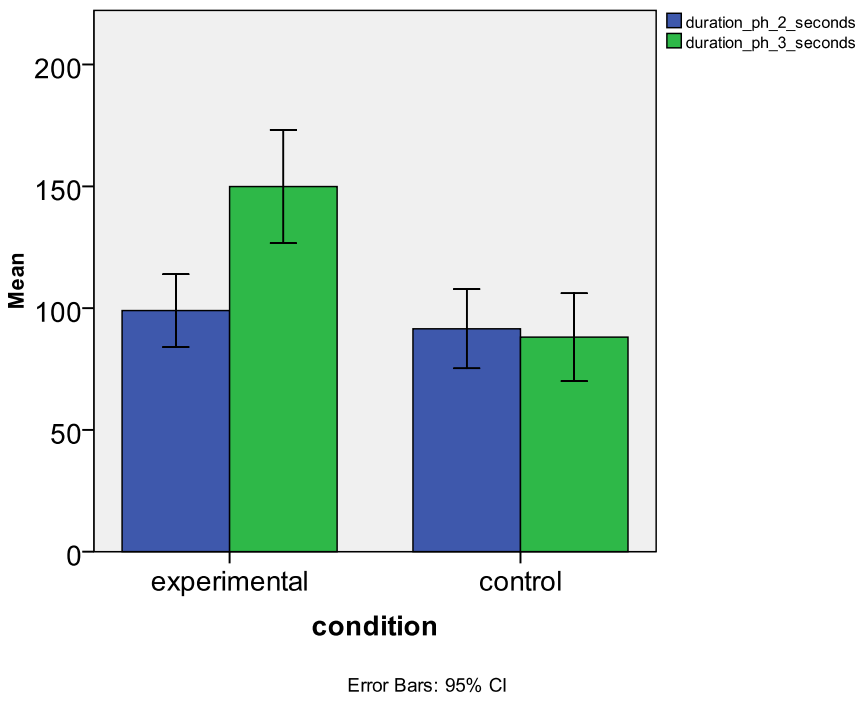
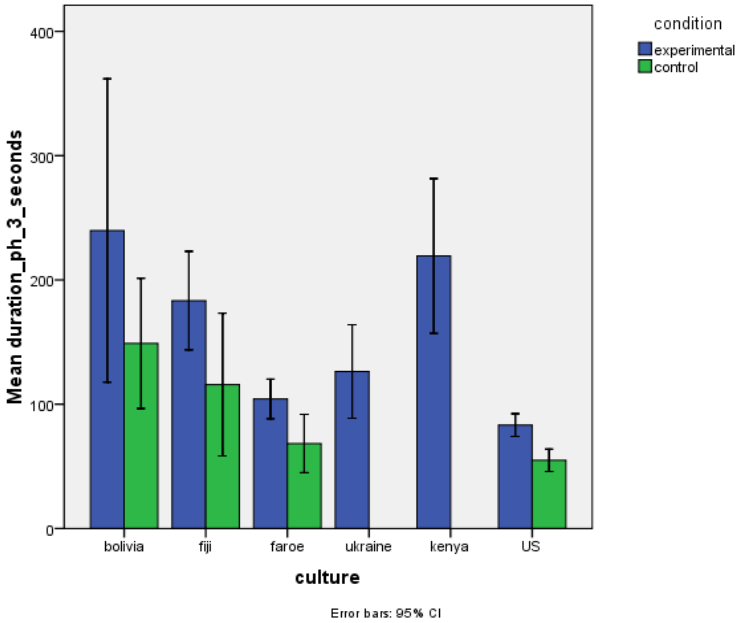


Figure 6.0: Mean duration (sec) in transmission phase by condition and culture (p<.01).



Appendix

Appendix A (script)

Initial instructions for Informed Consent (to teacher and learner):

> "Thanks for waiting/coming in. Now, we have a game for you to play and here is how it goes. First, one of you will see how to make one of these [show them exemplar]. Then you will both have a chance to make these to earn some money. Who would like to go first? Okay then, first we will have [teacher—use person's name here and throughout] play the game in here. [learner—use person's name here and throughout], would you mind waiting in this other room for a few minutes?"

Initial Instructions to teachers:

> "This study involves a game, where first you will see how to create one of these [shown example of completed "fox" origami design]. Once you know how to make one of these on your own, you will team up with a partner. You can practice with your partner, and after this, we will see how many your partner can make in a [5 minutes?]. For each one that your partner succeeds at making your team will earn [10% of day's wage] amount, to be evenly split between you and your partner. I will judge whether each attempt is a success. The more successful ones that your partner makes, the more that each of you will earn. Because I am interested in how you do, we will videotape the whole session.
>
> "Okay, are you ready? Now, to see how to create one of these "fox"s, you can watch this video. You can watch it as many times as you want, and you can stop the video for a little while if you want, and you can also go back in the video, as much as you want. When you are working with your partner, you will not be able to watch the video anymore though, and so you will have to know how to make these on your own. So, please watch the video as much as you wish, then, when you are ready to make one on your own, please close the lid like this (demonstrate) and make one on your own! Let me know when you are finished. Do you have any questions?
>
> Now, I can operate the video for you if you like. Please tell me when you would like me to *play, stop, pause or go back* in the video. I cannot help you making the "fox". I can only help you with the video. Are you ready? Okay, let's start.
>
> "Ok, I will be over there while you watch the video. Please let me know when you have succeeded in making one of these with the video machine turned off. Please take your time, and make sure that you are able to make one well on your own." [This last paragraph should be omitted if the experimenter is going to sit with the teacher and help them to operate the video.]

Instructions to learner and teacher

"_[teacher]_ has learned how to make these (show both successful exemplar). Now we will have a sort of contest. First, there will be a practice time where you both [teacher and learner] will have some time together making these. Then, after the practice time, we will see how many of these “fox” _[learner]_ can make in _[5 minutes]_. For each of these that _[learner]_ can succeed at making (I will judge whether they each try is successful) your team will earn _[10% of days wage]_, to be evenly split between the two of you, _[teacher]_ and _[learner]_. Because I am interested in how you do, we will videotape the whole session.

"Before the competition time, you will have a period of _[5 minutes]_ to practice together. During this time you are not allowed to talk to one another. I will tell you when this time is over.
Ok, I will be over here, and I will let you know when the practice time is over. Remember, please do not talk to one another during this period.”

“Ok, the practice time is now over. _[learner]_ now has _[5 minutes]_ in order to make these “fox”. I will be over here during this time, and I will let you know when the time is over.”

Appendix B (coding scheme)

General Instructions: All coders will begin with one coding category (hands, eyes, head, steps) and complete the training process with all the practice videos. After reliability is achieved (70% minimum mean across all videos), the coder will move on to complete the coding for that category for all of the assigned videos. This process is repeated for each coding category.

General coding instructions: The section of video to be coded is the following: Code the production of one fox by the teacher (ignore learner's behavior for determining which portion to code) for the baseline session and the transmission opportunity session. Production of one fox includes the occasions when the teacher stopped making his/her own fox and finished the learners fox (never to complete their own).

Ethogram: A 'state' behavior in Jwatcher assumes mutual exclusivity. For this reason, we are coding 10 sub-sections with mutual exclusivity *within* each subsection. The ten subsections are: Origami Steps (teacher), Origami Steps (learner), Eyes (teacher), Eyes (learner), Hands (teacher), Hands (learner), Head movements (teacher), Head movements (learner) and Eye brow raises (teacher) and Eye brow raises (learner). For each subsection, you will watch the entire video once. This means, you will be watching and coding each video ten times – each time you will be focusing on a different subsection of behavior.

For all 'state' behaviors, press one key for beginning of behavior and another new key for the beginning of a new behavior. A new key press will assume the end of first key press. Each behavior (in each sub section) is mutually exclusive for the purpose of calculating durations. Therefore, you must be coding a behavior at all times.

Begin Coding: Begin coding when TEACHER's (even when you code the learner) hands touch the origami paper. Note: at times, the videos are not edited perfectly and you may see a few minutes of instructions (by the experimenter) to the team. In these cases, you must WAIT until the teacher has both hands on the paper and is ready to begin and the experimenter (or another individual in the room) is no longer giving instructions. if the teacher hands paper to the learner, do not code this. wait until the teacher begins working on her own, by placing both of her hands on her origami.

End coding when TEACHER ceases manipulation and places the fox on table/floor and hands no longer touching.

Durations of each phase: When calculating the amount of time it took each participant to produce one fox in phase 2 and in phase 3, I went back to the edited videos (because the jwatcher data file is not perfectly accurate as it ends when the video ends, therefore the

timestamp is dependent on the video being edited properly – ending precisely when the teacher takes her hands off the fox, which isn't always the case for the editing). I watched each video and scrolled through the production of one fox, to the point at which the teacher stops manipulating the fox and removes both her hands. this is considered the end and therefore the duration to produce one fox.
(note that if the jwatcher timestamp and my timestamp (from watching the video) are within 0-3 seconds of each other then I used the jwatcher one).

The durations are in milliseconds (2 min = 120,000 seconds).
CRITERIA – they had to complete something that resembled the fox! I didn't check the steps, but it did have to have ears, etc… not necessarily a recognizable tail etc.

(NOTE – the 'end' is determined by the point in time when the teacher removes both hands from the fox. however, many teachers went back to continue manipulating, probably to 'teach' and to instruct the learner to focus on certain aspects etc., but this is not captured in the current coding).

What to code: Code each behavior when there is a recognizable 'change' in behavior. If multiple behaviors occur within the same category, hit the key repeatedly. For example, if teacher gestures two different ways, but both are considered to be referential gestures, then hit the key code twice. However, if the same behavior happens continuously, without a change in behavior (for example, a continuous gesture), then only hit the key at the beginning and then a new key at the end. If two behaviors appear NOT to be mutually exclusive, ALWAYS remember and apply this rule: YOU ARE CODING ANY *CHANGE* IN BEHAVIOR. THIS MEANS THAT IF SOMEONE BEGINS ONE BEHAVIOR AND THEN IT CHANGES INTO ANOTHER, YOU THEN CODE THE NEXT BEHAVIOR AS THAT CHANGE ETC. ETC.

Press key when a recognizable behavior begins (with the exception of fold). This enables you to code in real time. If a teacher lifted their arm to point, you would not press the key until you recognize that they are producing a pointing gesture.

When coding Origami steps (folds) you press the key when a fold is complete. 'Completion' refers to the folding of the paper which also creates a crease (the paper will stay folded if hands were removed). Any extra creasing or smoothing is not included here.

If participant never produces any of the coded behaviors (example – no hand movements) then simply watch the entire video (ie – create a j-watcher file) but do not enter any codes other than beginning 'o' and end.

A pause is defined as any pause in behavior lasting more than ONE second (trick – try counting 'one, one thousand' etc. in your head).

How to code when you can't determine what behavior it is: At times, your view will be occluded, or the lighting or camera angle is poor, or you just cannot determine with any level of certainty what you are seeing. In the interest of simplicity, we have decided NOT to add two more keys to each subsection for unobservable behavior. This means, the datafile you are creating is *assuming* that all behavior is observable.

If a behavior is unobservable, first, try coding on a larger monitor to be sure that the video is potentially problematic. Next, send me (Tanya) an email and request for a better quality video (I reduce the quality when I edit the videos to reduce the file size, but if you request better quality, this is not a problem). If the video is quite problematic, you need to let Tanya know, but here is the general rule of thumb for most code-able videos: Less than 10 seconds of uncode-able video: continue coding and make a note of this if it happens twice or more in the video.

More than 10 seconds of uncode-able video: continue coding (if you can) and make a note of this. Do NOT try to interpret the behaviors – rather, code objectively at all times, based on the coding scheme. If you try to interpret the behaviors, you may, for example, be better at interpreting behaviors with cultures you are familiar with.
**note – if the focal individual is doing something to the experimenter – gesturing etc. or asking for clarification, this does not get coded

Appendix C (ethogram)

Steps: Button press indicates the completion of a fold. 'Completion' refers to the folding of the paper which also creates a crease. Any extra creasing or smoothing is not included here. End – use same rule for coding 'hands'. Only code when focal individual is working on their own origami. *face – only code a clear undo and refold of the face – don't code if uncertain

Teacher codes:	**Learner codes:**
u - erroneous step or variant	U - erroneous step or variant
1-version 1-fold in half	!-version 1-fold in half
2-version 1-flip and fold	@-version 1-flip and fold
3-version 1-quarter	#-version 1-quarter
5-version 1-bring corner to middle	%-version 1-bring corner to middle
6-version 1-bring other corner to middle	^-version 1-bring other corner to middle
7-version 1-fold in half	&-version 1-fold in half
8-version 1-long fold	*-version 1-long fold
9-version 1-face	(-version 1-face
0-version 1-tail	)-version 1-tail
1-version 2-fold in half	!-version 2-fold in half
2-version 2-flip and fold	@-version 2-flip and fold
3-version 2-quarter	#-version 2-quarter
r-version 2-corner to opposite corner	r-version 2- corner to opposite corner
t-version 2-flip and crnr to opposite crnr	t-version 2- flip and crnr to opposite crnr
8-version 2-long fold	*-version 2-long fold
9-version 2-face	(-version 2-face
0-version 2-tail	)-version 2-tail

Eye gaze:

At times, due to poor camera angle or lighting, it may be difficult to determine precisely where the focal individual is orienting their gaze. As a general rule of thumb, when in doubt, use the direction of their head turn. If you cannot see their eyes, but can see their head turn to the side, assume that their eyes have followed (pretty reasonable assumption). If, however, the eyes 'flick' in an ambiguous direction, make the best possible guess that you can. If it is toward the exemplar, assume they have gazed at the exemplar. Try to make the BEST POSSIBLE guess that you can. Remember to always keep in mind, "would others also agree with this coding decision?"

Teacher codes:
a-Gaze at Learners hands and/or origami
s-Gaze at Learners eyes and/or face
d-Gaze at Teachers own work
f- Gaze at Exemplar
g-Gaze away (anywhere other than previously mentioned)

Learner codes:
A-Gaze at Teachers hands and/or origami
S-Gaze at Teachers eyes and/or face
D-Gaze at Learners own work
F- Gaze at Exemplar
G-Gaze away (anywhere other than previously mentioned)

Hand movements:
If coding while manipulating, code the gesture. This violates the assumption of mutual exclusivity, however, this is a rare occurrence therefore we decided upon this simple rule of giving gestures privilege. If a 'pause' is so fleeting that you're unsure if it's a pause, then do not code it as a pause. Consider it uninterrupted manipulation. *Remember to begin coding once the **teacher** begins touching the paper.

Teacher codes:
h-manipulating own (teachers) origami
j- manipulating other (learners) origami
k-pause (pause in manipulation) – pause of the fingers/no manipulation AT ALL for at least one second.
l-gesture directing attention (example – point) – directing attention toward a focal point, but the focus can also be an individual if it is very clear
;-gesture directing behavior (example – stop or do it differently, or holding others hands).
*note – in order to clearly distinguish b/t these two different types of gestures, we coded any clear attn. directing gesture as 'l', and all other clear, but ambiguous gestures (clearly a gesture, but ambiguous meaning) as ';'.
*note – the one second pause rule applies, however, there is an exception – if the focal individuals hands leave the origami (ie throw it down or simply remove hands) then it is considered a pause because it is CLEAR and identifiable by all coders.

Learner codes:
H-manipulating own (learner) origami
J- manipulating other (teacher) origami
K-pause (in manipulation)
L- gesture directing attention (example – point)
'-gesture directing behavior (example – stop or do it differently, or holding others hands)

Head movements:

Teacher codes:
q- nodding (vertical, up and down movement of head)
w-shaking (horizontal, side to side movement of head)
e-no head movement (no nodding or shaking)

Learner codes:
Q- nodding (vertical, up and down movement of head)
W-shaking (horizontal, side to side movement of head)
E-no head movement (no nodding or shaking)

Durations:
To calculate the durations which are entered in spss for phase 2 and phase 3 edited videos (time taken to produce one fox), this is how I calculated and checked. For each dyad, for each phase, I simply opened a .dat file which was created by the original coder using jwatcher. At the end of that file, there is a time stamp which indicates the total duration of the edited video in thousandths of a second (1000=1second; 60000=1minute). I entered this number into spss. To check these durations (as each video may have been edited incorrectly), I opened each video and watched to be sure it contained only the portion we want to include in the duration: from the time the teacher begins manipulating her origami, until she removes both her hands from the origami and it is complete (I did not check carefully for a 'face' and tail etc., just namely that it appeared to be a good attempt to produce a fox). Margin of error: If the video was discrepant with the .dat file by 5 seconds or less, then I did not make any adjustments, and accepted the .dat duration as the final one. If there was a discrepancy > 5 seconds, then I made the correction.
Note: At times, the teacher does not begin precisely when the video begins, however, as long as she has her hands on the origami, I considered this ok and included it in the total duration. However, if there is a delay of 10 seconds or more before starting, then I subtracted this from the total time (i.e. I edited the duration to reflect the actual time and considered the video not edited properly). I did not alter/edit the duration if the teacher is simply waiting for the learner to begin.

General Discussion

The goal of this project was to explore three aspects of social learning across cultures – first, to examine non-verbal communicative signals from mothers to infants; next, to investigate infant directed speech, and lastly, to determine whether pedagogical signals exist across cultures. The central question of interest is whether there is cross cultural consistency in the non-verbal cues used in a communicative interactive context. At first glance, some may find questions examining the universality of basic behaviors such as speaking in 'babytalk' to an infant, engaging in face-to-face dialogue, or teaching another human being – largely unfalsifiable. Based on our experiences living in urban, industrial settings and relying heavily on formal education, one would expect that all *humans* engage in these kinds of behaviors that seem basic and essential to our existence. Intuition is bad science, as anthropologists have demonstrated with their documented descriptions of cultures that engage in practices which go against our basic intuitions (Henrich, Heine, & Norenzayan, 2010).

I conducted three cross cultural studies investigating non-verbal communicative behavior of mothers in a dyadic conversation with their infants as well as one experiment investigating adults teaching other adults. I report cross cultural consistency in the presence of mothers' behaviors and vocalizations to their infants, consistent with the literature on early mother-infant interactions. I also report evidence of teaching across all six cultures tested, consistent with the theory of Natural Pedagogy. Overall, mothers mirrored their infants' emotional expressions and responded contingently to an infant's behavior to the same degree in all cultures, with some specific cultural variations reported. After analyzing the acoustic properties of maternal speech to an infant and comparing it to speech to an adult, I concluded that mothers across cultures modify their speech in

specific ways when speaking to an infant. I report some cross cultural variation in infant directed speech, however my data suggest that this effect may be attributable to age and education.

To summarize, I report universality in mother-infant interactions and infant directed speech, with some cultural variations in the ways mothers respond to their infants. I also report universal evidence for the presence of pedagogical signals across cultures, with some cultural differences in the frequency of the specific pedagogical signals used in each culture.

Although the data lend support to Gergely and Csibra's theory of natural pedagogy, which suggests that adults provide non-verbal communicative signals for the purpose of teaching other individuals, more evidence is needed to explore this theoretical perspective (Gergely & Csibra, 2006). The data reported here influence three theoretical questions of interest. 1) What is the function of these behaviors – In other words, *why* do we do them? 2) What is/are the mechanism(s) underlying these behaviors? 3) What is unique about human social learning?

First, although I find evidence for affect mirroring and contingent responding across cultures, the low frequency of these behaviors leads me to wonder what function they serve and what they are providing to the developing infant. If, for example, an infant produces a smile 100 times in a day and only 30 times that smile is returned with a rapid response (within one second), and of those 30 times, only 15 of those are a mimicked smile, what could these episodes provide an infant with? What if, as my data suggest, the occurrence of these behaviors is even less frequent? Why would we see such behaviors universally across both small and large scale societies in both urban and rural, farming,

and fishing communities? What is the infant *getting* from these interactions? As Harry Harlow demonstrated with his monkeys in the 1950's, there is more to existence than physical survival (Harlow & Zimmermann, 1959). In addition, the work of psychologists such as Ainsworth and Bowlby demonstrated that human infants must bond to a nurturing caregiver (typically the mother) for healthy social and emotional development (Ainsworth, 1979; Bowlby, 1988; Harlow & Zimmermann, 1959; Lamb, Thompson, Gardner, & Charnov, 1985). Later, work with human infants who were deprived of such an emotional bond indicated that they suffered cognitive delays as well. Precisely which features of the early mother-infant relationship are necessary for healthy development? Using microanalytic tools to investigate small units of behavior, a substantial body of literature describes this first relationship in great detail, putting enormous weight on evidence obtained from as little as 3 minutes of interaction in a laboratory setting, such as the data provided here. On the other hand, gross observations are made across cultures, claiming that such face to face interactions do not exist in some societies, suggesting that these micro-level behaviors are meaningless in some societies. I am not convinced by either body of knowledge and suggest that there needs to be more cross discipline investigations in order to help us discover what is vital and unique about the first relationship. Is it realistic to think that the features that are being observed during a 3 minute observation are *the* essential features of healthy human social development? My data suggests that these behaviors are present across diverse cultures, but it leaves open the question of their significance and importance in development. The 'dance' that is described so carefully by Stern (2002) may be only a small slice of a bigger picture, and

that slice may not, and cannot literally, represent the ongoing relationship throughout the day-to-day lives of mothers and their infants.

The developmental research indicates that infants not only detect these subtle behaviors, but they also remember and prefer them (Bigelow & Rochat, 2006; Watson, 1979). This suggests that the behaviors are satisfying some function in the developing needs of an infant. The function is not clear. It could be, as some have suggested, that they enable the infant to learn about her efficacy on the world (Neisser) – or about her own emotional expressions (Gergely & Watson, 1996), or the specific display rules and social expectations of her society. The infant may be calculating frequencies and probabilities and developing social expectations based on these early experiences.

An alternative perspective to the 'contingency detection' view is that infants prefer this social responding and imitative behavior as it enables them to have an effect on their social world and be *recognized* in some way by others (Rochat, 2009). Under this perspective, the function is the social connection itself, rather than the frequency of the behavior. The capacity for the infant to detect frequencies and probabilities is similar to any other kind of social detection mechanism in that it enables recognition, and recognition may facilitate proximity between the two partners.

Alternatively, perhaps it is the mother and not the infant who is benefitting from these behaviors. It has been suggested that mothers who kept their kin close may have had an adaptive advantage (Falk, 2004), therefore it may be the case that mothers imitate their infants' emotional expressions in order to *feel* what the infant feels, aiding them to respond appropriately. An appropriately responding mother is at an advantage over a mother who struggles to determine the needs of her infant and respond appropriately.

This parental mimicking of an infant may enable the parent to better address the needs of her infant, through a simulation or theory of mind mechanism – the mother imitates the expression and subsequently it is easier for her to identify the expression and needs of the infant. The same argument may serve as an explanation for infant directed speech. Some have suggested that the manner of vocal modification resembles the linguistic capacities of infants and is adjusted to meet their capabilities as the infant ages (Liu, Tsao, & Kuhl, 2009). Therefore, rather than facilitating language learning for example, it could be that infant directed speech is merely parental imitation of infant vocalizations. We know that infant directed speech changes as different developmental needs arise, therefore it is plausible that mothers are adjusting their vocalizations as a symptom of a larger imitative mechanism which enables them to 'feel' what the infant 'feels'.

However, Gergely and Csibra would argue that evidence for maternal responsiveness and affect mirroring across cultures further support their Natural Pedagogy theory. They would argue that such behaviors serve the function of 'teaching' at different stages in human development (Csibra & Gergely, 2006, 2011). Affect mirroring and vocal modification of the acoustic properties of speech both provide examples of slowing down, simplifying and exaggerating behaviors – all non-verbal communicative behaviors produced in order for the novice partner to learn the social constructs of her culture (Gergely & Csibra, 2006). Under this theoretical perspective, my data provide evidence for a general pedagogical social learning mechanism which is specific to humans. In addition, there is no clear evidence for teaching, affect mirroring or infant directed speech in non-human primates.

Would observational learning be considered one form of 'teaching' under their theory? Although my data went beyond observational learning and I demonstrate that teaching does occur across cultures, in this implicit, non-verbal manner, but to what extent is it relied upon and under what circumstances? How are less observable skills taught? How are customs, complex knowledge and traditions passed on? If several anthropologists and psychologists (myself included) observed a distinct absence of teaching at a gross level in several human societies, then is seems unlikely that this is *the* uniquely human behavior which enabled social learning to evolve into the complex human culture that exists today. Alternatively, imitation is widespread across human societies – observed in infants, children, and adults across the globe. Not only does it exist, the way pedagogical signals *exist*, rather it is abundant. It seems intuitively more plausible that the propensity to imitate is one of the driving forces underlying human social learning. As Whiten and colleagues have demonstrated – imitation and the transfer of knowledge through imitation is not unique to humans. What is unique is the propensity to rely on this capacity.

How then, do we go from blind imitation, to solving the problem of transmitting relevant information across generations? This ability may rest on the capacity to transmit – or the motivation to transmit information in this way (as Tomasello and others have suggested). In my reading, and through my observations, it seems likely that the motivation to connect with others via imitation supports a mechanism, such as attending to and imitating prestigious or successful individuals – which enables us to pass on complex knowledge through generations. Why do we see teaching across cultures? It may be that teaching *in combination with* other forms of social learning enables cultural

transmission. My data suggest that pedagogical signals are present across human societies; however, there is less of a propensity to rely on these signals in more traditional societies (based on ethnographic reports). Therefore, it may be the case that although we have the capacity to utilize pedagogy, it is merely one form of communication strategies for cultural transmission. It seems plausible (and likely, based on the ethnographic and empirical evidence) that the ability to flexibly utilize these resources is a uniquely human aspect of social learning.

Where to go from here? I would argue that the next scientific step is to take one step back for developmental psychologists, enabling a broader perspective, and one step forward for anthropologists studying human development, enabling a closer look at these subtle behaviors and trends in human societies. Robert LeVine and Barry Hewlett are two scholars who have provided us with substantial micro/macro level analysis of childhood in small scale and hunter-gatherer societies (Hewlett & Lamb, 2005; LeVine et al., 1994). Although gathering data such as theirs takes a lifelong commitment, it need not be the only way to address these questions. One might begin by analyzing the daily lives of individuals in the west, or examining smaller scale societies of which a macro-level description of the daily lives already exists. A combination of these methods will help answer the question of what function these non-verbal behaviors are serving in human development.

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