Cultural Evolution Conference 2018

Tempe, AZ

Abstracts

Abstracts are in alphabetical order by the first author's last name.

Thomas Abel

The role of the 'information cycle' in cultural evolution

In human-ecological systems, the role of information is to maintain time-tested energy pathways. Both cultural and genetic information provide this function. Cultural and genetic information are preserved, transmitted, tested and evolved within 'information cycles', the energy systems model originally proposed by HT Odum, and expanded in my research. For this paper the information cycle is simulated in various forms. It will be explored as a basic model and it will be explored in nested forms as has been proposed in my work as nested scales of cultural information production. The results should demonstrate the dynamics of cultural information transmission and the upgrading of information within the model of nested cycles.

Alexander Allan, Dennis Sandgathe and Mark Collard

Risk and hunter-gatherer toolkit structure: a regional perspective from the pacific northwest

Identifying the factors that drive variation in technological complexity among hunter-gather societies is important for understanding cultural evolution. The leading hypothesis focuses on risk. It argues that environmental risk affects hunter-gatherer toolkit complexity in such a way that high risk environments lead to complex toolkits while low risk environments result in the opposite. This hypothesis has been supported in analyses of worldwide and continental samples. However, a test of the hypothesis using data from the Pacific Northwest (PNW) failed to support it. Collard et al. (2011) focused on subsistence technology and compared the toolkits of groups on the PNW coast with the toolkits of groups on the interior plateau of the PNW. Their analyses suggested that the plateau is riskier than the coast, but they found no difference in the complexity of the toolkits of the coast and plateau groups. Here, we reported a study in which we revisited Collard et al.'s (2011) study and sought to determine why their results departed from those of the worldwide and continental studies. We began by replicating Collard et al.'s (2011) analyses with a larger dataset. The results of this analysis were consistent with those obtained by Collard et al. (2011). Subsequently, we ignored the coast vs plateau distinction and focused on the correlation between individual tool complexity and measures of riskiness for the species with which they were associated. This analysis supported the risk hypothesis. We found that species that are difficult to capture and/or have restricted seasonal availability are associated with higher complexity tools. We conclude from this that Collard et al.'s (2011) study failed to support the risk hypothesis because their

research protocol was too coarse. When a more sensitive approach is employed, the PNW data support the risk hypothesis, like the worldwide and continental datasets.

Jenny Allen, Ellen Garland, Rebecca Dunlop and Michael Noad

Cultural revolutions reduce complexity in the songs of humpback whales

A substantial body of evidence for non-human culture comes from vocally learned displays, such as the songs of birds and cetaceans. Many songbirds use the complexity of these displays to assess male fitness the role of complexity in the songs of male humpback whales (Megaptera novaeangliae) is uncertain because, unlike most birds, there is population-wide conformity to one song pattern. Although songs change gradually each year, the eastern Australian population also completely replaces their song every few years in cultural 'revolutions'. Revolutions involve learning large amounts of novel material, which are introduced from the western Australian population. We examined two measures of song structure, complexity and entropy (a measure of sequential predictability and information content), in the eastern Australian population over 13 consecutive years. These measures aimed to identify the role of complexity and information content in the vocal learning processes of humpback whales. Given the song's hierarchical structure, complexity was quantified each year using principal component analysis (PCA) at two levels: the entire sequence of individual sound 'units'; and the stereotyped arrangements of units which comprise a 'theme'. Complexity increased as songs evolved over time but decreased when revolutions occurred. No correlation between complexity and entropy estimates suggests that changes to complexity may represent embellishment to the song rather than changes to information content. The consistent reduction in complexity during song revolutions suggests a potential limit to the social learning capacity of novel material in humpback whales.

Mark Atkinson and Christine Caldwell

Inferring behaviour from partial social information and the cultural transmission of adaptive traits

Human culture is unique in that many traits become increasingly beneficial to their users as they are repeatedly transmitted, resulting in later generations being able to exploit behaviours and inventions which might also have been preferred by their predecessors if they had been available. Social information which later generations are exposed to is therefore often more valuable than the equivalent social information received by earlier generations. But even if traits are typically transmitted with high fidelity, limiting backward slippage and the loss of the accumulated value of the social information of later generations, how is it that less beneficial traits which were abandoned by earlier generations are avoided by the later generations who refine and modify the traits they receive? And how can these later generations do this despite having no direct exposure to those traits of earlier generations? One possibility is that learners are sensitive to cues of intentional production in others' behaviour, and that particular variants (e.g. those containing structural regularities unlikely to occur spontaneously) are recognised to have been produced deliberately and with some effort. If this non-random behaviour is attributed to an informed strategy, then the learner may be able to infer that apparent avoidance of certain possibilities may indicate that these have already been sampled and rejected. This could potentially prevent, or at least delay, performance plateaus that might otherwise be expected if learners simply modified socially inherited behaviours randomly, treating all possible unknowns as equally

worthy of personal exploration. We test this hypothesis by asking participants (recruited in the UK), either individually or in interacting dyads, to locate rewards in a search grid, guided by partial information of another participant's previous searches. We assess the roles of coordination and transparency of social information on task success, avoidance of previously sampled unrewarded selections, and structural regularities in search behaviour.

Mark Atkinson, Bill Thompson, Elizabeth Renner, Gemma Mackintosh and Christine Caldwell

Robust source- independent biases in children's use of socially and individually acquired information

Culture has an influence on human behaviour which is unparalleled in other species. Some theories propose that this is due in part to children possessing domain-specific mechanisms for social learning which function to promote rapid enculturation. We assess this by comparing children's performance on simple stimulus choice problems when they are provided with information from either a social source or from their own personal experience. Over three experiments, involving both a WEIRD sample of 18-month- to 5-year-old children recruited in Glasgow, Scotland (Study 1; N = 172), a non-WEIRD sample recruited in Beijing, China (Study 2; N = 159), and a variant of Studies 1-2 with a counter-intuitive reward structure (Study 3; N = 184), we find little evidence that children perform differently in response to information acquired from a social source compared to information received via their own individual exploration. Expectations about the predictive value of information thus appear to be independent of source. Furthermore, error rates show evidence of a consistent bias driven by motivation for exploration as well as exploitation, which was apparent across both conditions in all three studies. We conclude that some apparent peculiarities identified in human social information use likely reflect domain-general learning and motivational biases rather than domain- specific enculturation mechanisms.

Duman Bahrami-Rad

Keeping it in the family: female inheritance, in–marriage, and seclusion of women

I study historical origins of existing differences in marriage practices and gender norms across societies. I argue that, in patrilineal societies that mandate female inheritance, such as Islamic societies, cousin marriage and endogamy have developed to preserve property in the male lineage, prevent land fragmentation, and limit conflicts over inheritance. In these societies, female inheritance has also encouraged seclusion of women and restrictions on their premarital sexual freedom to arrange cousin marriages and avoid out-of- wedlock children as potential heirs. The incompatibility of such restrictions with female participation in agriculture further influenced the historical gender division of labor. Using data on pre-industrial societies, Italian provinces, and Indonesian individuals, I find evidence consistent with these hypotheses: female inheritance is associated with higher cousin marriage, endogamy, and arranged marriage, and lower female economic participation and premarital sexual freedom. Finally, I exploit a 2005 reform of Indian inheritance laws to obtain causal estimates of the effect of female inheritance on the cousin marriage rate and the female premarital sex rate.

Duman Bahrami-Rad, Anke Becker and Joseph Henrich

Tabulated Nonsense? On the Validity of the Ethnographic Atlas and the Persistence of Culture

A large body of empirical research in the (social) sciences makes use of an old anthropological database, the Ethnographic Atlas, e.g., to uncover systematic links between ancestral culture and contemporary outcomes. However, its reliability and usefulness has been questioned particularly within anthropology, the discipline from which it originated. This paper provides a systematic assessment of the validity of the information contained in the Ethnographic Atlas by benchmarking it with high-quality individual-level data from descendants of ethnic groups covered by the database. For most dimensions, we find positive associations between historical ethnicity-level and contemporary individual-level measures, providing strong evidence for the validity of the ethnographic information and showing cultural persistence. The second part of the paper is then devoted to analyzing heterogeneity in cultural persistence at the individual level. We introduce a novel domain-independent measure of cultural persistence and show that variation in this measure is determined by how much an individual was exposed to tradition and by how strongly an area was affected by Christian missionary activity. We also find that more educated people, those living in urban areas, and Muslims are less persistent, while older people tend to be more persistent than younger ones.

Jay Baldwin

Cop art: The evolutionary origins of the police procedural narrative form

An array of empirical and theoretical studies across disciplines falling within the broader literature of cultural evolution supports the following claims: Population bottlenecks negatively affect cultural evolution through the loss of technologies, loss of accumulated knowledge, and loss of models for social learning. Mathematical models have shown that only when population numbers increase sufficiently enough to offset the negative effects of the bottleneck can various forms of cultural practices be sustained and evolve. It follows that under the bottleneck condition at least some newly emergent cultural practices would likely be the product of higher risk, trial-and-error learning, the most successful practices rewarding those learners with perceived competence among their peers, resulting in prestige status, and leading to the practice's spread through the population via social learning biases and narrative traditions. In this paper I take a broadly ethnographic approach to show that just such a scenario unfolded in the immediate aftermath of WWII among the officers within the Los Angeles Police Department, resulting in the emergence of the police procedural form of narrative fiction as a mode of social learning and status acquisition. I first briefly outline the social and historical conditions that resulted in a modern-day bottleneck at the LAPD (circa 1948); I then describe the behavior of officers; present the evidence of an emerging prestige hierarchy based on storytelling skill; and trace the evolution of this cultural practice from its origins to its continued social influence in modern life. The

paper lends a bit of external validity to a number of widely-held and well-supported theories of cultural evolution, evolutionary psychology, and evolutionary literary studies.

Elisa Bandini and Claudio Tennie

Factors affecting spontaneous reinnovation of tool-use by primates

Recent work (e.g., Bandini & Tennie, 2017) has identified some behavioural forms of tool-use that can be readily reinnovated by naïve chimpanzees, without requiring social learning of any kind. Indeed, in some cases, behavioural forms are reinnovated by related species that do not practice the target behaviour in the wild. One explanation for these observations is that related species share similarities in cognitive skill, derived via phylogenetic ties. Yet this does not imply that all primates will reinnovate the same behavioural forms. Bandini & Tennie (2018) identified one such case. A subspecies of long-tailed macaques (Mfa) regularly uses stone tools to crack encased foods in the wild (a behaviour known as pound-hammering). When provided with all the materials of pound-hammering, a highly related subspecies (Mff) did not reinnovate the target behaviour when tested in captivity. In these cases (absence of reinnovation), it is important to know whether the sample sizes tested are sufficient to draw conclusions on the cognition of the species as a whole. We provide a novel method to calculate (based on binomial cumulative distributions) the minimum sample sizes required to draw conclusions on a species-level from testing samples. Furthermore, we also extend the reinnovation testing methodology to examine the role of social learning in the acquisition of behavioral forms in primates, after baselines tests have been carried-out.

Brendan Barrett and Susan Perry

Effects of demographic changes on extractive foraging traditions in wild capuchin monkeys

Observations of demographic changes from longitudinal studies in the wild permit the exploration of social learning and cultural transmission in species with slow life histories. We discuss how demographic changes, including immigration, emigration and group fissions, influence the population dynamics and social learning strategies underlying Sloanea terniflora food processing traditions in white-faced capuchin monkeys, Cebus capucinus. From 2001-2011, demographic and behavioral data were collected on 9 groups of capuchins (5-41 individuals/group) at Lomas Barbudal, Costa Rica. During this study, 5 group fissions, dozens of dispersal events, and 88 alpha male turnovers were observed. This provided us with repeated observations of changes in size and social composition of capuchin groups. Nearly 18,000 observations of Sloanea processing techniques, which are candidate behavioral traditions, were recorded for 233 individuals, and we noted who closely observed foragers while processing. These data were analyzed with a series of Bayesian Experience Weighted Attraction models. We find that Sloanea processing techniques are transmitted via social learning.Consistent with theoretical predictions, reliance on social learning (over individual learning) and strength of frequency dependent learning increases with group size. We also find that dispersing males reduce reliance on social learning and are less likely to be conformist after dispersing, suggesting they act as sources of novel cultural variation in

their new social groups. Lastly, we discuss the role of sex and age on social learning and the multiple social learning strategies employed by capuchin monkeys.

William Baum and Peter Richerson

Evolution of cooperation in the laboratory-ii

The evolution of cooperation has been studied in a variety of ways. Mathematical models have explored various factors that might promote or retard cooperation. Empirical studies have examined phenomena that might underlie cooperation. Few experiments have been carried out that model evolution of cooperation in laboratory conditions. We have provided such an experimental model. In our first iteration, groups of 10 undergraduates of diverse ethnic backgrounds played a public-goods game. Each group constituted a generation, played for 10 rounds, and then left advice for the next group. The advice from the previous generation was read aloud to the new generation before the first round. When the participants were given the opportunity to punish anyone who contributed too little to the public account, punishment evolved across generations only when the cost of punishing was low. Our present method substitutes elders who are experienced in the game instead of group advice, to see if bringing people back might serve transmission. We allow strength of transmission to vary by allowing the number of elders to vary. Although some elders counsel punishment, some also exploit the newcomers and disavow punishment, but this behavior eventually sparks punishment. The methods and the results indicate that experimental models of evolution of cooperation are possible. As an example, decriminalizing drugs is gaining popularity because the cost of policing drugs is so high.

Anke Becker

On the origins of son preference and female genital cutting

This paper investigates the historical origins of contemporary variation in son preference and the most invasive form of female genital cutting. It tests a hypothesis that emerges from the anthropological literature and that speaks to both dimensions of female well-being: Pre-industrial pastoralism was a particularly male-dominated form of subsistence making sons more valuable than daughters, and characterized by (extended) periods of male absenteeism, implying higher paternity uncertainty and presumably a need to control female sexuality. Using data on pre-industrial societies, the paper first shows that, indeed, in pre- industrial times dependence on pastoralism was associated with societal measures of male dominance over women. This pattern has apparantly persisted until today. Using contemporary data on individuals from 44 countries around the globe, the paper shows that ancestral dependence on pastoralism is associated with a preference for sons, as stated by the individuals and as revealed by the share of sons at birth. Women whose ancestors depended more on pastoralism are also more likely to have undergone infibulation, the most invasive form of female genital cutting. In line with the historical results, this seems to be part of a more general pattern of male dominance over women today that is rooted in ancestral pastoralism. For example, we also find that female descendants of societies with a stronger dependence on pastoralism are less able to refuse sex with their partners or demand safe sex practices. To provide empirical support for a causal relationship between this particular

form of pre-industrial subsistence and male dominance over women, the paper makes use of biogeographic data on land suitability for pastoralism.

Bret Beheim

Milk consumption is globally widespread and increasing: time to rewrite the textbooks?

One of the most popular examples of human gene-culture coevolution is the prevalence of adult milk consumption and lactose tolerance in some parts of the world, places which can be connected to long historical periods of dairying. The cultural-historical hypothesis describes how culturally-distinct mutations arose in these locations that maintained high levels of lactase enzymes, uniquely enabling adult milk drinking in humans. A widespread assertion within cultural evolutionary literature, then, is that milk is only consumed by certain populations in Europe, Africa and the Near East, leaving the majority of humanity unable to digest raw dairymilk as adults. We assert that this argument cannot properly account for the recent spread of milk consumption over the last 100 years, using evidence drawn from the Global Lactase Persistence Association Database and from hydrogen-breath lactose intolerance tests administered in two populations with no history of dairying, in Japan (n=41) and lowland Bolivia (n=26). We find that not only is milk consumed in many places outside the populations supported by the cultural-historical hypothesis, but that direct measures of lactose intolerance show unexpected physiological tolerance for lactose within these populations, despite no known genetic mutations for this ability. We argue that the traditional story must be suuplemented with the role of group-structured evolutionary forces in spreading milk consumption worldwide and mutualistic microbiotic relationships among populations adopting this behavior.

Adrian Bell

Measuring ethnic markers in the field using a classification study

A rich body of theoretical work on the evolution of ethnic markers, or honest signals of group membership, has provided a number of predictions yet to be rigorously tested in the field. The primary difficulty is the ability to measure the prevalence of ethnic markers in naturalistic settings. To address this challenge, we present a field classification study in the Kingdom of Tonga and the Tongan diaspora of Utah, where participants completed triad sorting tasks in religious, symbolic, plant and animal classifications. Under the basic assumption that social coordination leads to lower variance in classification, we derive a statistical model to estimate variance across the four domains. We further compare variances across Tonga and the Tongan diaspora, predicting even lower variance in symbolic domains in the diaspora. Following predictions, symbols and religious classification shared the least variation in some regions, and comparison with a non- Tongan control group provides evidence of social coordination on specific symbols.

R. Alexander Bentley, Paul Ormerod and Damian Ruck

Cultural-historical dynamics of obesity in the U.S.

From a gene-culture evolutionary perspective, the recent rise in obesity rates around the Developed world is unprecedented; perhaps the most rapid population-scale shift in human phenotype ever to

occur. Focusing on the recent rise of obesity and diabetes in the United States, we consider the predictions of human behavioral ecology (HBE) versus the predictions of social learning (SL) of obesity through cultural traditions and/or peer-to-peer influence. To isolate differences that might discriminate these different models, we explore temporal and geographic trends in the inverse correlation between household income and obesity and diabetes rates in the U.S. Here we show how inverse correlations have evolved steadily over recent decades, with marked geographic heterogeneity across the U.S., and we present equations for their time evolution since 1990. We conclude that these patterns favor an HBE explanation more than a SL explanation. Comparing with additional historical and nutritional studies, we further suggest that refined sugar in processed foods has been a prime driver of the recent increase in obesity and diabetes.

Richard Berl, Alarna Samarasinghe, Seán Roberts, Fiona Jordan and Michael Gavin

Tell me a story: Comparing the effects of prestige and content biases on cultural transmission

Context-based cultural transmission biases such as prestige are thought to have been a primary driver in the dynamics of cultural evolution. Laboratory experiments have shown that, in some contexts, prestige can have a powerful effect on an observer's choice of which model to copy. However, few empirical studies have measured the importance of prestige relative to the variety of informational content biases, which have received less attention in the literature. We conducted a study to systematically compare the effects of high and low prestige with the presence of various types of information including social, gossip, survival, positive and negative emotional, moral, counterintuitive, and rational. Participants from the US (n = 107) and UK (n = 98) were presented with a recording of an artificial creation story (constructed with content comparable to stories from real societies) read by an individual with a high- or low-prestige regional accent. We then asked them to recall the story and coded their responses on a propositional basis with the original text to determine which content types were recalled and under which prestige condition. Results show that the prestige of the model is a significant factor in determining informational salience, but that several types of content are many times more influential, including negative emotional information and counterintuitive information, the latter of which was previously thought only to increase the salience of stories as a whole. This study demonstrates that no single bias fully explained variation in transmission rates; rather, all the model and content biases tested influenced transmission to different degrees and that future theoretical and experimental work is needed to reevaluate prestige effects relative to the less-frequently-considered content biases.

Richard Berl, Shyamalika Gopalan, Gillian Belbin, Chris Gignoux, Marcus Feldman, Barry Hewlett and Brenna Henn

Demographic and cultural history of the Chabu hunter-gatherers of southwestern Ethiopia

The process by which populations transitioned to agriculture and agropastoralism remains a major research question in both anthropology and human genetics. In particular, the fates of hunter-gatherer populations through cultural diffusion, extinction, or incorporation into expanding populations during a transition in subsistence may vary substantially across Africa. The Chabu people of southwestern Ethiopia are currently undergoing such a transition, having been solely reliant on hunting and gathering

for their subsistence until the late 1990s. Additionally, the Chabu are regarded as a linguistic isolate and are relatively unknown ethnographically, meaning we know little of their demographic and cultural history. Using genetic sequencing, we investigated the signatures of this subsistence transition in the Chabu and their close neighbors, the Majang and the Shekkacho. The genomes of the Chabu indicate that they are genetically distinct from all other Ethiopian populations characterized so far, with distant shared ancestry with the Majang and strong genetic affinities to Mota, an ancient Ethiopian man who lived 4,500 years ago. We also show that the Chabu have experienced a steady population decline that has accelerated over the past 30 generations and have much less genetic diversity than their neighbors. These results help to elucidate the consequences of the spread of agriculture on hunter-gatherer populations in Ethiopia and provide information on the history of the Chabu people.

Cristina Bicchieri, Eugen Dimant, Simon Gächter and Daniele Nosenzo

Feel the power of the dark side: on the evolution of norm erosion

We study how exposure to peer behavior affects the evolution of norms in a non-strategic setting in which individuals can actively comply or violate a pro-social norm of giving. Using a novel multi-period give- or-take donation game, we vary the observability of both peer behavior and social proximity among peers across treatments. We find that overall, exposure to peers drives the erosion of norms by facilitating the spread of norm violations. In the presence of proximity to one's peers, however, individuals are influenced by the exposure of both examples of norm violations and norm following. We also find substantial heterogeneity with respect to how susceptible individuals are to behavioral change. These insights are particularly important from a policy perspective, in that they can inform and improve the effectiveness of norm-based interventions on the individual and collective level and help to advance our understanding regarding the role of social proximity in the evolution of norms and behavioral change. (Study sample: North America)

Kirsten Blakey, Christine Caldwell and Eva Rafetseder

The effect of others' goals on children's strategic use of social information

Experimental social learning paradigms are almost exclusively designed so that a demonstrator and participant are motivated to reach the same goal. In reality it may be relatively rare to opportunistically encounter social information in the form of the performance of another individual who shares our immediate goal. Rather, adult humans actively seek, and strategically use, relevant social information about others' successes and failures to help them fulfil their own particular goals. This may require sophisticated cognitive mechanisms that may be unavailable to other species, which might help to explain why cumulative culture appears to be unique to humans. As a means to evaluate the cognitive challenges involved, we are examining 3-to-7-year-old British children's ability to strategically use social information provided by a demonstrator (puppet) who had either the same goal as or a different goal to themselves. Children are required to use the demonstrator's reaction to the contents of a capsule (acceptance or rejection), selected from one of two possible reward locations, to decide whether to select their own capsule from the same or an alternative location. We expect that strategic social information use, and thus success, will increase with age, regardless of the demonstrator's goals. Children are also expected to be more successful when they share the same goal as the demonstrator

compared to when their goals are different, even though our task is designed such that both conditions are potentially equally informative.

Axelle Bono, Andrew Whiten, Carel van Schaik, Michael Krützen, Franca Eichenberger, Alessandra Schnider and Erica van de Waal

Payoff- and sex-biased social learning interact in a wild primate population

Social learning in animals is now well documented, yet few studies have determined the contexts shaping when social learning is deployed. Theoretical studies predict copying of conspecifics gaining higher payoffs [1-4], a bias demonstrated in primates only in captivity [5]. In the wild, research has shown selective attention towards the philopatric sex, a group's stable core [6]. Here we report the first rigorous experimental test of the existence of a payoff-bias in wild primates and its interaction with the sex of the model. We created a payoff bias in which an immigrant alpha male in each of three groups of wild vervet monkeys received five times more food upon opening a foraging box than did the philopatric alpha female, whereas in two control groups male and female models received the same amount of food. We tested whether this payoff asymmetry would override the previously documented selective learning from resident females. Group members were tested after having watched both models. When both models received the same amount of food, audience members copied the female model significantly more than the male model, confirming previous findings. However, when a marked payoff bias was introduced, male, but not female, vervet monkeys significantly more often copied the male model receiving a higher payoff. These results demonstrate behavioral flexibility in the dispersing sex in these primates and suggest that the philopatric sex can afford to be more conservative in their social learning. Our findings show that multiple social-learning biases can coexist and interact within the same species.

Karalyn Boyer and Nicole Creanza

Studying cultural and genetic variation to shed light on the migration history of the Americas

Despite ongoing efforts to sequence modern and ancient DNA from Native American populations, reconstructing a detailed demographic history of the Americas has remained an elusive goal. To help illuminate the population history of this region, we synthesized and analyzed in parallel genetic, geographic, and linguistic data from populations in the Americas and Siberia. In addition, we studied linguistic data, in the form of phoneme inventories and syntax features, from over 500 populations in the Americas. Our previous analysis of worldwide linguistic and genetic data revealed signals of both ancestral relationships and more recent population contact, with geography showing a stronger relationship to genes than to languages. For the current analysis, we compiled 1,226 complete mtDNA genomes from 104 unique populations in northeast Asia and the Americas, and we matched each population to its native language. We then assessed the geographic patterns of genetic and linguistic variation in the Americas. We then repeated our analyses with autosomal SNP data representing 67 unique populations in this region. In both cases, we found a surprising pattern that contradicts the results of our worldwide analysis: in the Americas, languages carry more geographic information than genes do. This pattern was consistent in both distance-based and principal-components-based analyses,

which showed that the geographic relationships between populations are more closely associated with linguistic variation than with genetic variation. These results hint that population-level language information might be particularly informative about human demographic history in the Americas, thus shedding new light on the patterns of human migrations across the Bering Strait and within the Americas.

Miran Božičević

Cultural evolution of social power: autocatalysis and random grammar models

Critics of cultural evolutionary approaches (e.g. Fracchia & Lewontin 1999, Lewontin 2005, Ingold 2007) object to a relative lack of attention to traditional social scientific concerns of cultural symbolic systems, social relations, and social power. Beside their prima facie relevance to social life, it is easy to see why these concepts are salient in an evolutionary approach. Cavalli-Sforza and Feldman (1981) point out that the details of reproduction channels, in the case of human social learning interactions structured into relations, are centrally important to predicting the character of evolutionary change. Dawkins (1999) notes that the replicators that reproduce together, which in culture include closely related symbols, share common evolutionary interests and are likely to inform coherent larger entities (vehicles/interactors). Social power is of interest by definition as the capacity of one person or group to regularly and reliably shape actions of others, i.e. their enactments of cultural variants; besides, the question one asks to identify social power is the evolutionary one: cui bono? to whose benefit? Existing work to address these concepts in cultural evolution is reviewed, along with potentially promising quantitative modeling techniques in evolution and ecology. Adaptations of autocatalysis and random grammar models (Kauffman 1993) to modeling aspects of social power relationships are introduced and evaluated.

Charlotte Brand and Alex Mesoudi

Is there evidence of prestige and dominance-based social hierarchies in naturally occurring local community groups?

Prestige and dominance are thought to be two evolutionarily distinct routes to gaining status and influence in human social hierarchies. Prestige is attained by having specialist knowledge or skills that others wish to learn, whereas dominant individuals use threat or fear to gain influence over others. Previous studies with groups of unacquainted students have found prestige and dominance to be two independent avenues of gaining influence within groups. We tested whether this result extends to naturally-occurring, already- established social groups. We ran an experiment with 30 groups of 5 people from Cornwall, UK (n=150). Participants answered general knowledge questions individually and as a group, and subsequently voted for a team representative to answer bonus questions to win money on behalf of the team. Participants then rated all other team-mates anonymously on scales of prestige, dominance, likeability and influence on the task. Using a model comparison approach with Bayesian multi-level models, we found that prestige and dominance ratings were predicted by influence ratings on the task, replicating previous studies. However, prestige and dominance ratings did not predict who was voted as group representative. Instead, participants voted for team members with the highest individual quiz scores, despite this information being unavailable to them. Interestingly, group members

who were initially rated as being high status in the group, such as team captains or group administrators, had higher ratings of both dominance and prestige than other group members. In contrast, those who were initially rated as someone that group members would like to learn from had higher prestige ratings, but not higher dominance ratings, supporting the claim that prestige reflects social learning opportunities. Our results suggest that prestige and dominance hierarchies do become established in naturally occurring human social groups, but that these hierarchies may be more domain-specific and less flexible than anticipated.

John Bunce

Boarding schools and cultural dynamics in a multi-ethnic Amazonian population

When the children of one ethnic group are educated by adults of a different ethnic group, cultural dynamics in one or both groups may be affected in important ways. These dynamics, and the mechanisms underlying them, are often of interest to society, but are currently not well understood. Such a situation has historically characterized the formal Western-style education received by, or imposed upon, indigenous peoples in many parts of the world. Here I examine the distributions of distinctive cultural norms across a range of domains in a population of Mestizo colonists and indigenous Matsigenka, living in Amazonian Peru, who engage in inter-ethnic educational interaction. Matsigenka secondary school students attend three different boarding schools in Mestizo towns and one non-boarding school in a Matsigenka community. The schools differ markedly in the frequency and form of interactions between Mestizo teachers and Matsigenka students inside and outside of the classroom. I use Bayesian item-response theory models to characterize the distributions of measured norms among teachers, students, and non-academic Matsigenka and Mestizo residents in this population. I interpret these distributions in light of my participant observation and ethnographic experience in the boarding schools and in the Matsigenka and Mestizo communities. I develop hypotheses for how and why Matsigenka-typical cultural norms are likely to change in coming years under several possible educational scenarios. This is an initial step in a longitudinal study of how inter-ethnic interaction influences cultural dynamics in this and other populations.

David Buss and William von Hippel

Do Psychological Adaptations Impede Understanding the Foundations of Cultural Evolution?

We argue that three interlocking barriers beset social scientists seeking to develop a proper science of evolutionary psychology and cultural evolution. The first is the widespread adoption of an outmoded view of human nature—a blank slate whereby immoral behavior is caused solely by bad parents and damaging cultures. The second is a rejection of theories and findings believed to contravene that view of human nature—those coming from evolutionary approaches to human behavior. The third is a suite of evolved psychological adaptations that actively impede an understanding of evolutionary processes—(1) adaptations for social persuasion rather than truth-seeking, (2) adaptations for prestige and status attainment, and (3) adaptations for forming in-group coalitions and for punishing competing coalitions. We examine these scientific impediments with empirical data based on a survey of 335 well-established PhD social psychologists from an elite scientific society, The Society for Experimental Social Psychology

(SESP). Our empirical findings support the existence of these key psychological impediments among these social scientists. We conclude with the irony that our evolved psychology actively interferes with developing an adequate scientific understanding of the evolved psychology on which cultural evolution is based.

Felipe Valencia Caicedo

Christ's shadow: non-cognitive skills and prosocial behavior amongst the Guarani

This article studies human capital formation, beyond formal education, among the Guarani, in modern-day Paraguay and Argentina. We focus on non-cognitive skills and pro-social behavior by conducting a household survey and performing a lab-in-the-field experiments in the areas where Catholic religious missionaries proselytized historically. We find higher non-cognitive skills and pro-social behavior in former Jesuit missionary areas, consistent with this Catholic Order's focus on human capital and particular religious values. Current inhabitants of former Jesuit missions exhibit a higher Rotter Locus of Control, less cheating, more altruistic behavior and higher positive reciprocity. Clear differences emerge with respect to respondents in former Franciscan missionary areas. The persistent results are consistent with cultural transmission mechanisms of occupational persistence and inter-generational knowledge transmission. Results do not seem driven by religion per se, as evidenced by a religious priming experiment.

Gerd Carling, Sandra Cronhamn and Harald Hammarström

Can semantic evolution be predicted? A case study on the Eurasian vocabularies for hunting, farming, and technology

The change rates and directionality of semantic evolution in vocabulary is a topic which remains an enigma within comparative and evolutionary linguistics. We know that basic vocabularies (or Swadesh lists) are very useful for classifying languages: the change rates of basic vocabulary is relatively consistent, the borrowability is low (Tadmor and Haspelmath 2010), and change rates are relatively slow in relation to, e.g., grammar (Greenhill et al. 2017). Also, the colexification patterns of basic vocabularies show universal tendencies (Youn et al. 2016). However, little is known on change rates and semantic evolution of vocabulary outside of the domain of the (universal) basic vocabularies (Urban 2014). We have compiled a set of 100 Eurasian lexical concepts of importance to hunting, farming, and technology from a perspective of high age and presumed high cultural stability. These core concepts include, e.g., bovine cattle (BULL, OX, COW), animals of traction (HORSE, DONKEY), important metals (GOLD, IRON, COPPER), important crops (GRAIN, WHEAT), important game (HARE, DEER), and essential technological innovations (WHEEL, WAGON). The concepts are supposed to represent items that have been in consistent use in Eurasian farming cultures at least since the Chalcolithic. We have compiled a complete data set of lexemes from Indo-European, Caucasian (Kartvelian, Nakh-Dagestanian, Northwest Caucasian), as well as adjacent Uralic and Turkic languages, in all around 160 languages. In particular the Caucasian data is rich and new, based on fieldwork of poorly documented languages. The lexemes have been coded for cognacy as well as for borrowing, lexical derivation and semantic change, and are amassed in a lexical cognacy database (Carling 2017). The cognates are built around etymological trees, which code etymological relations independent of their colexification patterns and meaning changes.

Further, the exact and full (dictionary) meaning of lexemes in languages is given in the data. In all, the data contains 15,686 lexemes, of which 2,089 lexemes have polysemous or colexified meanings and 2,541 lexemes have completely changed meanings. The cognates are organized into 1,113 etymological trees. We have standardized the meanings and coded the type of semantic relation between them, defined as metaphor (change by similarity), metonymy (change by semantic nearness), generalization, specialization, synechdoche (change based on whole-part relation), hyperbole (change from weak to strong), and meiosis (change from strong to weak) (Bloomfield 1933).By means of this data and a phylogenetic reference tree by basic vocabulary, we will test rates of change of various concepts as well as frequency and directionality of different types of semantic changes (lexical substitution, tendency to colexify and change). We will test various hypotheses. First, we hypothesize that the change rates vary highly between various concepts. We hypothesize that the reasons are partly cognitive, partly cultural: concepts relating to small-scale farming, such as products and small domestic animals, have lower change rates, whereas concepts relating to outdoor farming, industries, and technology have higher change rates. Finally, we predict concepts relating to hunting and war, in particular taboo concepts (DEER, WOLF), to have the highest change rates. We also hypothesize specialization to be more frequent than generalization, and metonomy to be more frequent than metaphor, but here, we predict metaphor to be more common among the frequent-changing concepts (industry, war, hunting). We also predict a difference between the families: metaphor we predict to be more common in large, migratory families, such as Indo-European, whereas metonomy is more frequent in small, non-migratory families, e.g., Caucasian families.

Alessandra Cassar and Mary Rigdon

Competition for influence

A large body of experimental evidence suggests that women have a lower desire to compete than men. Here, we advance the hypothesis that this gap may depend on how we elicit such preferences, as different incentives could activate competition in different spheres, depending on culture. We test this through experiments in China, Colombia, Bosnia and Togo. In societies that exhibited an initial gap using cash, data on parents show that gender differences disappear when incentives are switched to child-benefitting. Results on non-parents suggest that such differences diminish when incentives align to gender stereotypical interests. Overall, female competition can be just as intense as male competition, indicating important implications for policies designed to promote gender equality in the workplace.

Michael Chimento, Christine Cuskley and Simon Kirby

Modeling strangers: Population size, fluidity, and complexity in shared cultural systems

Languages are equal in their ability to convey complex meanings, but there is variation in their encoding complexity. There has been a mounting body of evidence that language complexity is shaped by social features of its population (Lupyan & Dale, 2010; Reali, Chater & Christiansen, 2018) However, the causal mechanisms and dynamics of this process are still open questions. We present an agent-based model exploring how the arrival of new agents interacts with social network features to shape the complexity of a cultural system. We apply the model to language complexity, though the paradigm readily extends to other forms of cultural consensus (Baronchelli, 2018). A population of agents plays a variant of the

regularity game (Cuskley, Kirby & Loreto, 2018), where shared rule paradigms emerge over successive paired interactions. Importantly, agents change their generalization strategy as they become more proficient, mirroring experimental findings (Cuskley et al., 2015). We manipulate population size, turnover rate, and network position of entering agents to examine how these affect the complexity of the emerging systems. Results show that larger, more fluid populations result in simpler rule systems due to constant pressure from new learners. Languages also become simpler when new learners inhabit central nodes of a heterogeneous network. These results support the claim that less proficient learners may be one of the drivers of language simplification, but shows that the mechanisms underlying this involve dynamic interactions between population structure and growth. We argue that size, turnover rate, and network position of incoming agents influences cultural outcomes because these parameters effect overall information loss in a population (Spike, Stadler, Kirby & Smith, 2016). Our results emphasize the importance of memory for shared conventional structure in culturally transmitted systems, providing a useful empirical frame for future experimental and observational approaches to examining complexity and consensus in cultural systems.

Robin Clark and Steven Kimbrough

Exploring honeybee models of social learning

We implement and extend Seeley's model of nest-site selection by honeybees (Passino and Seeley, 2006; Seeley, 2010) in order to investigate social learning (Mesoudi, 2011; Laland, 2017; Hoppitt and Laland, 2013; Rendell et al., 2010). Honeybees seeking new nest sites swarm outside their former hive and send out a small number of scout bees in search of candidate sites. Scouts encountering promising sites return to the swarm and dance with varying levels of enthusiasm, according to their assessment of their site's value. Scouts who have not found promising sites observe the dancers and probabilistically choose either to provisionally select a danced site (imitation, biased in favor of more valuable sites) or to search for a new candidate site stochastically. When a sufficient number of bees have settled upon a particular site, the swarm recognizes this, travels to the new site, and occupies it. (Details and caveats suppressed in the interests of space.) We study and explore this system from three perspectives:(a) As a biological system, subject to evolutionary forces, (b) As a metaheuristic, for solving search and optimization problems (Blum and Roli, 2003; Burke et al., 2003; Gendreau and Potvin, 2010), (c) As a strategic agent in a game, competing for hives with other swarms or with predators. We conduct four kinds of related studies: (i) we replicate with our own implementation the model described in (Passino and Seeley, 2006); (ii) we extend the replicated model to explore the effects of parameter changes and of candidate site locations and distributions; (iii) we explore the bee system as a general metaheuristic by evolving system parameters (imitation probabilities, etc.) using evolutionary algorithms, in particular, we study the rate of imitation versus innovation in a variety of landscapes and compare it with known results (Rendell et al., 2010); (iv) we model multiple swarms in the same neighborhood as playing a game of strategic competition for nest sites, we study this augmented system as in (iii) but with multiple co-evolving swarms. We conclude with a discussion of future research and our plans to extend these

models to include niche creation (Odling-Smee et al., 2003). Our code (in Python) with supporting documentation will be publicly posted.

Jennifer Clegg, Nicole Wen, Cristine Legare, Cara DiYanni and Kathleen Corriveau

Cross-cultural evidence for the role of socialization in children's conformity

A growing body of evidence suggests that children conform at different rates depending on their cultural background, with children from more collectivist cultures (e.g., China) displaying higher levels of conformity than children from more individualistic cultures (e.g., U.S.). Here, we explore variations in conformity focusing on data from comparisons of children from three distinct cultural groups (Euro-American, Chinese-American, and Ni-Vanuatu). We also examine the potential influence of the socialization of conformist behaviors in more collectivist cultures as an explanation for observed cross-cultural differences. For example, Chinese-American preschoolers were more likely to conform by imitating and transmitting an inefficient action when it was demonstrated by a majority than Euro-American preschoolers (Corriveau et al., 2017), including first generation Euro-American preschoolers (DiYanni et al., 2015). Thus, there is within- nation evidence that cultural background, particularly an orientation towards collectivism, influences children's likelihood to conform across two types of behaviors. Further research indicates that this phenomenon is not limited to Chinese-American preschoolers. Primary school-aged children from Vanuatu, a Melanesian collectivist culture, are also more likely to conform by imitating inefficient actions compared to their Euro- American peers (Clegg & Legare, 2016). To explore the possible influence of conformity in children's socialization, Ni-Vanuatu and Euro-American adults' preferences for high conformity behavior was examined. Ni-Vanuatu adults were more likely to view children's high conformity behavior positively (Clegg, Wen, & Legare, 2017). Evidence from Euro-American adults indicates that individuals with higher independence orientations (as opposed to collectivist orientations) are more likely to view low conformity behavior positively. Thus, within- and cross-cultural comparisons indicate that not only are children from different backgrounds displaying conformity at different rates, but also adults display different preferences for children's conformity. We discuss the role of parental preferences in the socialization of children's conformity in collectivist versus individualistic cultures.

Marco Tulio Coelho, Elisa Pereira, Hannah Haynie, Thiago Rangel, Patrick Kavanagh, Kathryn Kirby, Russell Gray, Simon Greenhill, Claire Bowern, Robert Colwell, Nicholas Evans and Michael Gavin

Drivers of geographic patterns of North American language diversity

Although many hypotheses have been proposed to explain why humans speak so many languages and why languages are unevenly distributed over the globe, the factors that shape geographic patterns of cultural and linguistic diversity remain poorly understood. The underlying drivers of diversity patterns likely vary over space and encompass direct and indirect effects from multiple processes. However, prior research has tended to focus on identifying universal predictors of language diversity, without accounting for how local factors and complex causal chains interact. Here we use a unique combination of path analysis, mechanistic simulation modeling, and geographically weighted regression to investigate the spatial pattern of language diversity in North America. We show that a diverse set of predictors are connected in a complex web of causality, linked by both direct and indirect effects. The strongest effects

imply a role for previously developed hypotheses regarding the effects of resource availability, resource diversity and ecological risk on population density and language diversification. Our understanding of drivers of language diversity varies across the continent from regions where our model predicts approximately 86% of the variation in diversity to areas where less than 40% is explained. No single variable explains the pattern of language diversity in North America. Instead, the best predictors of language diversity vary over space, indicating that language diversification is likely shaped by distinct processes that operate at different strengths in different locations. Our study also offers a methodological template for uncovering causal pathways shaping geographic patterns of different forms of human diversity.

Mark Collard, Chris Carleton, Brea McCauley and Andre Costopoulos

An evolutionary agent-based model contradicts Dunnell's version of the waste hypothesis for cultural elaboration

Ancient monuments represent a puzzle from the perspective of evolutionary theory. It is clear that they would have been energetically expensive to construct but they are not easy to explain in terms of reproductive success. In a sense, they are evolutionarily wasteful expenditures. In the late 1980s, the well- known evolutionary archaeologist Robert Dunnell argued that these and other cases of what he called cultural elaboration actually conferred a fitness advantage in highly variable environments. He hypothesized that wasting energy can be adaptive in two ways. First, according to Dunnell, it lowers birthrates leading to a gap between population levels and environmental carrying capacity, which acts as a buffer against environmental fluctuations. Second, he argued that waste creates a sink for excess time during good environmental conditions that could be used for additional resource gathering should conditions worsen. Here, we report a study in which we tested the key predictions of Dunnell's waste hypothesis with an agent-based model. In the model, the agents inherited continuous traits that determined their wasting behaviour and were subjected to selective pressure from a variable environment. The traits determined the propensity for a given agent to waste and the amount of energy wasted. By tuning the level of environmental variability, we could determine whether increased variability led to increases in the continuous traits that determined wasting. The results we obtained do not support the hypothesis. Most importantly, we found that the propensity for waste was strongly selected against in all environments. At the start of each experiment agents were likely to waste 50% of the time on average, but selection drove that rate down to the minimum possible level of ~10%. This suggests that wasting does not provide an adaptive advantage in highly variable environments in the manner that Dunnell proposed.

Taylor Davis

Internalized Norms and Taboo Tradeoffs: Taking the Sacred Out of "Sacred Values"

While the term "sacred values" picks out a very important set of cultural phenomena, it does so in a confused and misleading way, because the concept of sacred values conflates cognitive traits with motivational traits. The notion of sacred values implies that the relevant motives depend upon, or are somehow inherently related to, beliefs about the sacred. In fact, however, the "taboo tradeoffs" that are the hallmark of sacred values are best explained without any reference at all to representations of

the sacred. The theory of gene-culture coevolution predicts that humans possess a suite of psychological adaptations for acquiring cultural norms, and among these are capacities for being intrinsically motivated to follow and enforce norms, rather than being merely instrumentally motivated to avoid negative consequences of punishment, or positive consequences of social reward and approval. In other words, humans are often motivated to "do the right thing" just because it is right—without regard for any consequences at all. Thus, taboo tradeoffs result from the internalization of norms in general—regardless of whether those norms have anything to do with beliefs about what is sacred. Of course, many important norms do indeed involve beliefs about the sacred, and thus sometimes representations about what is sacred do trigger the intrinsic motives that give rise to taboo tradeoffs. But this entails that representations of the sacred are just one source of taboo tradeoffs, not that sacredness is essential to "sacred values." A detailed understanding of norm psychology reveals that beliefs about what is sacred must always be distinguished, as culturally inherited traits, from the motivations produced by internalized norms.

Maxime Derex, Jean-François Bonnefon, Rob Boyd and Alex Mesoudi

Causal understanding is not necessary for the improvement of culturally evolving technology

The tools essential for life in even the simplest foraging societies are complicated artifacts made of multiple interacting parts. In theory, cultural evolution can give rise to these complex, highly efficient technologies via the gradual, aggregate efforts of generations of individuals, even in the absence of explicit understanding of how they work. This prediction, however, has never been properly tested, and it is not clear how the gradual improvement of tools affects individuals' understanding about how these tools work. We provide such a test by asking participants (French university students) to improve the configuration of a wheel going down on rails such that the wheel descends as fast as possible. The wheel comprised 4 weights that could be moved along 4 spokes. Participants were part of chains of 5 individuals and each participant had 5 trials to improve their wheel. We ran two treatments. In the Configurations treatment, participants could view the last two configurations from the previous participant in the chain. In the Configurations + Theory treatment, participants additionally received the previous participant's explicit, written theory about the physical system. After completing their trials, participants' understanding was evaluated in isolation by presenting them with pairs of wheels and asking them to predict which wheel would reach the bottom of the rails in the shortest amount of time. Our results show that the performance of the wheel gradually improves across generations in both treatments, but that participants' understanding does not correspondingly improve. We also find a strong canalizing effect of theory transmission on both individuals' exploration and understanding. These results indicate that cultural evolution operates to improve a technological artifact even though

individuals don't understand what they are doing. In fact, the transmission of explicit causal theories might result in long term, detrimental effects on cultural evolution.

Juliet Dunstone, Christine Caldwell and Mark Atkinson

The impact of executive functions on flexible decision making during social learning

The use of explicitly metacognitive learning strategies has been proposed as an explanation for uniquely human capacities for cumulative culture. Such strategies are proposed to rely on the use of executive functions (EF) and explicit, system-2 cognitive processes, and to enable advantageous selective copying. To investigate the plausibility of this theory, participants' ability to make flexible learning decisions under EF- resource load was investigated. 166 participants (predominately white British) were recruited at the University of Stirling. Participants completed a simple win-stay lose-shift (WSLS) paradigm task, intended to model a social learning situation where vicarious information can be used to inform response choice, by copying rewarded responses and avoiding those that are unrewarded. This was completed alongside a concurrent EF distractor task. Participants were split into 3 strategy groups: those that should use a flexible WSLS strategy, those that should always copy (information trial always revealed the target), and those that should always do the opposite (information trial never revealed the target). There were significant effects of EF load and strategy group; using a flexible strategy was more challenging than using one rule consistently, and copying was less challenging than avoiding stimuli selected in the information trial. However, each information condition was equally affected by competing executive function demands. A significant training effect was also evident after a small number of trials. These results suggest that learning decisions are underpinned by the use of executive functions even at a very basic level, but we found no evidence that flexible learning strategies relied on executive functions any more than did non-flexible strategies. However, the observed learning effects suggest that ceiling effects could be masking differences between conditions which might be apparent in other contexts.

Pierce Edmiston, Maxime Derex and Gary Lupyan

The effects of cultural inheritance on problem solving ability

Cumulative cultural evolution depends on the ability of populations to solve increasingly complex problems that isolated individuals would struggle to solve on their own. Previous lab experiments investigating cumulative culture have shown that groups in which solutions are shared vertically over generations and groups in which solutions are shared horizontally within a single generation can both result in group performance greater than isolated individuals attempting the same problems. However, it may be that groups outperform individuals because of their extended time budget, and not that cultural inheritance actually improves problem solving ability beyond what could be achieved individually. To test this, we compared the performance of isolated individuals to the performance of groups inheriting information vertically or horizontally while controlling for labor time. We find that two-person groups outperform individuals given the same total amount of time in a single session, suggesting that the benefits of information-sharing in groups may extend beyond a savings in labor time. Specifically, we show that two-person groups are more efficient at searching the space of possible solutions compared to individuals in a single session who are slowed by fixation on previous and

incorrect solutions. In comparing the effectiveness of vertical and horizontal forms of transmission, we find that the strategies differ in scalability, as adding two generations to a vertical transmission chain improved performance more than adding two individuals to a group working in parallel. Finally, we compare the effectiveness of vertical transmission over four generations to an individual returning for four separate sessions, finding support for the hypothesis that cultural inheritance via vertical transmission may be more effective than isolated labor when individuals become fixated on previous and incorrect solutions. This work helps reveal some of the mechanisms by which human populations can arrive at solutions that individuals could not on their own.

Carol R Ember and Ian Skoggard

Resource stress, beyond-household sharing, and the involvement of gods

Beyond-household sharing is an important form of cooperation and it is widely believed that an important mechanism for increasing cooperative behavior is the threat of supernatural punishment. Using a worldwide cross-cultural sample of 98 largely preindustrial societies from the Standard Cross-Cultural Sample (SCCS), we recently tested and found support for the idea that resource stress, particularly unpredictable natural hazards that seriously destroy food supplies, will increase the likelihood of customary beyond- household sharing in both food and labor (Ember et al. 2018). In many societies in the ethnographic record, hazards (droughts, floods, pest infestations) are often viewed as having supernatural causation, whether by deliberate punishment for human misdeeds or for capricious reasons. In some societies, supernatural agents help people avoid hazards by providing rain or protection. So we decided to ask: Are societies in more hazard- prone environments more likely to believe that supernatural agents cause them? What is the relationship between supernatural agents' involvement in weather and beyond-household sharing? Might natural hazards be the teeth of the supernatural punishment hypothesis? Using the SCCS sample, our recent findings suggest that: 1) supernatural agents are more likely to be thought to be involved with weather when hazards and other resource stressors are greater; and 2) that beyond-household sharing is more likely when supernatural agents are believed to either harm or help food supply with weather. However, we note that our data shows a broader involvement by gods in benevolent actions rather than punitive actions. When it comes to natural hazards few gods are acting in anger, suggesting that hazards are by themselves terrible enough events to contend with and there is no need to add moral condemnation to injury.

Cara Evans, Joseph Watts and Russell Gray

Did intergroup warfare drive the evolution of within-group cohesion and complexity in traditional Austronesian societies?

The ability of humans to live and cooperate in large groups of unrelated individuals poses a significant evolutionary puzzle. Competition between groups, particularly in the form of warfare, is frequently posited as an important selective driving force in the emergence and spread of cohesive, complex societies characterized by cooperative institutions and norms. Yet while a number of theoretical models and approaches have provided broad support for this thesis, direct empirical tests utilizing real-world data are lacking. Here, drawing on a geographically and socially diverse cross-cultural database (Pulotu; Watts et al. 2015), we modeled the evolutionary relationships between warfare and indicators of social

cohesion and complexity in ~90 traditional Austronesian societies. The analyses we present benefit from detailed purpose-built ethnographic information on external warfare at the societal level, including information on its initiation, prevalence, frequency and costs, in addition to variables relating to within-group social cohesion, and indicators of demographic and socio-political complexity (e.g., population size, social stratification and political organization). Employing Bayesian phylogenetic methods and ancestral state reconstruction, we ask: Did intergroup competition play a causal role in driving and sustaining the evolution of within-group social cohesion and complexity in Austronesian societies? The implications of our findings for evolutionary theories of large-scale cooperation and societal complexity are discussed.

Vanessa Ferdinand

Evolution and inference: how cognitive biases can be selection pressures on culture.

Learning is rarely, if ever, an unbiased process. As cultural artifacts replicate by being passed from individual to individual, among social groups, and across generations, the cognitive biases involved in the perception, processing, and production of these artifacts can operate as selection pressures on them, causing certain forms to increase in number at the expense of others. Here, I will discuss the similarities between replicator dynamics (a general model of evolution) and Bayesian inference (a general model of learning) and utilize their mathematical equivalence to specify a model where cultural artifacts and learners' hypotheses about those artifacts co-evolve. Culture is a special evolutionary system that is composed of two types of replicators: public structures in the world, such as artifacts and behaviors, and private structures in the mind, such as brain states or hypotheses (Sperber, 1996). The most interesting part of this model is the interpretation of fitness for both types of replicators. The fitness of public replicators is given by their likelihood under the population of hypotheses in learners' minds, and the fitness of private replicators is dictated by their likelihood under the population of artifacts in their environment. Both of these replicators can place constraints on one another as culture evolves and drive the system to unexpected places when fitness values are asymmetric.

Nicole Fider and Natalia Komarova

Quantitative studies of color categorization and category evolution

Color categorization in humans is a topic in psychology and linguistics which can shed light on human thought and perception in general. Although individuals can divide the color space in different ways, it is accepted that in a linguistically unified society there exists a specific set of basic color categories which speakers use when categorizing the color space. These categories give members of the population the ability to communicate color information with each other, and can evolve over time as the culture and language evolve. We believe that dynamic changes are less likely to occur within categories and more likely to occur on or around category boundaries. We present a mathematical method of identifying a language's set of color categories and boundaries based on color-naming data provided by the World Color Survey Data Archives, and we further present interesting cases that appear when we study color

categorization trends on gender-separated data. We discuss the possible dynamics of category evolution and how they can be related to the numerical data.

Emma Flynn, Rachel Kendal and Kayleigh Carr

Innovation takes time: Children's novel behaviour production is aided by increased time

Cultural evolution is underpinned by a dynamic between the transmission of information from others (social learning) and doing something new (innovation). Learning from others has received decades of attention, while innovation has only recently been a focus of intensive investigation. The current study set out to gain a more comprehensive and ecologically-valid understanding of children's exploration and innovation abilities. Following the provision of social information and acquisition of personal experience with a novel puzzle box (Multiple-Methods Box, Phase 1; Carr, Kendal, & Flynn, 2015), 4- to 9- year-old children (N = 199, predominantly White, UK) were permitted additional prompted attempts with the MMB in a second task phase. The MMB offers multiple exploration and innovation opportunities, by providing numerous tool, access point and exit combinations. Having previously evidenced high levels of imitative fidelity and low rates of innovation, children were seen to produce a significantly greater number of tool, access point and exit innovations with increased time and opportunity to explore the box along with explicit instructions and prompts to do so ($\chi 2(2) = 36.61$, $p < .001$). The efficacy, or not, of the social demonstrations observed prior to participants' first round of attempts in Phase 1 were of lesser influence in Phase 2, with the social method being enacted on fewer attempt trials. Nonetheless, the exploration of those participants who had initially observed a more efficacious social method (75% and 100% success conditions) was selectively enhanced in the case of two outcome variables. In discovering imitation to decrease with age and innovation to increase, this study replicated the developmental trends reported in Phase 1 and supports the competence-based interpretation advanced. Critically the results indicate that common experimental approaches with short timeframes in which innovation may be evidenced will underestimate children's capacity to produce novel behaviour.

Patrick Francois

Cultural group selection in the workplace and the laboratory

Human pro-sociality towards non-kin is ubiquitous and almost unique in the animal kingdom. It remains poorly understood, though a proliferation of theories has arisen to explain it. We present evidence consistent with a set of theories based on group level selection of cultural norms favoring pro-sociality. The evidence is drawn from survey data and from laboratory treatment of experimental subjects. The findings provide support for cultural group selection as a contributor to human pro-sociality.

Jessica Fujii, Sarah Espinosa, Michael Haslam, Katherine Ralls, Michelle Staedler, Natalie Uomini, Karl Mayer and Tim Tinker

Social learning and evolution of tool-use in sea otters

Sea otters are the only marine mammal species to have a durable material culture, in the form of stone tools that they use to break open hard-shelled marine invertebrates such as clams. However, it is unclear how long ago this culture was invented, how it evolved, and how it is transmitted. All three

subspecies of sea otters sometimes use tools, and the characteristic blunt molars of sea otters were already present in the Miocene period, suggesting that tool-use behaviours may have evolved millions of years ago. Sea otter tool-use frequency varies geographically and is linked to the availability of hard-shelled prey. When prey are scarce, sea otters show inter-individual variation in the frequency of tool-use that is related to variation in individual diets. Young otters are thought to learn tool skills, at least in part, from their mothers, probably as a mix of individual and social learning. As an interdisciplinary team, we present the current state of knowledge on geographical and individual variation in sea otter stone tool-use, how it is transmitted from one generation to the next, and the archaeological signatures of sea otter stone use that can yield data on prehistoric sea otter presence and behaviors. The longevity of their stone tools makes sea otters ideal candidates in which to study behavioural evolution.

Gwendolyn Gardiner and David Funder

Geographic predictors of personality traits

Large cross-cultural assessments of personality have found meaningful variation in traits around the world (e.g., Schmitt et al., 2007). Researchers have speculated these group-level individual differences may be due to geographic factors, such as climate, distance from the equator, and historical pathogen prevalence (Shaller & Murray, 2008). We present new data from the International Situations Project that assesses personality traits using the Big Five Inventory-2 across 65 countries in 42 languages from over 16,000 participants. Because of potential within country variation in climate, all analyses were conducted at the city level, resulting in 87 unique data points. City-level personality trait averages and their variance were correlated with city-level average annual temperature. Overall, openness to experience had the strongest correlation with average temperature (r = -.41), such that cities lower in openness had higher average temperatures. On the facet level, this relationship seemed to be strongest for the facets of creativity (r = -.30) and intellect (r -= -.46), and less so for aesthetic appreciation (r = -.18). Agreeableness (r = -.32) and extraversion (r = -.23) were also negatively related to the average temperature of a city. For extraversion, this relationship was entirely driven by the facet of sociability (r = -.43). Conscientiousness was unrelated to temperature on the trait level (r = -.04), but on the facet level, responsibility was negatively related to temperature (r = -.33). Additionally, the variation in personality traits for each city (i.e., standard deviation) was also correlated with a city's average annual temperature. The variability in all five traits were strongly, negatively correlated with a city's average temperature, indicating higher temperatures are related to less variation in personality traits. In sum, hotter climates are associated with lower levels of openness, agreeableness, sociability, and responsibility, and less variation in overall personality.

Ellen C. Garland, Luke Rendell, M. Michael Poole and Michael J. Noad

When revolutions fail: understanding the underlying mechanisms of humpback whale song revolutions through investigating failures

Multiple humpback whale song revolutions (where a song introduced from a neighboring population rapidly and completely replaces the existing song) have spread across the South Pacific region from the east coast of Australia to French Polynesia. This has occurred repeatedly in each of the five western and central South Pacific populations until reaching French Polynesia, where the song revolutions periodically failed. Here, we investigate how undocumented population substructure, aberrant singers,

and/or potential bidirectional introductions may contribute to revolution failure. Song unit sequences were extracted from over 2,000 phrases recorded across French Polynesia (Society, Gambier, Tuamotu and Austral archipelagos) from 2009-2015, to allow fine-scale analysis of composition and sequencing to understand subpopulation structure. Two decades of theme sequences in French Polynesia (1998-2015) were also analyzed to understand the overall song progression in the central Pacific. Clustering of song phrases using the Levenshtein distance indicated potential subpopulation structure across the region. Structure resulting in reduced residency times in migratory locations may contribute to song revolution failure. Understanding the mechanisms driving song revolutions and the factors that may disrupt this phenomenon will have wide-reaching implications to our understanding of song learning, song evolution and cultural transmission in non-human animals.

Indra Gesink

Three arguments against evolution by group selection, in particular as a driver of cooperation, and a way forward

Responding to earlier work this paper presents three arguments against evolution by group selection, in particular as a basis for cooperation, and shows a constructive way forward. I illustrate that 1) although groups can be simply posited in mathematical models, in physical reality their persistence requires a causal basis, 2) selection of groups or their drivers does not naturally lead to cooperation and is in fact orthogonal to a spectrum of cooperation versus competition, or even to two spectra of presence versus absence of cooperation and competition, and 3) competition and cooperation are not a dichotomy but two sides of an identical coin, and likewise, individuals units and groups of smaller, less complex constitutive units are only two different perspectives on one phenomenon. Respectively this is to defuse the appeal of group selection, defuse its appeal as a basis for cooperation and destabilize the associated confusing terminology. Taken together this forms the basis on which this paper subsequently constructs a way forward. The paper then also addresses some expectable objections.

Amir Goldberg and Sarah Stein

Beyond social contagion: Associative diffusion and the emergence of cultural variation

From musical taste to political beliefs, contemporary societies exhibit remarkable and persistent cultural differences. Where does this patterned cultural heterogeneity come from? Network models of diffusion predominantly think about cultural variation as a product of social contagion. But culture does not spread like a virus. In this paper, we propose an alternative explanation which we refer to as associative diffusion. Drawing on two insights from research in cognition---that meaning inheres in cognitive associations between concepts, and that such perceived associations constrain people's actions---we propose a model wherein, rather than beliefs or behaviors per-se, the things being transmitted between individuals are perceptions about what beliefs or behaviors are compatible with one another. We demonstrate that associative diffusion leads to the emergence of cultural differentiation. Whereas conventional contagion models require an assumption of network segregation to explain cultural variation, we show that the endogenous emergence of cultural differentiation can be entirely attributable to social cognition and does not necessitate a clustered social network or a preexisting

division into groups. Moreover, we show that prevailing assumptions about the effects of network topology do not hold when diffusion is associative.

Gili Greenbaum, Marcus W Feldman, Erella Hovers and Oren Kolodny

Could an increase in population connectivity in the Levant have been the driving force of the transition to the Upper Paleolithic?

The transition from the Middle to the Upper Paleolithic (UP) constitutes a major turning point in human evolution, reflected in the material culture, demography, and geographical expansion of modern humans circa 40kya. However, somewhat surprisingly, attempts to identify the origin of this so-called 'revolution' in the form of a particular stone-tool techno-complex that spread across the human range, representing the spread of cultural modernity, have failed. Instead, the record from this period comprises multiple 'transitional techno- complexes', some associated with modern humans and others with Neanderthals. The cultures that these techno-complexes represent are characterized by precursors of the material cultures of the UP, often alongside features that suggest local cultural continuity. The coordinated appearance at a similar timing of these transitional cultures, despite a lack of a clear common origin, is puzzling. We suggest that these local 'revolutions' have a common driving factor, which did spread from a single origin, explaining the coordinated timing of the appearance of transitional techno-complexes, but which in itself did not determine the particular form of each local revolution. We propose that this driver of the transition to the UP may have been an increase in inter-population connectivity, which allowed local cultures to rapidly evolve and attain greater complexity than ever before. We study the possibility that this change occurred in the Levant, in the context of the interaction between modern humans and Neanderthals, and spread from there. In this article we outline processes that are expected to have influenced inter-population connectivity, we offer simple models to explore them, and we use these models to derive predictions that stem from our hypothesis.

Thibaud Gruber and Dora Biro

Efficiency as a driver of cumulative cultural evolution: from birds to primates

While evidence for socially transmitted behaviour in a variety of species from taxa as diverse as birds and primates supports claims of cultural variation in wild animals, cumulative cultural evolution (CCE) in animals itself remains a controversial topic, because of limited evidence for progression toward more complex behaviour. As such, animal cultures remain largely seen as unchangeable constellations of knowledge that are perpetually re-invented by each new generation of a given population, with little progression from one variant to another across generations. We believe that this view results mainly from the theoretical approach applied to CCE, inspired by modern humans, which tends to blend the concept of cultural evolution with an increase in cultural complexity, the ratchet, scaffolded by high-fidelity social learning processes such as imitation or teaching. While we agree that increase in complexity has characterized much of human cultural evolution, and possibly some animal cultural traits, we believe that complexity may not be a driver per se for CCE. Indeed, it is unclear why individuals would naturally strive for more complexity. Rather, both humans and other animals select for greater efficiency, which may in turn select for more complex behaviour as a by-product. As a result, an increase in complexity does not appear to be a requirement for CCE to occur. We will analyse examples from the

literature and some of our recent studies in this light: the spread of moss-sponging as an alternative to leaf-sponging in wild chimpanzees, and the collective/cumulative learning of flying routes across artificial generations in homing pigeons. We argue that both examples may be considered evidence of CCE, which arose through selection for greater efficiency, rather than complexity. Accordingly, efficiency rather than complexity may be the main driver for CCE.

Daniel Grunspan, Michelle Kline and Sara Brownell

The lecture machine: a cultural evolutionary model of pedagogy in higher education

Lecture is the norm in Western higher education, despite a body of work establishing that alternative methods are more effective, and an array of key stakeholders calling for change in educational practices. Many departments and institutions are enacting interventions aimed to change faculty's instructional practices, but most of these interventions fail to make major impacts. Leveraging these change efforts to their fullest potential may require accepting change at a generational pace, where cultural evolutionary dynamics are extremely relevant. We present a conceptual model of faculty change grounded in cultural evolution. This model considers two interacting processes that take place across the life history of an academic career starting from time as an undergraduate progressing to tenured professors: 1) natural selection during career advancements (e.g. hiring and tenure promotion), and 2) cultural transmission of pedagogical methods. We consider these processes in both the context of PhD granting institutions and non-PhD granting institutions, and specifically how the unequal flow of individuals and ideas between different institutions may affect the evolutionary trajectory of pedagogical practices. This framing helps conceptualize the best actions for enacting change in pedagogical practices. We discuss how this model serves as an organizational framework for cultural evolution in academia, how it helps in understanding historic constraints on pedagogical change, developing testable hypotheses about pedagogical change, and ensuring that efforts toward enacting change are maximally impactful. We further discuss recommendations based on this model as well as future directions.

Andone Gurruchaga

A demographic-structural hypothesis for Tiwanaku state collapse

The state of Tiwanaku was an Andean polity based on the city of Tiwanaku in western Bolivia that extended around Lake Titicaca and in present-day Peru and Chile from 500 to 1150 AD. Archaeological evidence suggests that around 1100 AD the Tiwanaku state collapsed politically. The construction of monumental complexes stopped, residential areas were abandoned, and temples were destroyed. There are two main hypotheses to explain the state collapse. The environmental change hypothesis states that the collapse of Tiwanaku is the result of a long-term drought. This episode is paleoenvironmentally identifiable by sediments from Wiñaymarka lake and ice cores from the Quelccaya glacier. Although the environmental hypothesis is robust in terms of identifying a paleoenvironmental event of importance for the sustainability of Tiwanaku society and his agricultural productivity, it is insufficient to identify the social mechanisms that led to state collapse. The social hypothesis states that the collapse is the product of long-term social tensions, ongoing socio-political and demographic changes. This hypothesis is vague regarding the specific socio-demographic dimensions responsible for the social disintegration, it also lacks theoretical support and is only supported by evidence that seems to indicate violent events against the Tiwanaku elite materialized in

the ritual destruction of structures. The present work argues that demographic-structural theory provides a robust hypothesis to explain the state collapse. New population estimates and archaeological evidence suggest correspondence with the predictions of the theory. A potential explanation of Tiwanaku state collapse under the Turchin-Korotayev model of population dynamics and internal warfare in agrarian empires is discussed.

Dylan Hadfield-Menell, Mckane Andrus and Gillian Hadfield

Legible normativity: the value of silly rules

In this paper we model two important, we argue related, features of human normative systems: 1) that the enforcement of rules is routinely dependent on the voluntary enforcement actions of individual agents other than official enforcers; and 2) that human systems of rules frequently include rules with little or no discernible direct impact on welfare (silly rules). Using computational methods to model individual decisions to stay with or leave a group, based on estimates of the likelihood of norm enforcement, we show that agents in environments with dense normative structure (lots of silly rules) are able to more accurately and quickly determine whether important rules with consequences for welfare are effectively enforced by other agents. As a result, groups with dense normative structure are more robust to shocks to beliefs about enforcement and adapt more quickly to changes in the sustainability of enforcement. We argue that some norms, rather than directly impacting social welfare, may play a legibility function, assisting agents in their understanding of what are the active rules in a community.

Renée Hagen and Brooke Scelza

Outgroup norm adoption among the Himba in Namibia

What circumstances influence the adoption of outgroup norms regarding childbirth and infant care among first-time mothers? We will address this question in a mixed-method study among the Himba, a semi- nomadic pastoralist population of Northwest Namibia. The Himba are becoming increasingly market- integrated, although communities vary in their distance to town, proximity to the main road and participation in the cash-economy. Most Himba women subscribe to traditional perinatal care norms such as giving birth at home and withholding colostrum, but in accordance with the SDG, there has been a recent WHO campaign encouraging women to give birth in the regional hospital and shift to WHO-recommended perinatal care practices. Here we aim to use cultural evolution theory to test predictions about how individual wealth and status correlate with the adoption of outgroup norms. Hypothesis 1 is based on the biological market theory, which predicts that low-status individuals expect to benefit more from outside opportunities for change, whereas high status individuals expect to benefit most from maintaining the status quo. Low status individuals will adopt outgroups norms more readily. Our second hypothesis predicts that high status individuals with more wealth are exposed more to outgroup norms, because they can afford to pursue education and go to cities, hospitals and markets more often. More frequent interaction leads to more norm adoption through conformity bias and exposure to new prestige models. We will use focus groups with Himba women and health workers, and semi-structured interviews with first- time Himba mothers (n = 100) to measure personally held norms regarding perinatal care, and obtain information on demographics, wealth and status, exposure to outgroup norms, network data, and previous birth experience. We expect to find that above a certain

wealth threshold, lower wealth and status are associated with increased adoption of outgroup perinatal care norms.

Bing Han, David Hirshleifer and Johan Walden

Social transmission bias and investor behavior

We offer a new social approach to investment decision making and asset prices. Investors discuss their strategies and convert others to their strategies with a probability that increases in investment returns. The conversion rate is shown to be convex in realized returns. Unconditionally, active strategies (e.g., high variance and skewness) dominate, although investors have no inherent preference over these characteristics. The model has strong predictions for how adoption of active strategies depends on investors' social networks. In contrast with nonsocial approaches, sociability, self-enhancing transmission and other features of the communication process determine the popularity and pricing of active investment strategies.

Bing Han, David Hirshleifer and Johan Walden

Visibility bias in the transmission of consumption norms and undersaving

We study how bias in the social transmission process affects contagion of time preference norms. In the model, consumption is more salient than non-consumption. This visibility bias causes people to perceive that others are consuming heavily and to infer that others have a high discount rate. The transmission of norms for high discounting increases consumption and the equilibrium interest rate. Information asymmetry about the wealth of others dilutes the inference from high observed consumption that the discount rate is high. In consequence, in contrast with the Veblen wealth-signaling approach, information asymmetry about wealth *reduces* overconsumption. The visibility bias approach offers a novel explanation for the dramatic drop in the savings rate in the US and several other countries in the last thirty years. In contrast with other approaches, the visibility bias approach suggests that relatively simple policy interventions can ameliorate undersaving.

Swayze Hansen and Adrian Bell

Increased presence of cultural markers in constructing iconoclastic religious identities

Religious identities are constructed through beliefs and practices as well as through complex social relationships in the community. Our project addresses how people use ethnic markers and the classifications of the different religions in Tonga to identify themselves and others within the religious landscape of their society. Our methods include a combination of triad sorting tasks, ethnographic observations, and a Stick Figure Study which solicits sartorial representation of group identity. Analysis of the triad sorting tasks classified the iconoclastic churches as separate from the other Methodist religions in Tonga. Given the social benefits to coordinate among the iconoclastic and non-iconoclastic groups, we expect an increased number of cultural markers associated with the outlying religions. An

analysis of our Stick Figure Study and other observations support these expectations, though some complexities apply in this complex Judeo-Christian landscape.

Marcel Harmon

The owner project requirement's document as a tool of cooperation

In the building/construction industry, the design and construction process is often challenged with staying true to a project's original vision and goals. In the pressure cooker that sometimes develops towards the end of design, as deadlines loom, unforeseen problems arise, budgets tighten, and the overall owner/design/construction team group identity and unity of purpose is stressed, design goals are often value- engineered out of a project. Many of these value-engineered goals focus on sustainability, health/wellness and community, with lost prosocial benefits that would have extended well beyond a particular building, its owner, or its occupants. However, the Owner Project Requirement's (OPR) document has anecdotally shown itself capable of strengthening the owner/design/construction team identity in their cooperative pursuit of a project's original vision and goals. It does this in part because it satisfied Elinor Ostrom's fourth ultimate design feature – low- cost monitoring, so that lapses of cooperation can be easily detected. Ideally, the OPR holds everyone accountable to the project's vision and goals throughout the design/construction process. It does this by providing transparency of 1) the nature of the project's vision and goals, 2) design or construction changes that impact the vision and goals, 3) who instigated the changes, and 4) why the changes were made and what impacts they're estimated to have. However, it doesn't appear that any research has been conducted to formally assess an OPR's impact in this manner. This talk will present the results of a study currently being formulated to examine the impacts different types of OPRs have compared to no OPRs in preserving a project's original vision and goals. At a minimum, projects analyzed will come from the U.S., Brazil, Mexico, and Canada, and the results used to verify it's monitoring function as well as improve its effectiveness.

Jacob Harris, Robert Boyd and Brian Wood

Sources of variation in projectile technology among Hadza of Tanzania

Complex inventions, such as bow and arrow projectile technology, enabled our species to colonize every terrestrial habitat on the planet. Currently there are two leading hypotheses to account for our species' unparalleled technological sophistication: The cognitive niche hypothesis, and the cultural niche hypothesis. The cognitive niche hypothesis posits that much of the evolutionary success enjoyed by humans may be attributed to larger brains and greater computing power. The cultural niche hypothesis argues that although humans possess relatively large brains, we owe much of our success as a species to cultural proclivities, rather than increased intelligence alone. Thus, the relative roles of advanced cognition and cumulative culture in the adaptation and evolutionary success of Homo sapiens remain a topic of ongoing research.Hadza hunter-gatherers craft straight-stave self bows from local materials to hunt wild game. Hadza men begin using bows at a very early age, as young as 3 years old, and by adulthood are expert bow makers (bowyers). Hadza bowyers provide a valuable opportunity to explore how cultural traditions and beliefs about functional properties influence projectile technologies. In 2017 and 2018 we interviewed 67 active Hadza bowyers between the ages of 15 and 77 regarding bow manufacture and use. Drawing on these data, we evaluate the relative contributions of culture and

cause-and-effect understanding necessary for the successful manufacture and use of Hadza projectile technology.

Rachel Harrison and Andrew Whiten

The transmission of symbolic and non-symbolic images in transmission chains of four- to eight-year-old children

This exploratory study contrasts the transmission of a symbolic versus a non-symbolic image along 10 transmission chains each composed of 10 four- to eight-year-old children in the United Kingdom, aiming to investigate the relative importance of replication versus reconstruction in cultural transmission. The question of whether replicative or reconstructive processes explain the of stability of cultural items over time and space is integral to a debate between two schools of thought; 'standard' cultural evolution, and the cultural attraction or epidemiology of representations approach. The groups of drawings resulting from these transmission chains were presented to independent adult judges tasked with placing the drawings into the order they were produced (in other words, recognising which drawings were 'copies' of each other). Neither the symbolic nor the non- symbolic model images survived the transmission process, with both being radically transformed. Drawings in both types of chain were subject to a loss of complexity (as measured by file size), though this occurred more rapidly in chains seeded with the non-symbolic model image. Independent judges were more successful at placing images from chains seeded with the symbolic image than chains seeded with the non-symbolic image into the correct order. Some chains appeared to reach stability in the latter part of the chain, with children managing to produce images that resembled the previous image in the chain. This may indicate that such stability is only possible when images have reached a reduced level of complexity, due to decreased demands on children's working memory or motor skills.

Hannah J. Haynie, Patrick H. Kavanagh, Fiona Jordan, Carol R Ember, Russell D. Gray, Simon J. Greenhill, Kathryn Kirby, Geoff Kushnick, Bobbi S. Low, Ty Tuff, Bruno Vilela, Carlos A. Botero and Michael Gavin

Pathways to social inequality

Social inequality is ubiquitous in modern human societies in spite of the pervasiveness of relatively egalitarian, small-scale societies throughout the majority of human history. Here we examine the pathways that lead to the creation and maintenance of cultural institutions that formalize and perpetuate social inequality. Building on the conclusions of a recent review of the literature in this area (Mattison et al. 2016), we use cultural data and environmental variables for a global sample of 367 societies drawn from the D-PLACE database to examine in detail a proposed trajectory for the evolution of social inequality. We employ a structural equation model framework to investigate the relationships between several variables associated with the theoretical constructs of environmental stability, economic defensibility, and wealth transmission. Ultimately these models are used to predict the presence of institutionalized and heritable systems of social inequality, such as class, caste, and slavery. This approach allows us to evaluate potential direct and indirect effects of observable environmental and cultural variables on outcomes of institutionalized social inequality. Importantly, we find that patterns of intergenerational transmission of both material and social wealth are important to social inequality, and contrary to prior literature that predicts only indirect effects of subsistence on inequality

outcomes we also identify direct effects from intensive agriculture and domesticated animals. These results provide a richer understanding of the mechanisms that lead to widespread social inequality, illustrate that how social inequality is measured influences the pathways that predict it, and demonstrate the application of structural equation model methods to investigate the complex relationships between elements of human culture.

Barend van Heusden

Modeling the dynamics of cultural complexity

One way in which we might be able to account for the evolution of cultural complexity is by showing that this complexity can result from a relatively simple process structure. In my paper, I will argue that the structure of the cognitive process underlying human culture is both cumulative and recursive and by being so, generates increasing complexity, on the basis of a restricted number of relatively simple (cognitive)building blocks. Human culture emerged in primate evolution when our ancestors became aware of a difference between the past and present, between a relatively stable set of memories and a changing actuality ('decoupling'). The necessity to deal with this difference, and to relate past and present, generated and still generates culture. Moreover, as the process itself could now be stored in memory and therefore also recognized in actuality, it became necessarily recursive. The number of cognitive strategies that can be used to bridge the gap is limited, and they build upon each other: it involves, first, the perception of similarities, then the imagination, followed by conceptualization through language and, finally, the analysis of underlying structures through graphic symbols. Each time a new strategy came into being, it first went through an adaptation of all the strategies already present, before coming 'into its own'. In combination with the recursive character of cultural cognition, this may have caused growing levels of complexity, coming about at an ever increasing speed.

Elizabeth Hobson

The evolution of socio-cultural conflict strategies

In many social species across both humans and other animals, individuals both create their social worlds through interaction decisions and are then subject to and constrained by these social constructs, which can affect an individual’s future actions. Understanding how much individuals know about their social worlds is critical in understanding these potential feedbacks. However, it is difficult to determine how much knowledge individuals have of the social structures in which they live. I present new methods that make detecting the presence and use of social knowledge more tractable. I apply these methods across 85 animal species to detect the socio-cultural strategies that structure conflict decisions within 172 independent social groups. While most groups follow only the most basic rules of dominance hierarchies, others are more structured and exhibit more complex socio-cultural strategies such as focusing conflict with close competitors or with the most bottom-ranked individuals. Importantly, these strategies can vary within species, suggesting that socio-cultural rules may be plastic responses to environmental or social conditions rather than rigid characteristics of species. This approach provides

new potential for broad comparative analyses to better understand the evolution of complex sociocultural traits.

Ze Hong

Modelling the gene-culture coevolution of educational attainment in contemporary societies

The future evolutionary trajectory of cognitive and behavioral traits in contemporary human populations is arguable one of the most important scientific endeavors yet relatively little effort has been invested. Here I present an agent-based simulation model to examine the potential evolutionary outcomes of educational attainment (EA) under current selective pressure in western populations. As complex human behavioral and cognitive traits are likely to be the result of a combination of genetic potential and cultural input, both genetic and cultural evolution will contribute to the phenotypic change over time. With the assumption that genetic evolution operates under the mechanism of natural selection (more educated people have fewer offspring) and cultural evolution operates under the mechanism of prestige-biased transmission (more educated people appear more prestigious), I show that under realistic parameter settings, although the phenotype of EA is likely to keep increasing in the short term, the genetic component of EA may be undergoing a constant decline and eventually lead to a decrease in the phenotype. The simulation results not only shed light on the mechanism of much debated Flynn effect (recent consistent increase in IQ) but also provide some insight on general patterns of human cognitive and behavioral evolution.

Bailey House, Joan Silk, Patricia Kanngiesser, Clark Barrett, Alejandro Erut, Andrew Marcus Smith, Tanya Broesch, Senay Cebioglu, Alyssa Crittenden, Sheina Lew-Levy, Carla Sebastian-Enesco and Süheyla Yilmaz

Universal norm psychology and the origins of societal diversity in prosocial behavior

Human cooperation is unique both in its scale and in the degree to which different societies practice different forms of prosocial behavior, cultural diversity which emerges as children reach middle childhood. These features suggest that prosociality is partly motivated by culturally-transmitted social norms, which vary across societies and are acquired during development by a universal human norm psychology for learning and following these norms. Social norms are central to numerous theoretical models of human sociality and development from several different disciplines, but most empirical studies have not directly linked social norms to prosocial behavior. Here, we demonstrate this link through field experiments that measure prosocial behavior in eight different societies, using the Dictator Game. We tested adults (N=255) and children (N=833) aged 4-17 in India (Pune), Tanzania (Hadza people), the United States (Phoenix), Ecuador (Shuar people), Germany (Berlin), urban Argentina (La Plata), rural Argentina (Wíchi people), and Vanuatu (Tanna). We show that cross-cultural variation in adults' prosocial decisions is predicted by local norms about 'correct' prosocial behavior. We also demonstrate that children begin to spontaneously conform to these social norms in early adolescence, and that this occurs only after the emergence of a uniform tendency for children to conform to explicit social norms. This illustrates how the development of a universal norm psychology can lead to the

emergence of societal variation in prosociality, and provides empirical support for theoretical claims that human prosocial behavior is highly dependent on local cultural norms.

Joshua Conrad Jackson, Joseph Watts, Teague Henry, Johann-Mattis List, Robert Forkel, Simon Greenhill, Russell Gray and Kristen Lindquist

Human emotion across 1156 languages: an analysis using concept colexification

Since Darwin's Expression of Emotion in Man and Animals, scientific perspectives have debated whether emotion categories such as anger, fear, disgust, joy, and pride are universal or culturally variable products. Following Darwin, basic emotion theories argue that emotion categories should be universal neurobiological responses. In contrast, constructionist theories argue that emotion categories are culturally variable phenomena that result when people apply socially learned knowledge to explain their affective state (e.g. pleasantness). We present a large-scale test of these theories using a linguistic paradigm known as colexification, which indexes concept similarity based on whether concepts are co-expressed with the same word—for example, the Maori word hiako means skin, bark, and leather. After constructing a database of 1156 languages (22 language families) and 2463 concepts, we build a massive colexification network in which we can (a) isolate the colexification communities associated with semantic clusters of emotions and (b) probe for the stability of these emotion communities across language families. Consistent with constructionist theories, we find that emotion concepts vary highly in their community organization across language families. The similarity between language families' communities is predicted by geographic proximity, suggesting that historic intercultural contact may have influenced the cultural evolution of emotion category meaning. We also find evidence of universal dimensions of emotion organization. For example, emotions universally cluster into communities based on whether they are seen as pleasant or unpleasant. Our analysis suggests that emotion categories share universal affective dimensions, but they otherwise vary widely in their meaning around the world.

Cameron Jones and Simon Kirby

The effect of biasing information on a transmission chain of short texts

Cultural traditions, such as religions and myths, survive millennia impressively intact. However, simple messages can be substantially altered after changing hands only a few times. (Kirby et al., 2015; Griffiths et al., 2008). How can cultural macro-stability be explained by micro-infidelity? Proponents of cultural selection argue that, though imperfect, transmission is faithful enough in the aggregate to sustain these traditions (Richerson & Boyd, 2005). Cultural attractionists argue that transmission errors are manifestations of individual biases: traditions are sustained through shared biases across populations (Sperber, 1996). In order to test these hypotheses, we experimentally manipulated the bias of participants. 10 transmission chains of 5 participants read a biasing introductory text, either positive or negative, about a fictitious controversial chemical. Participants were then asked to read and recall a second text, constructed to be neutral at the start of each chain. Their recollection was passed to the next participant in the chain (Moussaid et al., 2015). The positivity of the transmitted texts was measured by 3rd party ratings, and participants self-reported positivity toward the chemical. Multilevel regression models showed no significant effect of condition on the positivity of recalled texts ($p = 0.112$), implying that biasing texts did not systematically alter the polarity of recollection. However,

biasing text significantly affected participant self-report ($p<0.01$) and, crucially, information was lost significantly faster in the positive condition ($p<0.01$), indicating that negative bias facilitated improved information recall generally. A Bayesian model of fidelity and bias implied that participants were influenced by biasing texts but nevertheless recalled polarity faithfully ($R2 = 0.32$). The results emphasise the complex interaction between selection and attraction in cultural evolution. Individuals are able to preserve the polarity of texts on subjects about which they are biased. However, information was not preserved well generally, and bias had a clear effect on recall overall.

Fiona Jordan, Péter Rácz, Sam Passmore, Catherine Sheard and Alice Mitchell

Cultural evolution of kinship diversity: the micro and macro of talking about family

Kinship terminologies are semantic and social systems that delineate categories of family membership. These systems vary cross-culturally, but within a limited space of diversity that suggests constraints. Accounting for this restricted variety requires examining kinship systems as linguistic, cognitive, social, and biological mechanisms. Taking a cultural evolutionary approach, the VariKin project aims to understand patterned variation in kinship as an outcome of phylogenetic, adaptive, developmental, and usage processes. We present results from two subprojects tackling cultural macro– and micro-evolutionary questions. First, we consider whether the rate of change in kinship terms over time is related to their frequency of use in language. We compiled 34 language corpora comprising over 90 billion words across different genres (written, spoken, web) in 21 Indo-European languages. We show that cross-linguistically, frequency of kin term use is predicted by genealogical distance from ego i.e. we talk more about close relatives. We then use phylogenetic comparative methods to show that in 47 Indo-European languages, terms used most frequently tend to evolve slowly, demonstrating a potential mechanistic constraint on system change. Second, we present results investigating the individual-level processes at work in the developmental trajectories of children's acquisition of kinship language and knowledge. We use elicitation tasks and naturalistic observations from fieldwork in a Datooga-speaking community in Tanzania to show that kinship talk is child-anchored and compare these results to patterns seen in child-directed speech in three other languages.

Johan Kamal and Monica Tamariz

Vertical and horizontal transmission of cultural traits in Malaysian and British students

Cavalli-Sforza et al. (1982) found that some cultural traits are predominantly transmitted vertically (e.g. politics, religion) and others predominantly horizontally (e.g. watching sports). Following on their steps, we examined to what extent students resembled their parents (vertical transmission) and their peers (horizontal transmission) with respect to 30 traits, classified into 8 themes (beliefs, entertainment, food, habits, politics, religion, social and sports). We additionally compared two nationalities: Malaysian and British. An ANOVA of questionnaire responses returned a significant main effect of Nationality on social learning ($F(1)=3.914$, $p=.048$), with British showing more social influence (both vertical and horizontal) than Malaysians; a significant main effect of Transmission type on social learning, with more horizontal than vertical transmission ($F(1)=30.348$, $p=.000$); and a significant interaction ($F(1)=15.980$ $p=.000$), with British students showing strongest horizontal transmission and weakest vertical transmission. For

beliefs, entertainment and habits, transmission from peers trumped transmission from parents, and this difference was stronger in British than in Malaysian students. Social traits were preferentially inherited from peers for both nationalities, and there was a clear interaction for religion, which was transmitted mostly from parents in Malaysians and from peers in British students. Overall, these results show that cultural transmission pathways are, themselves, affected by national culture and cultural domain.

Anne Kandler

Comparing innovation rates across different social systems

In this talk we explore the applicability of neutral theory for comparing different social systems with regards to their innovativeness. The analyses of complete and thresholded datasets, i.e. datasets where variants with a frequency smaller than a specified threshold are omitted, may present contradicting evidence for underlying cultural transmission hypotheses. Based on the progeny distribution, i.e. the distribution of the number of variants that have produced a given number of new instances within a specified time interval, it has been shown that neutral theory can provide a plausible description of abundant variants, but rare variants can still deviate from neutrality. While this result is bad news for inferential purposes it may provide a way to compare effective innovation rates across different systems. In this situation, using the same threshold for all datasets allows us to use neutral theory to calculate maximum-likelihood estimates of the effective per-capita innovation rates, which then can be compared with each other. We apply this idea to the distributions of first names in various countries and find that the thresholded datasets indeed can be replicated by neutral theory. Interestingly, the comparison of the corresponding effective innovation rates reveals a scaling relationship: the larger the populations, the smaller the per capita innovation rate. Using different age-structured population models we show that this scaling relationship can emerge as the balance of the counteracting forces of diversification and homogenisation. Lastly, we point to the large differences between theoretical results regarding the accumulation of cultural variants in age-structured and non-age-structured populations.

Rohan Kapitany, Christopher Kavanagh and Harvey Whitehouse

The structural model of ritual

Ritual practice (shared, symbolic, and social acts) are culturally universal, yet display great morphology diversity. Previous analysis of the ethnographic record suggests that rituals ‘cluster’ around intense, infrequent ‘Imagistic’ varieties, and high frequency, low arousal ‘doctrinal’ varieties. However, it is likely that there are other important structural complexities that are yet to be evaluated. In this work we address two questions: 1) Does the relative frequency of ritual occurrence predict arousal in a contemporary cross cultural sample [of rituals]? and 2) Does the morphology of ritual in the ethnographic record reveal the two factor structure, when accounting for ~100 additional features? In the first instance, we will present an analysis of new survey data of self generated descriptions of ritual experiences collected in the US, Japan, and India (N = 600; 200 per country). In the second instance, we will present a new analysis of the factor structure of ritual features, as obtained from the Ethnographic Dataset on Ritual coded from the Human Relations Area Files (eHRAF). In so doing, we will examine the hypothesis that morphological diversity of ritual form is undergirded by common experiential and

structural dimensions. Implications for the evolution of ritual, and the adaptive role in human evolution, will be discussed.

Donna Kean, Elizabeth Renner, Mark Atkinson and Christine Caldwell

Capuchin monkeys can learn and generalise a win-stay, lose-shift strategy under social information and individual exploration conditions

The ability to learn discriminatively from the successes and failures of others may be integral to the capacity for cumulative culture. This ability has not been sufficiently tested in non-human primates, but such investigations could provide insights into the apparent lack of cumulative cultural evolution in their natural behaviour. To investigate this, capuchin monkeys were tested in a visual discrimination task for which success required copying of rewarded, and avoidance of unrewarded, behaviors. Thirteen monkeys housed at Edinburgh Zoo were trained to take part in a touchscreen stimulus selection task beginning with two-stimulus, and progressing to three-stimulus, discriminations. Subjects were either in a social condition where the experimenter performed an information trial (IT) by choosing between the available stimuli, or an individual condition where the subject performed the response during the IT. Eight monkeys reached our pre-determined performance criterion on the two-stimulus task (four in the individual condition, and four in the social condition). The subjects that reached criterion were significantly more successful following rewarded ITs, compared with unrewarded, suggesting that it was easier to learn the win-stay rule, compared with the lose-shift. Their ability to generalise the win-stay, lose-shift strategy was then evaluated by transferring these monkeys to the three-stimulus version. Selections that were rewarded during the IT were repeated with high accuracy (>80% success) even following transfer to the three-stimulus discrimination problems, suggesting that these monkeys recognised the predictive relationship between the information trial and the test trial, and could use this information with high fidelity. Results suggest capuchin monkeys can learn to use social information in ways that could in principle support cumulative culture, since the application of a win-stay, lose-shift strategy allows an individual to outperform a demonstrator. Future research will investigate the extent to which this could support improvements in performance over multiple generations.

Daniel Kelly

Cultural evolution, norm change, and moral progress

I formulate the most charitable and theoretically sophisticated version of an argument I want to resist, which I'll call the Cultural Evolutionary Argument Against Guided Moral Progress. Henrich (2016) and others have recently emphasized that cultural evolution is another blind watchmaker, capable of producing packages of complex adaptations in the absence of foresight or understanding. Moreover, the extended process of cultural evolution can design complex adaptations that are causally opaque to the humans who use them. There is now a persuasive case that packages of cultural adaptations often have virtues and functions we individually and collectively fail to completely understand. I argue that morality itself is one such package, and that of clusters of norms and the more complex institutions they constitute exhibit many characteristics likely to render them opaque to us. We remain distressingly ignorant in many ways of how this complex, evolved system of social technology works. Moreover, this ignorance, together with how complicated, numerous, and intricately intertwined the elements of a society's normative framework are, directed attempts to bring about specific changes to the social order

or the moral codes that govern it may be more likely to go awry in unforeseen ways or trigger ripple effects of unwanted consequences than to produce genuine moral progress. In short, the line of thought seems to imply that intentional attempts to change this social technology will be nothing more than shots in the dark, at least as likely to impair as to improve it. Hence, an evolutionary perspective that appreciates causal opacity (or in this case, institutional opacity) appears to militate against certain kinds of activism, intervention, and other attempts to usher in moral progress (see e.g. Gaus 2016, Kling 2016). After formulating the argument, I identify important assumptions and offer an initial assessment of its weaknesses.

Rachel Kendal, Camila Coelho, Clara Corat and Eduardo Ottoni

Experimental field investigations of cultural capacities in the, tool-using, bearded capuchin (Sapajus libidinosus)

Experimental studies of captive capuchin monkeys and wild observational data indicate they are 'cultural', yet direct experimental evidence of social learning in wild individuals is sparse. The populations of bearded capuchins (Sapajus libidinosus) inhabiting the caatinga of the Serra da Capivara National Park (SCNP), in Brazil, are ideal for acquiring such evidence as they possess the largest toolkit described for monkeys . We present social network analysis and several open-diffusion experiments, involving posing novel foraging tasks to two wild groups of capuchins. Using network-based diffusion analysis we find, across tasks, that observation from close range, versus a distance, better predicts learning by naïve individuals, indicating observational learning rather than local/stimulus enhancement. We thus empirically support the argument that inter-population variability of toolkits in wild bearded capuchins is underpinned by cultural behaviour patterns. In addition, we present evidence for various biases in the cultural transmission of information in this species and briefly discuss how these biases compare to those seen in other species, including humans. For example, grooming networks outside the experimental context robustly predicted the diffusion of one task's solution, highlighting the importance of considering the role of social interaction, as well as association, networks in cultural transmission studies. We also find evidence for a bias towards observing the most successful individuals, moderated by sex. Finally, we discuss findings from a study using a cumulative problem solving task, indicating that the capuchins are able to use social information to switch flexibly to higher payoff behaviour , a requirement for cumulative cultural evolution. Understanding the social context of tool use in New World monkeys provides comparative insight, beyond great apes, regarding the cultural evolution of technology.

Kathryn Kirby, Simon Greenhill and Russell Gray

Evidence for niche partitioning within and among linguistic groups

There is an astounding diversity of subsistence strategies within and among the world's 7000+ linguistic groups, yet the causes of this diversity at macro-ecological and macro-evolutionary scales has received little empirical attention. In contrast, a substantial body of evidence points to niche partitioning as a strategy for reducing inter-specific competition in non-human species. Here, we explore the evidence for the partitioning of food resources over space and time among neighbouring human groups. We first describe different approaches to mapping the ranges of human linguistic groups at the time of western colonial contact in each major world region, as well as alternative approaches to linking these language

ranges to data on subsistence practices. We then test for evidence of niche partitioning within and among groups, while controlling for linguistic ancestry and population size. We discuss our findings in terms of their implications for the role of human culture in shaping the world's landscapes, from prehistory to modern times.

Michelle Kline, Cristina Moya, Matthew Gervais and Robert Boyd

Irrelevant-action imitation is short-term and social: evidence from two under-studied populations

Across the lifespan and across populations, humans overimitate causally unnecessary behaviors. Such irrelevant-action imitation facilitates faithful cultural transmission, but its immediate benefits to the imitator are controversial. Over short time scales, irrelevant-action imitation may bootstrap artifact exploration or interpersonal affiliation, and over longer time scales it may facilitate acquisition of either causal models or social conventions. To investigate these putative functions, we recruited community samples from two under- studied populations: Yasawa, Fiji and Huatasani, Peru. We use a two-action puzzle box: first after a video demonstration, and again one month later. Treating age as a continuous variable, we reveal divergent developmental trajectories across sites. Yasawans (44 adults, M=39.9 years, 21 women; 42 children, M=9.8 years, 16 girls) resemble Western Europeans, with increasing irrelevant-action imitation across childhood until reaching a plateau in adulthood. In contrast, Huatasaneños (48 adults, M=37.6 years, 33 women; 47 children, M=9.3 years, 13 girls) evince a parabolic trajectory: adults at the site show the lowest irrelevant-action imitation of any demographic set in our sample. In addition, all age sets in both populations reduce their irrelevant actions at Time 2, but do not reduce their relevant-action imitation or goal attainment. Taken together, and considering the local cultural contexts, our results suggest that irrelevant-action imitation has a short-term social function, hinging on affiliative social motives.

Eva Kundtová Klocová

Kneeling: communication of morality or power asymmetry?

Some cultures consider kneeling posture the most salient bodily expression connected to religious ritual practice. Closed, collapsed and lowered postures such as kneeling are generally perceived as either expressing submission and obedience or shame and atonement. Therefore, depending on the associated affective state (submission or shame), these postures might either emphasize power asymmetry (between the superhuman agents and human participants) or signal conformity with moral norms. With the use of the free-list technique, I compared two distinct cultural models and understanding of the kneeling posture. The two studied cultures are Czech and Mauritian, providing a significant contrast of religious traditions: the inhabitants of historically Christian, now highly atheistic Czech Republic

compared with Mauritians living in considerable ethnic, religious and cultural diversity in one of the most densely populated countries in the world.

Bernard Koch, Daniele Silvestro and Jacob Foster

The birth and (brutal, blackened) death of cultural things: a macroevolutionary history of metal music 1968-2000

Cultural evolution is a unifying theory in many social sciences, yet conspicuously absent from Sociology today. In this paper, we argue that the histories of cultural categories (e.g. music genres) can be explained through the analysis of the populations of cultural things (e.g. artists) that constitute these categories. First, we articulate an evolutionary theory for how cultural categories are transmitted, reproduced, and vary over time within these populations. By examining fan co-listening habits, the spatiotemporal distribution of bands, and band personnel records, we then demonstrate the plausibility of these mechanisms in a population of 30,000 Metal bands active between 1968-2000. Finally, we quantify diversification rates in Metal and nine of its subgenres using a macroevolutionary model originally designed for paleontological data. Our findings suggest that the growth of each genre is shaped by diversity dependence among artists, indicating that there are only so many sonic niches to be occupied within the stylistic parameters of a genre. Beyond its contributions to the sociology of art genres, we believe that the theory and methods introduced here could provide insight into the histories of other cultural categories like industries, religions, or types of consumer products.

Radek Kundt

Effects of religious auditory cues on dishonest behavior

Previous studies suggest that religious reminders and contexts enhance the saliency of group-specific norms and increase prosocial behavior. However, the effects of religious situational factors on dishonest behavior are less well documented and the underlying perceptual-behavioral mechanisms through which religious cues affect decision-making are still not fully understood. Moving beyond both the anthropomorphic depictions triggering reputational concerns and the priming carrying semantic associations with moral norms, we tested how an arbitrary subtle sensory cue associated with religion that does not bear any inherent meaning by itself affects moral behavior. Using an instrumental religious music, we conducted two experiments across four different sites: Japan, Mauritius, the Czech Republic, and the USA. Participants were exposed to one of three kinds of auditory stimuli (religious, secular, or white noise), and were given a chance to cheat on the subsequent task to increase their monetary reward. We report on the interaction between the condition and religiosity across sites as well as on the cross-cultural differences.

Ehud Lamm

Norm psychology in multi-cultural societies

Norm psychology refers to the psychological underpinning of the human capacity to acquire and deploy social norms. Norm psychology must be clearly distinguished from any particular set of social norms to enable a full understanding of the potentially different processes through which social norms and norm psychology evolve. Multi-cultural societies are natural experiments for studying this distinction. In complex, multi-cultural societies, multiple normative systems interact. Agents move between contexts in which one normative system dominates (e.g., the home) and contexts where others dominate (e.g.,

work), in addition to interacting with other agents driven by disparate normative systems. Here we discuss how the major theoretical and empirical approaches to norm psychology can address these phenomena and evaluate which approach is most promising. A key issue that will be clarified is whether people's norm psychology transcends the different normative systems they encounter. In particular, what are the different possible explanations, open to each account, for how someone may be highly normative with respect to one normative and social context while being less so in others in which they operate. This requires carefully distinguishing between social and normative causes of differential adherence to norms and variation in norm psychology. Understanding and measuring population variation in norm psychology and the ways in which normative systems interact are important for understanding the evolution of norm psychology and of social complexity. They are also critical for attempts to instill new social norms (e.g., those related to climate change) and to eradicate harmful norms (e.g., female genital mutilation) in complex societies. Beyond theoretical analysis we hope to show preliminary data from studies conducted in Israeli society, which is comprised of several large and often fairly self-contained yet still mutually interacting social groups.

Cristine Legare

Anthropomorphizing science: How does it affect the development of evolutionary concepts?

Despite the ubiquitous use of anthropomorphic language to describe biological change in both educational settings and popular science, little is known about how anthropomorphic language influences children's understanding of evolutionary concepts. In an experimental study, we assessed whether the language used to convey evolutionary concepts influences U.S. children's (5- to 12-year-olds; N = 88) understanding of evolutionary change. Language was manipulated by using three types of narrative, each describing animals' biological change: (a) need-based narratives, which referenced animals' basic survival needs; (b) desire-based or anthropomorphic narratives, which referenced animals' mental states; and (c) scientifically accurate natural selection narratives. Results indicate that the language used to describe evolutionary change influenced children's endorsement of and use of evolutionary concepts when interpreting that change. Narratives using anthropomorphic language were least likely to facilitate a scientifically accurate interpretation. In contrast, need-based and natural selection language had similar and positive effects, which suggests that need-based reasoning might provide a conceptual scaffold to an evolutionary explanation of biological origins. In sum, the language used to teach evolutionary change impacts conceptual understanding in children and has important pedagogical implications for science education.

Hillary Lenfesty and Thomas Morgan.

Modelling cultural evolutionary dynamics of prestige-biased copying

Human psychology includes social learning biases which guide our decisions about who and when we copy. While conformist-biased copying has been widely-studied, both theoretically and empirically, relatively little is known about prestige-biased copying. Nonetheless, fieldwork in small-scale societies has consistently shown that there are certain prestigious individuals to whom status is freely conferred, and that these individuals are sought out as models for social learning. Here, we present results from an agent-based simulation exploring the cultural evolutionary dynamics of prestige-biased transmission. We find that, contingent on the strength of observers' prestige-bias, prestige biased copying produces a

range of cultural systems, including council-like groups of influential individuals, or single big men. We also find that, like conformist transmission, prestige can homogenize group behaviors, but unlike conformist transmission, it still allows innovations to spread and so group cultures can change over time.

Kirsten Lesage and Rebekah Richert

Can God Make the Impossible Improbable? Anthropomorphism and Children's Belief that God Can Do the Impossible

By 4-years-old, most children can correctly judge events that are impossible or fantastical as being impossible (Shtulman & Carey, 2007). However, telling children God is present when impossible things happen may instead cue children to view those events as real, as children's belief in fantastical beings is related to the support that parents explicitly provide to encourage that belief (Woolley et al., 2011). The current study examined parents' and children's belief in God's agency to effect supernatural change in the physical world. Participants were recruited from Southern California from four religious affiliations (Protestant, Catholic, Muslim, Non-Affiliated) (N=222). Parents and 3.43- to 6.98-years-old children (Mean-Child-Age = 4.70) were asked separately if two Bible-based and two non-Bible-based events could happen in real life and then if God could make the four events happen on a 5-point Likert scale [-2] Not possible, Really Sure to [+2] Possible, Really Sure. Multilevel models estimated the possibility judgments: Level 1: causal mechanism, event type; Level 2: religious engagement, anthropomorphism of God, religious affiliation. For parents, events with God and Bible-based events were judged as more possible than their counterparts, and compared with all other religious affiliations, Muslim parents judged the events significantly more possible. For children, events with God were judged as more possible but the older the child, the less possible they judged the events. However, on average, Protestant children older than 4.94-years and Muslim children older than 4.58-years judged the events with God as possible (above 0) whereas Catholic and Non-Affiliate children remained at 0, or 'don't know.' This indicates that for children, God does not make all impossible events possible, but God does make impossible events improbable. The age at which this developmental shift in reasoning about supernatural causality occurs is influence by the child's religious cultural context.

Aaron Lightner and Edward Hagen

Simulating strategic defection in need-based transfers: A re-analysis of risk pooling and herd survival

East African Maasai pastoralists rely on herds that are vulnerable to environmental volatility. Previous simulation models of osotua, a need-based resource transfer (NBT) institution among the Maasai demonstrate its effectiveness for pooling risk and improving overall herd survival in unpredictable environments (e.g., Aktipis et al. 2011; Aktipis et al. 2016). NBTs consist of 2 rules: (1) ask for resources only when in need, and (2) when asked, give as much as possible without becoming needy. It is not clear, however, how and when NBTs are susceptible to defection. Possible ways to defect in NBTs are (1) feigning need, and (2) refusing to give when asked. Maasai social norms against defection suggest it is a realistic temptation (e.g., Cronk 2007). We therefore hypothesize that while NBTs are effective for pooling risk, this can be undermined by temptation to feign need and/or refuse to give. In a simulation study, we first replicated baseline pairwise agent-based models of standard osotua (no defection possible) in Aktipis et al. (2011). We then added two sets of defect conditions: feigning need and refusing to give. Each condition simulated pairwise outcomes for cooperators vs. defectors and mutual

defection. Standard osotua outperformed the no exchange condition, but defecting against a cooperator by feigning need was more profitable than standard osotua and cooperating with a defector was more costly. Mutually feigning need was more profitable than standard osotua in the short term, but average herd survival declines more rapidly than standard osotua and becomes more costly in the long run. Osotua herd survival also decreases when one or both partners refuse to give, and refusing to give to a cooperator is substantially more profitable than standard osotua. These findings motivate future empirical work investigating possible cultural mechanisms that incentivize cooperation and disincentivize defection in osotua and similar NBT institutions.

Patrik Lindenfors, Fredrik Jansson, Yi-Ting Wang and Staffan I. Lindberg

Investigating Sequences in Ordinal Data: A New Approach with Adapted Evolutionary Models

This paper presents a new approach for studying temporal sequences across ordinal variables. It involves three complementary approaches (frequency tables, transitional graphs, and dependency tables), as well as an established adaptation based on Bayesian dynamical systems, inferring a general system of change. The frequency tables count pairs of values in two variables and transitional graphs depict changes, showing which variable tends to attain high values first. The dependency tables investigate which values of one variable are prerequisites for values in another, as a more direct test of causal hypotheses. We illustrate the proposed approaches by analyzing the V-Dem dataset, and show that changes in electoral democracy are preceded by changes in freedom of expression and access to alternative information.

Emily Little, Tanya Broesch, Leslie Carver and Cristine Legare

Cultural variation in infant emotion expression during dyadic interaction

Infant survival is dependent on the capacity to display emotions that will elicit appropriate attention and care from adults, yet knowledge of early emotions is based almost exclusively on infants from Western populations. In three studies we measured variation in infant emotion expression in urban communities in the U.S., proximal care communities in Bolivia (characterized by high levels of physical contact), and subsistence- based communities in Fiji. During a still-face paradigm (Study 1), infants in the U.S. and Fiji displayed the typical still-face effect: increased negative affect and decreased social engagement from the interaction to the still phase, whereas infants in Bolivia showed no change in affect or social engagement. From the still to the reunion phase, U.S. infants increased positive affect and infants in Fiji increased gaze, consistent with previous research on partial affective recovery. In Study 2, we tested for variation in self-soothing and emotion regulation among infants in the U.S. and Bolivia. Infants in Bolivia increased tactile self-stimulation from the interaction to the still phase, while U.S. infants showed no change. In Study 3, we created a novel body-to- body still-face paradigm. U.S. infants decreased positive affect and increased negative affect and social engagement from the interaction to the still phase, while infants in Bolivia showed no change in affect or social engagement. Infants in Bolivia and the U.S. showed increased positive facial affect overall in the visual still- face in comparison with the physical still-face. Our results demonstrate that infant emotion display repertoires are dynamic, context-

dependent, and culturally-variable, calling into question the proposed universality of the still-face effect and motivate the need for theoretically-motivated cultural comparisons.

James Liu, Tomas Perez-Acle and Rodrigo Santibanez

Simulating the rise and fall of prosperity in developed and developing societies

Repeated interactions using the Prisoner's Dilemma Game has often been used as a testing ground for examining the evolution of cooperation in human societies. But usually, these simulations do not involve computer agents modeled on real data. The present simulation, PISKAS, builds on data collected from over a thousand individuals in New Zealand (a developed society) and 1000 individuals in Argentina (a developing society) and uses these data to model trust and cooperative tendencies from these representative sample as the starting point for simulating economic behavior. These data reported in Liu et al. (2018) and Romano et al. (2017). Simulation agents were modeled using latent profile analyses from real individuals, grouped into high, low, medium, and low institutional trust types. Simulations of both NZ and Argentina, using both a PD matrix with a very high sucker's payoff and a low sucker's payoff, and using both real and exaggerated propensities to trust showed that high trusters prospered most in both societies. The implications of these findings, and the limitations of the simulations used are discussed.

Sara Lowes

Matrilineal kinship and spousal cooperation: evidence from the matrilineal belt

I examine how matrilineal relative to patrilineal kinship systems affect spousal cooperation. In matrilineal kinship systems, lineage and inheritance are traced through female members. The structure of matrilineal kinship systems implies that, relative to patrilineal kinship systems, women have greater support from their own kin groups, and husbands have less authority over their wives. I use experimental and physiological measures and a geographic regression discontinuity design along the matrilineal belt in Africa to test how kinship systems affect spousal cooperation. Men and women from matrilineal ethnic groups cooperate less with their spouses in a lab experiment. This is not the case when paired with a stranger of the opposite sex. I examine the implications of matrilineal kinship for the well-being of women and children. Children of matrilineal women are healthier and better educated, and matrilineal women experience less domestic violence. The results highlight how household outcomes are tied to broader social structures.

Richard Lu, Jennifer Chatman, Amir Goldberg and Sameer Srivastava

Deciphering the cultural code: cognition, behavior, and the interpersonal transmission of culture

From the schoolyard to the boardroom, the pressures of cultural assimilation pervade all walks of social life. Why are some people more successful than others at cultural adjustment? Existing research has mostly focused on value congruence, the alignment between an individual’s strongly held beliefs and

the group's prevailing norms, as the core dimension of cultural fit. We develop a complementary conceptualization of cognitive fit: perceptual accuracy, or the degree to which a person can decipher the group's cultural code. We demonstrate that the ability to read the cultural code, rather than identification with the code, matters for contemporaneous behavioral conformity. We further show that a person's behavior and perceptual accuracy are interpersonally transmitted through observations of others' behavior, whereas value congruence is less susceptible to peer influence. Drawing on email and survey data from a mid-sized technology firm, we use the tools of computational linguistics and machine learning to develop longitudinal measures of cognitive and behavioral cultural fit. We also take advantage of a reorganization that produced quasi-exogenous shifts in employees' interlocutors to identify the causal impact of peer influence. We discuss implications of these findings for research on cultural assimilation, the interplay of structure and culture, and the pairing of surveys with digital trace data.

Francesca Luberti, Robert Brooks and Khandis Blake

The Opposition to Same-sex Marriage in the USA and Australia: An Experimental Test of Evolutionary and Economic Hypotheses

Cultural phenomena such as the opposition to same-sex marriage can have evolutionary and economic underpinnings. Research has shown that people oriented towards long-term mating strategies (i.e., sexually restricted people who not do approve of promiscuity) are more opposed to same-sex marriage than people oriented towards short-term mating strategies (i.e., sexually liberal people who are not bothered by promiscuity). However, in a recent study, sexually restricted people's opposition to same-sex marriage decreased when they were told that homosexuals are not stereotypically promiscuous. We sought to test whether this effect was due to the implication of promiscuity (vs. monogamy) in both homosexual and heterosexual mating markets (i.e., the social arenas where people exchange sex for other resources). In an online experiment, we randomly assigned American (n = 326) and Australian (n = 326) participants to one of four conditions, priming the concepts that either homosexuals or heterosexuals are either promiscuous or not promiscuous. We controlled for participants' age, sex, mating strategy orientation (i.e., sexually restricted or liberal), and baseline prejudice towards sexual minorities. We found that across all conditions, sexually restricted participants were more opposed to same-sex marriage than sexually liberal participants. Our manipulations did not have the effects we predicted, as they significantly interacted with participants' sex and mating strategy orientation to create a complex picture. Thus, we failed to replicate the published finding that priming homosexual promiscuity influences attitudes towards same-sex marriage. Neither did we find straightforward effects of priming messages of heterosexual promiscuity. However, our results do support evidence that sexually restricted people are more opposed to same-sex marriage than others. Our results have implications for the cultural evolution of beliefs about both sexuality and religion, suggesting that religious arguments may be used expediently to oppose same-sex marriage to defend the interests of sexually restricted individuals.

Dieter Lukas, Andreas Pondorfer and Toman Barsbai

The pervasive influence of ecology on behavioral variation

Humans show immense diversity in the environments they inhabit and in their behavior. However, the extent to which human behavior is adapted to the local environment versus humans relying on behavior to adapt the environment to their needs has frequently remained unclear. Here, we assess the influence

of the local environment on human behavior by comparing hunter-gatherer societies to those of mammalian and bird species that share the same habitat (within a 20km radius of the center of each hunter-gatherer society). We find that the global distribution of human behavioral variation closely mirrors that of other animals for food choice (diet composition, food storage) and demography (population density, migration). There are also some similarities in the variation of mating systems (sexual dimorphism, age at first reproduction) and social systems (offspring care, sex-bias in philopatry). Our results suggest that similar biological processes shape behavioral adaptions across animals, including our own species.

Gary Lupyan

Population size and the evolution of linguistic redundancy

The transmission of natural languages is a cultural process that is constrained by human learning biases. The only linguistic innovations that can persist are those that are learnable by young children. While all languages are constrained by the learning biases of young children, languages that have many adult learners are additionally constrained by what can be learned by nonnative speakers. It has been argued that the reason languages spoken by more people are morphologically simpler is due to selection against morphological complexity (which is difficult for adult learners). But this does not explain why so many languages are so complex to begin with. Here, we build on our previous hypothesis that morphological complexity is a form of redundancy that may facilitate language learning in young children. On this account, the greater complexity observed in languages that are not constrained by what adult can learn is a functional adaptation to increase learnability by young children through an increase in redundancy. Here, we use the Parallel Bible Corpus to confirm that languages spoken by fewer people have greater redundancy (i.e., lower entropy) for a much larger sample of languages while strictly controlling for vocabulary size, orthographic, areal, and phylogenetic factors. To our surprise, redundancy was largely independent of morphological complexity. Rather than arising from morphology, the greater redundancy appeared to stem from smaller languages having more frequent repetition of longer chunks. Testing the hypothesis that this type of redundancy aids language learning in young children requires further empirical work. However, our results provide strong evidence that population correlates not only with grammatical structures, but also relates to information-theoretic properties of language.

Gemma Mackintosh, Christine Caldwell and Mark Atkinson

Intentional Communication facilitates Cumulative Cultural Evolution

The cumulative nature of human culture is well documented in experimental research and real world data, showing clear evolution of ideas in language, artefacts and behaviours. However, the capacities that allow for the transmission of ideas in such a cumulative way remain poorly understood. This study explored the idea that one of these capacities could be Theory of Mind, in its role supporting intentional communication (an ability that appears to be – at least in its most complex form -unique to humans). 150 British participants completed a grid search task, after which they were asked to select a subset of their own search results to send to the next participant in a 10-generation transmission chain. The communicated information could then be used by the receivers to guide their own search of the same reward landscape. This intentional information condition was compared with a random information condition, in which an equivalent amount of (computer-generated) information was transmitted. In the

intentional communication condition, participants were able to maximise the grid score (locate all the rewards with the fewest possible search attempts) much more successfully than in the condition where equivalent random subsets of information were sent between participants. These results suggest that participants were able to identify information that would be particularly beneficial to their successor. This contributed significantly to cumulative improvements in task performance, relative to a condition intended to capture the effects of transmission via inadvertent social information cues, as opposed to intentional signalling. Human propensities for intentional communication may therefore facilitate many cases of cumulative cultural evolution. In contrast, if most animal social learning depends on inadvertent cues obtained as public information, this may place constraints on the potential for accumulation over learner generations.

Peter Maňo and Dimitris Xygalatas

Ritual signaling as an adaptation and status management strategy in a Tamil-Hindu religious group in Mauritius

The process of adaptation is the motor of animal evolution and one of the hallmarks of humankind - humans are considered to be one of the most adaptable animals, not least because we developed culture as an adaptive mechanism. Behavioral ecology looks at various adaptive strategies to local environments by assessing fitness outcomes of behaviors. Life history theory analyzes the timing of these behaviors across the life-span. One of the oldest evolutionary strategies in the adaptive toolkit is ritual - a communication device that guarantees the truthfulness of its message by raising the costs of delivering it. A successful ritual performance can secure access to mates, allies or even gods. Many individuals use costly rituals to signal adherence to the group, its values, norms, and taboos. Individual motivations notwithstanding, the costliness of performance alone communicates devotion and acceptance of the social and cosmic order. At the same time, certain groups or individuals can use ritual action to challenge the existing order or to improve their social standing in it. Through this, ritual systems and norms that surround them can change in the long-run. Our research on the Mauritian Tamil ritual Kavadi shows that young and low-status men engage in the most extreme and extravagant forms of participation, which is a finding not unique to this island. Lacking other resources, these men are using their bodies by ritually mutilating them to signal their underlying qualities to others and to bargain with gods for their fortune. Importantly, the motivations to participate differ as a result of socio-economic status, resulting in different cultural norms and expectations for proper execution of the ritual by the different sub-groups. In this context, ritual serves as an adaptation- and status management strategy in a religious group.

Luke Matthews

Toward a robust statistical toolkit for cultural evolutionary modeling

Research into cultural evolution requires statistical tools that can infer alternative cultural processes. Such processes include whether beliefs and behaviors are transmitted via diffusion across networks, inherited along tree-like lineages, and more specifically which networks or trees are most involved. Once this initial question is resolved, cultural evolutionists then require additional tools that correct for the patterns of statistical nonindependence (Galton's problem) generated by both network and tree-like social transmission. I conducted a set of agent-based simulation studies to evaluate major alternative

statistical tools for 1) inferring which network or tree governs the transmission of a cultural trait, and 2) correcting for Galton's problem with an appropriate network or tree. I simulated traits on empirical networks and trees from extremist religious groups, American physicians, and modern nation states. I also simulated traits on networks and trees that were themselves simulated. Regarding task 1) the results show that random effect models inferred correctly which network or tree governed the transmission of a cultural trait for nearly all conditions. This recommends greater use of random effect models when attempting to resolve the question of which network or tree is important. For task 2), correcting Galton's problem, the results show the phylogenetic autoregressive model produced correct statistical properties when traits arose by tree-like inheritance or by network diffusion on tree-like network structures. No statistical method I assessed, however, consistently corrected Galton's problem when traits arose by diffusion on networks that were not tree-like. In summary, selecting among networks and trees appears statistically resolved in a broad range of contexts, while correcting for Galton's problem is statistically resolved only in tree-like cases. Additional simulation and statistical work are required for our community to have robust tools for the many contexts in which cultural traits diffuse among highly reticulate and non-tree- like network structures.

Brea Mccauley, David Maxwell and Mark Collard

Upper Palaeolithic handprints with missing fingers: an ethnological perspective

Handprints with missing fingers occur at a number of Upper Palaeolithic rock art sites in Europe. It has been argued that they represent hand signals or a counting system, but there are reasons to believe that they were actually produced by individuals whose fingers had been amputated. Here, we report a cross-cultural study that was designed to shed light on this phenomenon. We identified 121 societies from Africa, Asia, the Americas, and Oceania that engaged in finger amputation at the time of ethnographic data collection, and we were able to distinguish ten different finger amputation practices within this sample. When the contexts and what we know about the participants are taken into account, the scenario that best fits the incomplete handprints is removal of fingers during life in order to appeal for supernatural assistance. This has interesting implications for social life in the Upper Palaeolithic, for traumatic religious rituals have been found to foster strong interpersonal bonds among group members and hostility towards members of other groups.

Helena Miton and Olivier Morin

When iconicity stands in the way of abbreviation: A reverse Zipfian effect in Heraldry

Zipf's law of Abbreviation (ZLA) refers to the correlation that he observed between word length and word frequencies (Zipf, 1949). The current research was conceived as an attempt to document a graphic equivalent of Zipf's correlation for heraldic motifs (the specific figurative or abstract figures composing coats of arms), which have been extensively documented throughout Europe, from the Middle Ages on. One reason to expect such a correlation is that an image's graphic complexity is similar in certain respects to a word's length: more complex images take longer to process and contain more information. Following ZLA, are, in our case, popular images simpler? Heraldry also distinguishes between iconic and non-iconic motifs. Does ZLA apply equally to both types of pictures? Graphic complexity is

operationalized in two ways, similarly to Tamariz & Kirby (2015), with both descriptive and perimetric measures of complexity, and applied to a standardized collection of thousands of drawings. Descriptive complexity is the smallest possible file size for a given image. Perimetric complexity is a ratio of inked surface and perimetric length, and has been shown to correlate with ease of processing (Pelli et al., 2006). Our frequency data -the number of coats of arms a given motif appears on- comes from two corpuses. The first one was constituted by us from secondary sources (mainly Renesse, 1894) and a second one based on Clemensen (2017), covering respectively 462 motifs and 344 motifs. We found that (1) while simpler motifs were to some extent more frequent in the Clemensen dataset, there was a correlation in the opposite direction (more frequent motifs were also more complex) in our other dataset, (2) this reverse ZLA applies mainly to iconic motifs, and (3) both complexity and iconicity predicted temporal changes in frequency of heraldic motifs.

Deeya Mitra and Jeffrey Arnett

Developmental Tasks of Emerging Adults from India

Emerging adulthood is marked by important decisions in the form of developmental tasks that need to be fulfilled by the individual. The success or failure of achieving these tasks are indicative of the individual's adjustment in future tasks (Havighurst, 1953). These tasks have their roots in sociocultural and historical conditions. Rapid economic and social changes in India is changing the way emerging adults prioritize and choose tasks. This research adopted a descriptive approach in the interpretation of developmental tasks focusing on the normative explorations among the current cohort of emerging adults from India (across five cities in India; Bengaluru, Kolkata, Mumbai, New Delhi, and Siliguri). The present study used a mixed-methods methodology, concept mapping (Trochim, 1989), to understand the life choices (developmental tasks) that are deemed as important by emerging adults from India. Phase 1 comprised 5 focus group discussions with emerging adults between 18 to 29 years (N = 40, Mage = 23) providing insight on the range of life choices. Phase 2 (N = 60, Mage = 23) incorporated rating and sorting methodologies to derive rating maps and cluster maps. Eight clusters emerged, namely, Faith and Community, Societal Norms, Romantic Relationships, Parental Expectation, Responsibility towards family, Independence/Autonomy, Financial Security, and Education and Career. Results indicated most agreement on importance of Responsibility towards Family, Independence/Autonomy, and Financial Security. Findings of the overarching factors that impact the decision making of these life choices ranged from self, other, circumstantial, and external. Findings have implications on positive identity formation, eudemonic happiness, and overall wellbeing. This study lays the foundation to the second and third part of a larger study which will explore how sociocultural factors influence decision making of these tasks, implications on later life, and attempt to build a preventive-intervention model that would help individuals make effective decisions.

Elena Miu and Tom Morgan

A model of recombination in cumulative culture

Cumulative cultural evolution-the process by which our species builds and improves upon knowledge from previous generations-has allowed our species to achieve the astounding ecological success witnessed today. A variety of factors have been deemed key for maintaining this process, from human cognition (including cooperation and high fidelity social learning) to demography (such as population size and connectedness). Despite the fact that cumulative culture routinely produces traits far beyond

the ability of any single individual, the modelling literature has typically operationalized traits in simple way - typically, as a sequential progression, where learning a more advanced trait merely depends on knowing the previous traits in a linear hierarchy. Here, we implement a more general depiction of a cumulatively evolving cultural trait. In this framework, a trait is defined by three parameters: (1) the number of levels through which it can be refined, (2) the number of options available at each level, and (3) the magnitude of dependency between options at different levels. Each option at each level is associated with a particular payoff, but as dependencies increase these payoffs change contingent on what options were chosen at other levels, capturing a level of path dependency often seen in human culture. This framework can collapse down to a variety of commonly used tasks (e.g. setting the number of options to 1 produces the sequential progression discussed above) while also being able to scale up to tasks of exceptional difficulty. We systematically vary these parameters and explore how they interact with the connectedness of the population to determine the ability of cumulative cultural evolution to identify traits associated with high payoffs. For easy tasks, a large, well-connected population achieves the highest complexity levels, as beneficial information is easily found and transmitted. For difficult tasks, however, the highest complexity is achieved at intermediate levels of connectivity, as this allows the population to search the solution space more effectively and reach better performance.

Karie Moorman and Teenie Matlock

Magnitude of metaphor: its effect on reasoning about immigration

Immigration drives cultural change. Perceptions and attitudes about complex issues like immigration are influenced by how they are described. In US political discourse, immigrants are often depicted metaphorically as Fluid Motion (e.g., tidal wave of immigrants), Animals (e.g., immigrants infesting the nation), and Burdens (e.g., immigrants overburdening our country). Natural metaphors like these structure our conceptions, effectively constraining the types of responses a listener or reader considers. Behavioral research shows that exposure to different categories of metaphors influences attitudes and reasoning about social problems. However, higher level, schematic shifts in metaphorical structure and semantic intensity (e.g., an entity's perceived size, shape, strength), too, can alter how we comprehend events. Using words within a single semantic category (Fluid Motion), we examined how shifts in semantic intensity (e.g., immigrants flooding vs. seeping into the country) lead to shifts in favorability of immigrants. In our study, US Amazon MTurk participants (N=448; mean age=36.6) read a fictitious story about immigrants coming to the US in one of three metaphorical frames differing only by three words (control [entering, moving, issue] vs. fluid-low-intensity [leaking, seeping, trickle] vs. fluid-high-intensity [flooding, pouring, tsunami]), and rated eight statements about immigration policy by agreeableness. Political affiliation was included as a predictor. We found, for self-reported conservatives and moderates, being primed to think about trickles of immigrants, leaking and seeping into the country resulted in increased anti- immigration attitudes as related to dispersal of the country's resources (e.g., welfare, citizenship, protection). No notable framing effects occurred for progressives. This suggests that participants who perceived immigrants entering the country as adversaries also exhibited increases in parochial tendencies towards in- group resource allocation, especially when immigrants were construed as less agentive. Our findings have implications for understanding the cognitive impact of immigration on subsequent cultural change.

Thomas Morgan, Jordan Suchow and Thomas Griffiths

Experimental gene-culture coevolution of human social learning in a changing environment

The past 2 million years have seen both unprecedented environmental instability and a dramatic increase in hominin brain size. This has led to the suggestion that human cognition, including our capacity for complex culture, is an adaptation to an unstable environment. In particular, it has been argued that culture allows adaptation to occur on shorter timescales than is possible through genetic change. However, theory suggests that only strategic social learning can cope effectively with environmental change. To test these hypotheses, we inserted populations of human participants (N=5000, internet users with US IP addresses) into an evolutionary simulation with a changing environment. In the first experiment, we limited participants to unguided ("random") social learning, and, consistent with theoretical predictions, found that unguided social learning performs poorly after environmental change. In a second experiment, we gave participants access to a greater number of demonstrators (1, 40, or 120) and allowed them to engage in frequency-dependent copying. Although participants were aware that the environment could change, they nonetheless engaged in conformist transmission, which, as theory predicts, compounded the difficulties faced by the population. In a final experiment, we allowed participants to combine both social and asocial information, which theory suggests would allow the population to rapidly adapt to environmental change. However, our results did not meet these predictions because participants made minimal use of asocial information and tended to rely on just social information. We thus suggest that if culture is an adaptation to a changing environment, the process of cultural adaptation is not guided by individual social learning mechanisms because these tend to copy existing information with high fidelity. As such, cultural adaptation more likely occurs through a multi-generational selective process.

Olivier Morin, Barbara Pavlek and James Winters

The evolution of money: How information grew on ancient coins (Greece 650-30 BCE)

Human cultural evolution is uniquely characterised by the exponential growth of our capacity to store and transmit information, through language and through graphic codes (writing and other visual symbols). Money, in the form of coinage, is one manifestation of this trend. Coinage, the practice of striking bits of metal with a design, appeared in Greek city-states in the VIIth century BCE. With coinage, a coin's value was guaranteed by a design, which was the mark of the issuing authority. So maybe The designs were official marks of issuing authority which guaranteed the coin's value. Early coins did not bear any written indications of their value, leaving designs (images of gods, heroes, animals, etc.) to carry this information .Surprisingly, however, the designs of early coins fulfilled this informative function only poorly. We show that coinage became more informative over the course of its early history. Using conditional entropy measurements, we show that the designs figuring on a coin carry an increasingly bigger amount of information about its denomination (whether it is a drachma, an obol, etc.) due to a general increase in the diversity of coin designs. This trend remains robust when nesting the data on a city-by-city basis. High-denomination coins, more valuable, tend to bear designs that carry more denomination-relevant information than low-denomination coins do. The Greeks, like us, had a non-linear currency structure: there is more money between a 1 euro coin and a 2 euros coins than between a 1-cent coin and a 2-cents one. Differentials in the high denominations range, being more important,

were worth signalling to a greater extent. The fact that high-denomination coins, being bigger, could carry more complex designs, does not explain this effect away. Overall, these results show how cultural evolution gradually imparts symbols with meaning, in an adaptive fashion. They also show how even the most obvious functions of a cultural artefact may take centuries to develop.

Olivier Morin, James Winters, Thomas Müller, Tiffany Morisseau and Simon J. Greenhill

The Color Game: Cultural evolution research with a gaming app

Calls for a "smartphone psychology" or a "computational cognitive revolution" regularly invite cognitive and behavioral scientists to make use of the new tools offered by smartphone apps. Yet although behavioral ecologists and cultural evolutionists are used to improving their experiments' power with crowdsourcing services such as mTurk, we do not usually make full use of the scientific potential of smartphone games. Compared to a standard online experiment, a gaming app lets participants interact freely with a vast number of participants, as many times as they wish. The gain is not merely one of statistical power. Cultural evolutionists can use gaming apps to avoid experimenter demand effects; to build realistic transmission chains that avoid the unavoidable losses of information that occurs in linear chains; to study the effects of partner choice as well as partner control in social interactions. We illustrate these methodological opportunities by presenting the Color Game app for Android and iOS smartphones (released April 2018). Built around a referential communication game where players must communicate a target color using black and white symbols, the game allows large numbers of players to interact freely and build shared visual languages. By assigning players randomly to evolving sub-populations, the app can simulate the population dynamics underlying language divergences. Publicly launched on May 15, the app has attracted players from more than 60 countries and hosts thousands of interactions each day. Six pre-registered hypotheses have been filed before the game's launch; they are kept confidential to avoid biasing participants and will be revealed in May 2019. The data already show massive improvements across time: performances in the referential communication task almost doubled. This phenomenon is consistent with experimental data and indicates that players successfully formed conventions to indicate the game's colours.

Cristina Moya

The cross-cultural development of beliefs that cultural group identities are stable

In some societies people expect children to acquire the cultural group identities of their birth parents, even in their absence. This genetic-like expectation of identity inheritance is puzzling given that cultural competence is acquired through socialization, and most neighboring groups are not very genetically differentiated. In this paper we try to understand the development of, and inter-site variation in, these expectations that identities are intergenerationally inherited. By meta-analysing switched-at-birth vignette studies run with children and adults across several sites, we examine the cross-cultural development of notions of identity inheritance, and compare it to the development of species identity reasoning. We also test whether people are more likely to reason as if identities are genetically inherited when social boundaries are marked by morphological, stylistically marked, linguistic, religious, or status differences. We find stronger evidence of early developing beliefs that species identities are fixed at birth than that social identities are fixed at birth. Furthermore, species identity beliefs homogenize

through development, whereas social identity beliefs diversify. Finally, all the above-mentioned features of cultural group boundaries increase beliefs that those identities are fixed at birth. However, boundaries marked by morphological differences are not particularly likely to trigger such essentialist inferences in children or adults, while status differences are most likely to provoke essentialist inferences among adults.

Katie Mudd, Yannick Jadoul, Connie de Vos and Bart de Boer

Investigating the factors maintaining sign languages using an agent-based model

Shared sign languages typically emerge in rural settings with a high incidence of often hereditary deafness and are used by both hearing and deaf community members (de Vos & Pfau, 2015). Thus, they provide the perfect case study to see how a sign language can emerge alongside an existing spoken language (de Vos, Roberts, & Thompson, 2016), providing insights into language emergence and evolution.Though features present in the emergence of shared sign languages differ on many levels (Zeshan & de Vos, 2012), it is unclear which ones allow for language emergence. Proposed influences are a small community size, high incidence of deafness and consanguineous marital patterns. To investigate, we turn to a computational model inspired by a shared sign language called Kata Kolok in Bali to understand what are the key features allowing for shared sign language emergence. The model investigates gene-culture co-evolution by studying the relationship between genetic deafness and language use. Language is modeled by the interaction of agents in a simple communication game occuring in the manual or vocal modality, dependent on whether the agents in the interaction are deaf or hearing. The social structure of the society is used to determine which agents communicate, such that family members and agents in the same clan are more likely to interact. The model itself is closely tied to Kata Kolok and is based on the observations of linguists, geneticists and anthropologists (de Vos, 2012), thus having a high level of ecological validity. As the current model is closely tied to features of a real language, it provides a unique opportunity to understand the precise factors allowing for the maintenance of this sign language, hereby providing a novel tool to investigate how language unfolds and shedding light on the mechanisms at play in gene-culture co-evolution.

Michael Muthukrishna

The Evolution of Evil Eye Beliefs and Related Behaviors

Evil eye is the widespread belief that other's envy can cause you harm. I present a possible explanation for the evolution of this belief using a formal model experimentally tested with 1800 participants. All theoretical predictions were pre-registered prior to data collection. The theory and experimental results support the idea that behaviors consistent with evil eye beliefs, such as avoiding displays of wealth, may be cultural adaptations to destructive anti-social behavior in social competition that itself evolves under limited good (zero-sum) conditions and moderate levels of property right protections. The model makes predictions that go beyond evil eye showing how these beliefs co-evolve with anti-social destructive competition or prosocial productive competition, levels of productivity and production, and levels of inequality. We identify three stable forms of societal organization that appear to match societal organizations observed in the anthropological and economic literature: (a) low production, low destruction (i.e., low level of witch hunts and evil eye beliefs), and low inequality—characteristic of

egalitarian hunter-gatherer societies; (b) high production, high destruction, and high inequality— characteristic of many developing nations; and (c) high production, low destruction, and moderate to high inequality depending on social competition levels— characteristic of many developed nations. Each of the three forms of societal organization are equilibria, despite the dramatically different outcomes on economic growth or stagnation. This theory and results reinforce the idea that hunter-gatherer egalitarian norms are an adaptation to their local conditions rather than representative of some innate preference for egalitarianism. Moreover, it offers an explanation as to why evil eye and witchcraft beliefs began to disappear in many parts of Europe during the Industrial Revolution and how they reduce economic growth in many parts of the developing world.

Damien Neadle, Matthias Allritz and Claudio Tennie

Non-human culture – An example of cultural simplicity in action, including a soft (minimal) definition of culture

Many fields, cultural evolution included, often fail to make distinctions between cumulative culture (i.e., human culture) and other strains of culture. While details are often debated, many accept that cumulative culture may require some kind of copying. It is unclear whether other forms of culture require this; however, there remains an implied causal, even necessary, relationship between social learning and non-cumulative culture. This study highlights the need for an alternative term, reserved for culture that may not require social learning, owing to the fact that many present definitions of culture discuss spreading of behaviours, which may imply copying. Therefore, here we present a minimal, lean, definition: behaviours are classified as cultural (in a minimal sense) if social learning (in any form) plays any role at all, in the form and/or frequency of the behaviour. This is similar to Galef's definition of traditions. Our study demonstrates the validity of this definition in a single case of putative culture, in wild Western lowland gorillas (Gorilla gorilla gorilla). The target behaviour was food cleaning, which has been identified as a putative case of culture, in wild Western lowland. Therefore, we provisioned culturally unconnected, captive, Western lowland gorillas with sand-covered apples as a part of a study into the spontaneous emergence of food washing (using water to remove contaminants from food; Allritz, Tennie, & Call, 2013) – the data from this study were recoded, observing for food cleaning. Each subject displayed food cleaning, on at least one occasion, with specific methods varying across individuals. Individual learning was likely the driving force behind the emergence of this behaviour, though social learning may have acted as a catalyst, accelerating the acquisition and harmonisation of the behaviour.

Sabine Nöbel, Arnaud Pocheville, Guillaume Isabel and Etienne Danchin

Fruit flies conform in love

Mate choice is a major fitness-affecting decision in any sexually reproducing organism. Mate- copying constitutes an example of social learning for mate choice in which individuals extract information from potential mates' sexual interactions. Mate-copying organisms thus socially acquire mate-preferences for potential mates that they observed being selected for copulation. Mate-copying exists in many vertebrates, and in the invertebrate, Drosophila melanogaster where females were shown to develop preferences for males artificially colored using green or pink powders. To test conformity in such social learning (i.e. whether females displayed an exaggerated tendency to adopt the preferences of a majority

of conspecific females, or simply 'copy the majority'), we developed the hexagon device, where 6 observer females in a central arena watch 6 simultaneous demonstrations occurring in 6 peripheral compartments. We tested 9 treatments with varying proportions of demonstrator females copulating with green or pink males: majorities of 100%, 83%, 67% and 60% for each color, plus one control (50%). Observer females were then given the choice between 2 males, one of each color, and we recorded the color of the chosen male. Control observer females did not build any mating preference, and as expected in view of previous experiments, experimental conditions in which all 6 demonstrator females copulated with males of the same color led to strong mate-copying. Furthermore, when the majority for one color decreased from 100% down to 60% we found that observer females learned to prefer the most commonly chosen male phenotype with similar efficiency in all cases, whatever the level of majority for it during the demonstration. Thus, mate-copying followed a step function with females learning equally well to prefer the most commonly chosen male color whatever the level of majority. This step function reveals surprisingly strong conformity in mate-copying. Conformity constitutes a major process of repair by which a population preference for a given male phenotype can persist over many transmission steps in which formerly observer females become demonstrators for a new set of observer females, and so on.

Alexandra Nikolic, Ellen Mok, Jesse Brinkman and Igor Nikolic

Exploring object-based learning in museums through agent-based modelling

We present an proof-of-concept agent based model exploring object based learning in museum collections. Interaction between the learner, artefact and the dynamic museum environment is modeled, with a goal of identifying useful and relevant conceptualization of the learner, artefact and the learning environment, allowing for representing cultural transmission based on artefacts. Presenting a large part of human environment and having multy-sensory qualities, artefacts have a certain capacity to stimulate cultural learning. In absence of inter-subjective contact, artefacts become a sole source of cultural information, which allows for understanding them not only as stimulus enhancement, but also as a particular cultural learning modality. This modality has been referred to as object-based learning (OBL), and it is commonly linked to museum collections at universities. Collections-based museum is a complex system of human and artefactual actors, as well as their intertwined relations in a dynamic settings. It can be understood as a socio-technical system and studied using agent-based modelling (Nikolic 2013). In the model, where heterogeneous individuals learn from interacting with objects during repeated museum visits, we explore the interaction of conservation and acquisitions on one hand side and learning from object on the other. We conceptualized the artifacts as a thing having the properties of Material, Use/Complexity, Robustness, State of Conservation and Context provided by curator. Agents learn about objects by considering these properties, using both Memory and Understanding as model concepts, assuming the absence of high- fidelity transmission (Dawkins 1976; Tomasello, Kruger and Ratner 1993; Whiten and Erdal 2012; Lewis and Laland 2012). From model experiment, we observed the effect of museum as a learning context and not the effect of original artifacts' context prior to musealization. Furthermore, models outcomes suggest relevant metrics for experimental work and empirical data collection (Nikolic, Damnjanovic and Cvetkovic 2017). Construction of the model provides

clear direction for future work, in both refining the conceptualization that is both modellable and well-aligned with theoretical models.

Erick Oduniyi and Vanessa Ferdinand

Emotion extraction in stories through sentiment analysis and physiological sensing

Stories change as they are told and retold. What elements of stories make it in to the next generation, and which do not? In this study, we explore how cognitive biases related to emotional valence affect the transmissibility of individual words during storytelling. In the domain of urban legends, we know that people are more likely to transmit legends that have content rated high in the negative emotion of disgust (Heath, Bell & Sternberg, 2001). At a more fine-grained level, Stubbersfield, Tehrani and Flynn (2017) have recently shown that strong emotional valence (positive or negative) predicts the accurate transmission of sub-elements in urban legends. Here, we extend this investigation to two more natural data sets in novel domains (i.e. 427 Dutch re-publications of Little Red Riding Hood spanning two centuries and 500 religious chain letters circulated in the USA spanning one hundred years) and increase the resolution of analysis further by investigating the effect of word-level emotional content on transmission fidelity using the pattern.nlp and syuzhet sentiment analysis algorithms. In line with Stubberfield et al. (2017), we found a positive relationship between the strength of words' emotional valence (positive or negative) on their probability of being transmitted. However, we also found that positively-valenced words were even more likely to be transmitted than negative ones, in both corpora. We are currently aggregating results from a laboratory-based experiment in which participants' physiological state is assessed via galvanic skin response (GSR) and facial electromyography (fEMG) as they listen to and transmit stories. Accordingly, we hypothesize that words with greater average GSR and associated fEMG are more likely to be transmitted and we expect that participants' own real-time GSR and fEMG signals will be more reliable predictors of word-level transmission fidelity than dictionary-based sentiment algorithms are.

Karsten Olsen, Andreas Roepstorff and Dan Bang

Knowing whom to learn from: Individual differences in social weighting sensitivity

To best reap the benefits of observing others and learning from their behaviour, we must distinguish the human models that are competent and informative from the ones that would misinform us. However, being able to detect others' competence or reliability is not sufficient in such a social situation, if we do not also weight the shared information appropriately in accordance with how reliable that individual has been. This ability to weight others' actions appropriately when socially interacting about a task (toward a shared goal), we refer to as social weighting sensitivity. However, it is not known whether this ability is simply dependent on the given partners that we are facing or whether it can better be characterized as an individual sociocognitive trait. To answer this question, we developed a psychophysical dot-motion task in which we gave participants the opportunity to revise their initial actions after seeing the actions of partners of varying competence. The results suggest consistent individual differences in the weighting of others opinions across worse and better performing partners. In particular, we observed similar individual differences in the social benefits that were gained from the partner. Moreover, we found that

individuals who were objectively underconfident were more likely to be affected by the partner's opinions, whereas individuals who were overconfident were less likely to listen to their partner. A recent analysis suggests that while most social learning strategies are likely to be based on domain-general psychological processes of associative learning (Heyes & Pearce, 2015), there are arguably some that distinguishes themselves by being based on the cognitive mechanism of explicit metacognition (Heyes, 2016). Our study offers an opportunity to investigate this type of metacognitive strategy further. For instance, our approach could be implemented to test the claim that these strategies are indeed socially learned and culturally variable, or not.

John Opfer

Knowing What Students Know About Cultural Evolution: Insights from Biology Education

Darwininan selection produces population changes in phenotypic frequency (traditional "evolution by natural selection"), individual changes in resistance to pathogens (clonal selection), and both population- and individual-level changes in the spread of imitative behavior (cultural evolution). How well do students understand any of these types of evolution? And how do we know what students know? In this talk, I examine tests of student understanding of evolution in plant and animal traits with no behavioral component at all. Design and scoring of items in a new test was explicitly guided by a cognitive model that reflected four principles of student learning: with development of expertise, (1) core concepts facilitate long-term recall, (2) causally-central features become weighted more strongly in explaining phenomena, (3) normative ideas co-exist but increasingly outcompete naive ideas in reasoning, and (4) knowledge becomes more abstract and less specific to the learning situation. We conducted an evaluation study with 320 students to examine whether scores from our assessment could detect gradations of expertise, provide insight into thinking about evolutionary change, and predict teachers' assessments of student achievement. Findings were consistent with our model of student learning, and the test was revealing about undergraduates' thinking about evolutionary change. Results indicated that (1) causally-central concepts of evolution by natural selection typically co-existed and competed the presence of naïve ideas in all students' explanations, with naïve ideas being especially prevalent in low-performers' explanations; (2) causally-central concepts were elicited most frequently when students were asked to explain evolution of animals and familiar plants, with influence of superficial features being strongest for low-performers; and (3) test scores accurately predicted students' later achievement in a college-level evolution course. Together, findings illustrate usefulness of general models of student learning in designing instruments intended to capture students' developing expertise.

Eduardo B Ottoni

The lasting and the passing: behavioral traditions and opportunities for social learning in wild tufted capuchin monkeys (*Sapajus* spp.)

There is already plenty of evidence to consider wild tufted capuchin monkeys' toolkits as behavioral traditions. Developmental studies show that infants' interest in nutcracking and adults' tolerance to scrounging optimize opportunities for socially biased learning. Field experiments provide further evidence on the socially mediated diffusion of new behaviors. The difference between forest

populations' lack of customary tool use and the typical savannah toolkit - stone hammers to crack open nuts - seems sufficiently explained by terrestriality, and the diversification of lithic tools' use, by local availability of proper stones. The narrower distribution of customary probe tool use, though - so far only observed in one population (SCNP, Brazil), cannot be accounted for by distinct diets or environmental affordances. Opportunities for social learning may be framed in Niche Construction theory, since social diffusion may depend on the conspicuousness and permanence of tools and leftovers. This is the case of nutcracking, which is highly conspicuous, leaves lasting environmental changes, and frequently allows delayed scrounging (enabling direct observation and late stimulus enhancement). Stick probes' production and use, however, create fewer opportunities for social learning: it involves quick, less conspicuous episodes, which usually occur without warning; scrounging opportunities are minimal, and there are no remaining tool use sites. All this may explain the observed distribution of probes' use. The lesser the role of environmental niche construction, the greater the role of inter-individual social dynamics in the diffusion of innovations and the establishment of traditions: toolkit sizes may be related to group sizes; male migration explains the diffusion of probe use across the SCNP population (as opposed to the restricted - intragroup - diffusion of a stone-throwing display by philopatric females in estrus). Furthermore, the nature of intragroup gender interactions during travel and foraging may explain the male bias in probe tool use.

Lluis Oviedo and Hansgeorg Hemminger

The enigma of religion’s cultural evolution

Religions evolve and that process can be easily followed by anyone who studies the history of a religious tradition. Such dynamics can be described as evolutionary, both resorting to biological or to cultural patterns. Many theories have tried to apply biological models and causes to explain religion’s evolution. However criticism has been raised showing strong limits to that heuristic program. Cultural evolutionary dynamics appear as alternative and more fitting, as far as they can complement the biological ones. Historical religions offer indeed a study case to apply such a framework. Nevertheless it is hard to find a ‘universal pattern’ of cultural evolution in that case, except after assuming specific traits in that cultural expression – like the incidence of revelations, prophecy and the like – and rendering its own evolution distinctive. Furthermore, being beliefs an essential component of religions, it seems more fitting to account for believing and its own evolution rules.

Alina Paegle and Adrian Bell

Finding potential ethnic markers through a three-step ethnographic investigation

The use of ethnic markers are prominent characteristics of the formation of new ethnic groups through migration. However, identifying markers is nontrivial as their significance may vary temporarily as well as regionally. To find markers in possible active use, we describe a 3-step ethnographic method conducted in the Kingdom of Tonga: (1) ethnographic description, (2) a utilization survey, and (3) a classification task. First, fieldwork across several locations yielded 17 motifs represented on contemporary Tongan barkcloth, mats, and tattoo designs. Then using a utilization survey, a much smaller subset of 6 symbols of broader use were identified and set aside for a classification study. Then finally, a triad sorting task was used to construct individual-level classifications. Variation between

individuals , with more consistent classifications assumed to be under the greater force of social coordination. After completing this 3-step process in the Tongan diaspora of Utah, we have possibly identified the construction and activation of homeland motifs and adoption of other motifs of greater regional significance in a Polynesian community in the United States.

Jonathan Paige

Were early stone tool technologies genetically transmitted? Comparing passerine nests and Acheulean handaxes

The Acheulean stone tool tradition spanned over a million years across Africa and much of Eurasia and shows little variation across its range. Culture-evolutionary theory suggests that traditions are unlikely to be so stable across such vast spans of time and space. To explain the conservatism of the Acheulean, researchers have suggested that it was transmitted primarily genetically, and that cultural transmission played only a minor role (Foley, 1987; Richerson & Boyd, 2005). According to one form of this hypothesis, Acheulean artifacts are more akin to animal technologies that are genetically transmitted, such as bird nest designs, than to modern human technologies (Corbey et al. 2016). Here I test this hypothesis by asking how the variation observed in Acheulean tools compares to the variation in bird nests. I compare variation in Acheulean tools (N = 3,526), in tools made by both Modern Humans (N = 2,560) and tools made by Neanderthals (N = 1,112) to variation among nests of North American passerines (N = 2,544). I find that Acheulean artifacts: 1) have low variation compared to similar modern human artifacts; 2) have similar variation to Neanderthal artifacts; and 3) have far more variation that what is found within any given bird species. In fact, the amount of variation in Acheulean tools is comparable to the variation in bird nests among species that share a common ancestor as far as ~10 million years ago. These results suggest Acheulean tools were not strictly the product of genetic variation, but also that the hominins responsible for Acheulean tools did not possess a modern-human-like capacity for cultural transmission.

Jonathan Paige and Deanna Dytchkowskyj

Measuring the complexity of stone tool technologies from the Lower Paleolithic through the Late Holocene

Modern humans have a unique ability to transmit and maintain complex cultural traditions (Tennie et al. 2009). When this capacity for cumulative culture appears in human evolutionary history is, however, unclear. Previous research suggests the complexity of stone tool traditions increased exponentially from the Oldowan onwards (Perreault et al. 2013; Stout 2011), with a marked increase during the Middle Paleolithic. But these studies focus on a small sample of sites and tool-making techniques. Here, we measure the complexity of a large number of stone tool traditions sampled across the entire archaeological record from the lower Paleolithic through the Holocene. Additionally, we measure cultural complexity using two different methods. First, we compiled the number of tool forms and core reduction techniques observed in 217 archaeological assemblages. Second, we recorded the number of distinct techniques or procedural units present in distinct tool making sequences across 27 assemblages. The results of both studies suggest an increase in complexity from the earliest record onwards that culminated during the Holocene. Within this overall pattern we confirm the presence of a marked

increase in complexity between 200 and 500 kya, and some evidence for extended periods of little increase in complexity across much of the lower Paleolithic.

Sam Passmore and Fiona Jordan

A phylogenetic approach to kinship

Cross-cultural diversity in human kinship organization is significantly more restricted than what is theoretically possible. Cognitive science approaches show that kinship systems optimise between communicability and complexity, which explains why observed diversity is smaller than the theoretical space (Kemp & Regier, 2012). However, these approaches do not explain why this underlying diversity exists at all. Anthropological approaches propose that patterns of descent, marriage, and residence are functional constraints on kinship systems (eg. Fox, 1967; Murdock, 1949). For example, cross-cousin marriage constrains Iroquoian kinship systems, which linguistically distinguish cross- from parallel-cousins (Goody, 1970). However, all of the functional constraint hypotheses we identified fail to control for Galton's problem, incorrectly treating societies as independent when they share common ancestry. Using Bayesian comparative phylogenetic methods, we test the coevolutionary relationship between kinship terminologies and social structure. We show that shared ancestry itself acts a strong constraint on kinship diversity. To assess the pervasiveness of these constraints, we test coevolutionary relationships on languages from the Austronesian, Bantu, and Uto-Aztecan language families (n=176), with data drawn from D-PLACE (Kirby et al., 2016). Treating each language family as an evolutionary experiment, we can more accurately assess the universality of theories on kinship diversity. We test 29 separate hypotheses across up to three language families (54 tests) and in only 10 tests do we find evidence of coevolution, none of which are supported across all language families. We therefore claim that the dynamics of these changes are lineage-specific. To more confidently explore kinship diversity and its determinants, we require more granular data than is currently available. We present the early stages of a new database, with kinship terms from approximately 800 languages, linking to 10 major language families.

Sarah Peoples, Joseph Watts, Cara Evans, Heidi Colleran, Simon Greenhill, Susanne Hardecker and Daniel Haun

How can humans acquire cultural values? Games!

Rule-based games are played in most cultures around the world (Sutton-Smith and Roberts, 1971), but the types of games played vary with cultural attributes, such as political organization or community size (Sutton-Smith and Roberts, 1971). While most previous cross-cultural studies on games focus on the type of skill involved in games, the current study focuses on the cooperativeness of games and how cultural facets of cooperation, as measured in social stratification and interdependence in subsistence, might be mirrored in games. The Social Interdependence Theory (Deutsch, 1949; SIT) proposes three types of goal interdependencies and suggests that cooperative goal structures promote positive interactions. The goal interdependencies of the SIT were expanded to create an original coding scheme for games in a cross-cultural context. In applying the SIT to games, we hypothesize that cooperative games should be more prevalent in societies with higher levels of cooperation. A two-sampled cross-cultural study from Eifermann (1971) suggests that cultural values of cooperation and egalitarianism are reflected in the cooperative games that are played by children, but does this relationship exist on a larger scale? The current study takes a broad and ethnographic approach, examining the relationship

between cooperation at a cultural level and cooperative games in more than 30 cultures in the Pacific. Data collection on games includes ethnographic records and historical journal articles, and a database, Pulotu, provides cooperative measures of cultures within the Austronesian language family. In addition to measuring the phylogenetic signal of games in the Pacific, phylogenetic comparative methods are utilized to control for Galton's problem. If a relationship between the cooperativeness of games and cultural values exists, games may enculturate members of a cultural group, and thus might be repositories, as well as training grounds, for cultural values and norms, ensuring high-fidelity vertical transmission of cultural knowledge.

Susan Perry, Brendan Barrett and Irene Godoy

Behavioral innovation in wild white-faced capuchin monkeys, *Cebus capucinus*, at Lomas Barbadal, Costa Rica

The process of innovation is important to researchers of cultural processes because it is the primary source of new behavioral traits. However, documenting innovation repertoires and rates is difficulty, methodologically in the field, because it is hard to know when a behavior is being performed for the first time. Here we propose a new method for diagnosing innovation in the wild, and present innovation data from a 5- year period encompassing 35,196 hours of observation of 234 individuals residing in ten social groups. 187 innovation events were documented, but only 127 of these were unique, i.e. invented in only one group. 17 of these innovations were novel ways of drinking water or processing food; 9 served to enhance comfort, self- soothe, self-stimulate, or aid in dental hygiene; 47 were new types of social interaction (e.g. types of aggressive display, or bond-testing behaviors, or ways to interact with infants), and 54 were investigative behaviors, i.e. creative ways of manipulating other species or inanimate objects, or novel ways of locomoting. 117 of 234 individuals in the data set innovated at least once. 80% of innovations were not retained in the innovator's behavioral repertoire, and <22% were transmitted to other group members. Older, more socially central monkeys were most prone to invent new social interaction types. Younger monkeys were more prone to invent new foraging, investigative or self-directed behaviors. Sex and dominance rank were not important predictors of innovative tendency.

Joaquin Poblete and Francisco Brahm

The evolution of productive organizations

We develop a cultural evolution model that illuminates the evolution of productive organizations, such as, partnerships, guilds and modern corporations. Specifically, we introduce productive organizations in a workhorse cultural evolution model, widely used to explore the conditions that make social learning adaptive (Boyd and Richerson, 1995). The existence of these exclusive organizations stops the negative externality generated by the replication of social learners by virtue of being exclusive and facilitating social learning. This solves Rogers's paradox without the need for social learning to improve individual learning (Rogers, 1988). The basic insight provided by the model is that productive organizations evolved because they favored the difficult-to-propel process of cumulative culture. Productive organizations make social learning and culture useful to society, playing a fundamental role on the adaptive success of the human species. The model also illuminates issues regarding adaptation and rigidity, the locus of innovation, secrecy and the origins of specialization. Our model has predictions regarding the benefits of organizations for society that are at odds with standard models of firms in economics and management

based on transaction costs. For example, while in transaction costs theories the firm is more valuable when uncertainty is high, in our model the firm is more valuable when it is low. These differences allow for empirical comparison of the theories. We test our theory using data from the Ethnographic Atlas and the Standard Cross Cultural Sample. We measure the presence of technologies in pre-modern societies (e.g., weaving, metal working, pottery) and whether they were executed throughout the society or mainly by a small group of people, that is, within a productive organization. Across several tests and robustness checks, we find consistent evidence for the propositions and comparative statics of our model.

Limor Raviv, Antje Meyer and Shiri Lev-Ari

Network structure and the cultural evolution of linguistic structure: An artificial language study

Understanding language diversity has long been a goal for philosophers, linguists, and evolutionary scientists. Research suggests that linguistic diversity may result from differences in the physical and social environments in which languages evolve (e.g., Lupyan & Dale, 2010; Meir et al., 2012; Nettle, 2012; Trudgill, 2009; Wray & Grace, 2007).For example, social network structure has been argued to affect the structure of languages, as well as the spread of innovations in the community. Specifically, computational models of language change have shown that sparser networks tend to develop more structured languages (e.g., Gong, Baronchelli, Puglisi & Loreto, 2012), and show less uniformity and slower convergence of the network (e.g., Ke, Gong & Wang, 2008; Fagyal, Swarup, Escobar, Gasser & Lakkaraju, 2010). However, the role of network structure in the cultural evolution of language has never been tested experimentally. Here we present results from an experimental study that examined the formation of new languages created in the lab by different micro-societies of eight Dutch participants. We contrasted three different types of networks: fully-connected, small-world, and scale-free. We used a group communication paradigm (see Raviv, Meyer & Lev-Ari, 2017) to examine differences in the artificial languages created by different micro-societies with respect to their linguistic structure, communicative success, stability and convergence. We found that regardless of network structure, the languages of all micro-societies became more structured, more accurate, more stable, and more shared over time. Importantly, while there were no overall differences between conditions, the small-world networks showed greater variation across all measures. This suggests that small- world networks are more susceptible to long-term effects of random linguistic changes (i.e., drift). This is the first experimental investigation of the cultural evolution of language in different social networks, and suggests that network structure can influence the degree of linguistic diversity across communities.

Elizabeth Renner, Delia Couper, Donna Kean, Mark Atkinson and Christine Caldwell

Capuchin monkeys' (Sapajus apella) and human children's (Homo sapiens) use of information from social, virtual, and individual sources in a stimulus choice task

For cultural transmission to occur, individuals must be able to learn by observing others. Is the uniqueness of human culture attributable to what or how humans learn from others? We used a touchscreen task to directly compare use of information from different sources by capuchin monkeys

(Sapajus apella) and 3- to 5-year-old children (Homo sapiens) living in the United Kingdom. In the task, an array of stimuli (2 or 3) was presented on the screen, and participants were given multiple attempts to find the single rewarded item. Information about one of the stimuli (i.e., whether it was the rewarded item) was provided on the first trial, and we compared three within-subjects conditions. In the social condition, the experimenter selected a stimulus on the first trial; in the virtual condition, an animated hand selected a stimulus; and in the individual condition, the participant selected a stimulus. On half of problems, the stimulus selected on the first trial was the rewarded stimulus, and on the other half, the selected stimulus was unrewarded. On the second trial, participants were given a raisin or sticker for selecting (touching) the rewarded item. If a participant selected the same item ("stayed") after seeing selection of the rewarded item or selected a different item ("shifted") after seeing selection of the unrewarded item, the trial was given a score of 1; otherwise, a trial was scored 0. The two capuchin monkeys who achieved proficiency in the task (>80% performance overall) performed marginally better in the individual condition compared with the vicarious (social and virtual) conditions, and after seeing selection of the rewarded item, compared with the unrewarded item. There was no difference in performance on problems with 2 and 3 stimuli. The pattern of performance from the monkeys will be compared with that of the children.

Peter Richerson

The Evolution of Cultural Maladaptations

Common culture variants are very frequently adaptive from the point of view of genetic fitness. However, as with genetic evolution, maladaptive cultural variants can arise and persist. They are interesting theoretically and often give rise to practical problems. Examples include incomplete transmission, selection on non-parental transmission, runaway status competitions, incomplete segregation of roles, spatial and temporal mismatches, cultural group selection, and malicious cultural transmission. I will attempt a complete taxonomy at a certain level of generalization. It is also an interesting exercise to make value judgements about cultural maladaptations. Which ones do we find ethically fine, which objectionable, and which debatable?

Carson Miller Rigoli and Sarah Creel

Diverse individual timing biases and the emergence of musical rhythm

The cultural evolution framework has recently been adopted to describe the emergence of rhythmic features of human musical systems as an adaptation to a 'neuronal niche' of stable biases based in adaptive perceptual or sensorimotor timing mechanisms. Adopting this framework invites the question of the degree to which specific timing biases are found universally or differ significantly between individuals. These two possibilities have been described as supporting alternate models for the cultural evolution of musical rhythm: in the nativist view, strong universal biases force musical systems to adapt to maximize learnability; in the interactive view, individuals possess weak, idiosyncratic biases that lead musical systems to form a 'sufficing' structure that may not maximize learnability for all individuals. We present an analysis of previously-presented and novel empirical data from two tapping studies involving repeated reproduction of two- and three- interval rhythms. These data indicate relatively stable individual differences in rhythm timing biases -- supporting the relevance of an interactive view of cultural evolution for musical rhythm. Analysis of the same tapping data additionally reveals nonstationarities in rhythm timing biases in the form of learning and serial dependence. This finding, combined with recent evidence for long- term plasticity in rhythm performance, supports a view in

which variability in timing biases are not only synchronically distributed across individuals but are diachronically distributed within individuals. We discuss the relevance of these findings to the design of empirical studies seeking to uncover the dynamics of musical rhythm transmission and evolution. We also highlight the importance of accounting for plasticity and heterogeneity in computational models of the cultural evolution of musical rhythm. Study participants were recruited from an urban Southern California university population with varied musical experience. No analyzed participant reported experience with musical practices that are known to heavily rely on complex meter or unmetered rhythms.

Erin Robbins

Toward a dynamic model of moral cognition: What culture, development, and individual differences tell us about fairness norms

Here we summarise a suite of studies investigating the emergence, expression, and transmission of fairness norms in young children (3-10 years) and adults in highly contrasted cultural contexts (including the UK, US, Taiwan, South Korea, Cuba, Costa Rica, Mexico, Samoa, and Vanuatu). In Part I, we describe a series of sharing (dictator) games and economic reasoning games (representing over 300 participants) and document how a preference for outcomes is transcultural, but that the strength of this preference and the means by which participants enforce the norm is highly variable, both within individuals and across populations. We also present data challenging the notion that many commonly used paradigms to study fairness reasoning do not necessarily yield consistent preferences for equitable outcomes, calling into question the ecological validity of these tasks. We discuss these findings in light of other evidence from our lab documenting cultural differences in perceptions of risk, perceptions of agency, causal reasoning, economic reasoning, and mentalising about others. In Part II, we discuss the development and transmission of fairness norms, with a particular focus on dynamic systems theory. In short, this theory proposes that concerns about self and others are integrated into valuations made about the moral rightness or wrongness of an action. This system integrates perceptual information as well as individual-level prior knowledge and societal-level expectations about behaviour, and is updated in a rapid and continuous fashion. We suggest that this model can help explain individual level differences in moral cognition as well as group-level traditions about norms and norm enforcement. We argue that consideration of individual differences and the degree of behavioural variability within a population are helpful in considering how normative conventions develop, are adapted, and transmitted between group members.

Sean Roberts

The Causal Hypotheses in Evolutionary Linguistics Database: A tool for effective research in cultural evolution

The Causal Hypotheses in Evolutionary Linguistics Database (CHIELD, https://chield.excd.org) is a tool for understanding the field of evolutionary linguistics and for designing effective research. The study of the cultural evolution of language has exploded, with theories and evidence pouring in from a wider range of disciplines than ever before. While very promising, it is increasingly difficult to synthesise the diverse range of experiments, models, statistics and case studies into coherent explanations. CHIELD offers a solution: cut up hypotheses into smaller claims and represent them as formal causal graphs (nodes

represent measurable quantities and edges represent causal influences). A custom web application allows users to search for variables of interest and to navigate the network of causal links with 'smart' tools. For example, users can find all hypotheses which connect two variables (e.g. population size and morphological complexity), or discover additional evidence for a causal link. Users can compare hypotheses, locating points at which they overlap or disagree. Too often, researchers oppose a theory wholesale when disagreements only hinge on a few causal links. CHIELD can help direct research by locating these critical links. Importantly, CHIELD also codes the type of support each link has (experiment, statistical test, etc.). This allows users to visualise "robust links" that are well supported and "weak links" which have little or no empirical support, suggesting targets for future studies. The database currently includes over 800 causal links from 134 publications, hand-coded by a team of experts. Promisingly, 81% of these links form a single connected network, suggesting that there is a lot of scope for weaving theories together. The database is growing thanks to the online interface which allows any researcher to contribute, review or edit data. The source code is openly available, allowing this approach to be expanded to other areas of cultural evolution.

Gareth Roberts and Robin Clark

Production, perception, and the dynamics of signaling systems

The emergence and evolution of structure in cultural systems is the product of multiple forces, including social transmission across generations and social interaction within them. We present a novel experimental paradigm for investigating the role of these factors in the evolutionary dynamics of combinatorial signaling systems. The work is primarily motivated by vowel systems, which exhibit striking organization (i.e., the vowels of a language are not randomly distributed across acoustic space but tend to be well dispersed). A number of theoretical accounts explain this with reference to the two (modality-independent) pressures of increasing perceptual distinctiveness and reducing production effort, although the proposed relationship between these varies. Distinguishing between accounts using natural-language data is difficult, as such systems are already the product of millennia of cultural evolution, which obscures how their structure emerged. Our experimental paradigm involves the collaborative construction of novel visual communication systems in the laboratory, allowing the pressures acting on such systems to be manipulated and their consequences measured, while reducing the influence of participants' own languages. Pairs of University of Pennsylvania students (n=60) played a signaling game, in which they had to communicate animal silhouettes using colors. Players took turns using a continuous space to generate discrete colors, which the other player had to interpret. The extent to which ease of production aligned with ease of perception was manipulated. Overall, resulting systems exhibited significant structural organization. Participants privileged ease of perception over ease of production, but did not maximize the former in all conditions, with consequences for the structure of the resulting systems. While our experiment was motivated by vowel systems and focused on social interaction in particular, the paradigm can be easily adapted to investigate the role of social

transmission, and our results have important implications for understanding the cultural evolutionary dynamics of any signaling system.

Alba Motes Rodrigo, Parandis Majlesi, Elisa Bandini, R. Adriana Hernandez Aguilar and Claudio Tennie

Tool excavating techniques are spontaneously reinnovated in captive task-naïve chimpanzees: implications for chimpanzee culture

Human culture is mainly composed of culture dependent traits (CDT), which are not reinnovatable by naïve individuals, and require copying social learning to exist across generations. Copying has been suggested to also be present in non-human animal species, specially in great ape cultures. If true, copying in great apes would have led to the existence of CDTs. Nevertheless, rarely these assumptions of the necessity of copying social learning in great ape culture have been tested. Some populations of wild chimpanzees excavate underground storage organs of plants (USOs) using tools, but this behavior is not present in other populations despite similar ecological conditions and genetic setup (criteria often used to identify potential cultural traits, at least in a minimal sense). We designed an experiment with target-technique naïve, captive chimpanzees in order to investigate if tool excavating techniques require copying social learning, or if they spontaneously emerge in naive individuals. We studied two groups (Ngroup1=5, Ngroup2=5) at Kristiansand zoo, Norway, where we buried food pieces in the outdoor enclosure. In both groups, wild-form tool excavating techniques spontaneously emerged and these were observed in the majority of individuals. Our study shows that copying social learning is not a necessary requirement for the emergence of tool excavating techniques in chimpanzees, invalidating the dependency of this behavior from copying (and as a CDTs). These results add to the growing body of evidence from captive studies showing that many behaviors previously considered to depend on copying social learning, should be more accurately considered behaviors that can be individually reinnovated, and therefore do not need require copying social learning to be transmitted. Instead, their frequencies within populations are harmonized via non-copying social learning mechanisms (e.g. stimulus and local enhancement). This new line of evidence calls for establishing criteria and definitions in the ape culture realm independently of those found in the human literature.

Hettie Roebuck and Gary Lupyan

Language and intelligence: the role of ‘nameability’ in fluid intelligence

Curiously, one of the strongest predictors of ‘nonverbal’ (fluid) intelligence is verbal ability— vocabulary in particular. This correlation is typically explained by invoking a latent general intelligence factor (‘g’): people high on g score well on both verbal and nonverbal assessments. Recently, however, growing evidence has suggested that people’s performance is reliant on language in cognitive and perceptual tasks that are not traditionally thought to be verbal, ranging from basic categorization, to visual memory, to perceptual discrimination. Here, we examined how linguistic factors may relate to the most widely used test of fluid intelligence: Raven’s Progressive Matrices. In a series of experiments with American adults we examined whether (1) the ease with which constituent parts of matrix reasoning problem can be named affect performance, (2) whether naming promotes abstraction and (3) whether manipulating the nameability of matrix problems affects all our participants equally. Our results reveal that making constituent features more difficult to name (while keeping the logic of the problem and perceptual factors constant) adversely affected solving performance. For example, problems using easy-

to-name polygons and textures were solved more accurately than identical problems with harder-to-name shapes and textures. Participants showed greater transfer from more to less nameable problems than the reverse indicating that nameability may promote abstraction and generalization. Finally, participants rated as having a greater propensity to verbalize (as identified by our newly constructed and validated 'Internal Representation Questionnaire' performed better on Matrices, but were similarly affected by our nameability manipulation. Our results call into question the claim that correlations between verbal and nonverbal IQ subtests simply reflect a positive manifold caused by latent general-intelligence factor. Rather, the culturally-evolved vocabulary of a language may influence both the construction and solution process of nonverbal Matrix-style problems. Our results also provide a new angle for group differences in fluid IQ.

Tamar Rosenberg-Yefet, Ran Barkai and Ehud Lamm

Where can we draw the line between individual learning and cultural transmission: the case of the Levantine Lower Paleolithic Levallois method

After producing stone items in several particular ways for over one million years during the Lower Paleolithic across the Old World, humans invented and adopted a sophisticated technology to produce desired stone items, of predetermined morphology, known as the Levallois method. It is generally accepted that the invention, introduction and assimilation of the Levallois method reflect significantly the cognitive and technological capabilities of Middle Pleistocene humans, as well as being a striking case of cultural evolution. A central question in prehistoric Archaeology concerns the mechanisms involved in the appearance, adoption and assimilation of significant technological innovations over a wide geographic and temporal distribution.Two models are generally considered in the study of the emergence and spread of significant innovations: cultural transmission and convergent cultural evolution. The first model relates to the possibility of invention in one core-area and a spread through social learning in the process of cultural transmission. The second model relates to an independent invention in different areas, through individual learning, a process known as convergent cultural evolution. The extensive research on the Levallois method and the recently excavated sites attributed to the emergence of the technology during Late Lower Paleolithic times pose a rare opportunity to examine mechanisms of invention and distribution of technological innovations. After presenting an up to date interdisciplinary review of the two main mechanisms, cultural transmission and convergent cultural evolution, we will examine the Levallois method and its distribution, focusing on which inferences regarding the two mechanisms are warranted by the archeological record. This will be done using both chronological and geographical perspectives, as well as analysis of various aspects related to the technology itself.

Cody Ross and Brett Beheim

Estimating social learning in social networks: A longitudinal analysis of 43 years of opening strategy in a network of 1,072 top-level Chess players

Models of cultural evolution predict that population frequencies of cultural and behavioural variants will be driven by individual-level costs and benefits, and by social learning. Analyses of longitudinal datasets

that demonstrate how individuals use payoff and frequency information in empirical contexts, however, are rare. One recent example explored strategy evolution in the East Asian board game of Go, finding substantial levels of social learning. In the current analysis, we draw on similar longitudinal records of Chess opening moves in a network of 1,072 top-level Chess players to measure the importance of payoff-biased individual learning, payoff-biased social learning, and frequency-biased social learning in explaining the dynamics of trait frequencies. We find that top-level Chess players are generally quite conservative in their opening play. Moreover, players who are too invariant in their behaviour, and players who are too variable in their behaviour both have lower rates of skill development over their careers, analogous to balancing selection drawn from evolutionary biology. In contrast to the game of Go, top-level Chess players show less reliance on payoff-biased social and individual learning. These differences are probably best explained by the fact that, in contrast to Go, the important cutting edge of Chess opening strategy lies deeper in the game tree.

Joshua Rottman, Angie Johnston, Sydney Bierhoff, Taisha Pelletier, Anastasiia Grigoreva, Josie Benitez and Prsni Patel

Selective trust and positive evaluations of clean informants across development and culture

President Trump's use of the term shithole countries to disparage foreign immigrants, along with his nasty woman comment during the final presidential debate, demonstrates the power of rhetoric in leveraging a general disdain of dirtiness to facilitate negative social attitudes. This mechanism of dehumanization, vilification, and stigmatization has perpetuated atrocities throughout history and across cultures (Nussbaum, 2004; Speltini & Passini, 2014). The present research investigates the nature and extent of biases toward dirty individuals in children and adults, and the degree to which these biases influence selective social learning. In Study 1, children and adults demonstrated clear explicit preferences and regard for clean over dirty adult informants, but this translated into enhanced epistemic trust primarily in adults, mirroring research demonstrating that children do not always preferentially trust individuals whom they evaluate positively (Chudek et al., 2016). In Study 2, children and adults demonstrated clear implicit and explicit preference and regard for clean over dirty child informants who either lacked an infectious disease or hadn't spilled soup on themselves, but in this case children demonstrated the strongest biases and tendencies to preferentially trust the clean informant, suggesting that selective trust is strongest for members of peer groups. Additionally, biases against sick individuals manifest differently, but not necessarily more strongly, than biases against non-infectious dirty individuals. Study 3, a replication with children in India (a country that has historically endorsed strong purity norms), has just been completed and data are currently being prepared for analysis. Overall, this research indicates that derogation of dirty people is pervasive across ages and may influence learning and thus spread of cultural information. People who are perceived as clean may be selectively trusted and therefore have the power to effectively transmit cultural beliefs and values, while people who are perceived as dirty may be marginalized and ignored.

Raul Sanchez de la Sierra

Why being wrong can be right: Magical warfare technologies and the persistence of false beliefs

Across human societies, one sees many examples of deeply rooted and widely held beliefs that are almost certainly untrue. Examples include beliefs about witchcraft, magic, ordeals, and superstitions. Why are such incorrect beliefs so prevalent and how do they persist? We consider this question through an examination of superstitions and magic associated with conflict in the Eastern Democratic Republic of the Congo. Focusing on superstitions related to bullet-proofing, we provide theory and case-study evidence showing how these incorrect beliefs persist. Although harmful at the individual-level, we show that they generate Pareto efficient outcomes that have group-level benefits.

Lauren Scanlon, Andrew Lobb, Jamie Tehrani and Jeremy Kendal

The effects of non-random social learning error on the cultural evolution of knots

Forms of non-random social learning error provide sources of inherited variation yet their effects on cultural evolutionary dynamics are poorly understood. Focusing on variation in micro-structure (forms of trefoil knot) within the ancient and ubiquitous technology of knot tying, we performed an experiment in which a non-expert sample of students were asked to copy forms of demonstrated knots. Using approximate Bayesian computation, we applied a mathematical model to the empirical results to derive quantitative estimates of social learning fidelity and three forms of bias affecting errors in social learning: mirroring, handedness and repetition. We show how these biases affect evolutionary dynamics, explaining the prevalence of granny over reef knots found in material culture collections. Our study also serves to show how, even if any copying error is random, social learning of micro-structures in artefact production can result in the evolution of non-random frequencies of cultural variants.

Brooke Scelza and Sean Prall

From cows to cash: Shifting norms among Himba pastoralists

Matrilineal systems in sub-Saharan Africa tend to co-occur with horticulture and are rare among pastoralists, with the causal arrow pointing from the introduction of cattle to the loss of matriliny. However, most work on this topic stems from either phylogenetic analyses or comparisons using historical data. To better understand the dynamics of the shift from matriliny to patriliny, data from societies that are currently in transition are needed. The Himba, who practice double descent may represent one such society. Using multi- generational ethnography and structured survey data, we investigate how norms associated with matriliny, including matrilateral inheritance, female autonomy and tolerance for non-marital partnerships, may be shifting with increased access to education and wage labor. We first use existing theory to test whether wealth, marginalization or paternity confidence predict men's preferences for matrilineal versus patrilineal norm structures. Next, we use responses to a series of counterfactuals to understand how market integration might trigger the breakdown of traditional modes of status and prestige. For example, does access to education free young men from a dependence on traditional wealth and wealth structures, thereby allowing them to thwart traditional norms and suffer fewer costs for norm violations? Finally, we assess the extent of concordance between

norms about inheritance and norms about other related behaviors such as tolerance for concurrent partnerships and female autonomy.

Hanna Schleihauf and Hoehl Stefanie

Dual-mode model for overimitation

Children and adults tend to imitate actions that are irrelevant to accomplishing a goal, they overimitate. This behavior seems to be uniquely human and is discussed to play a role in the evolution of conventions and rituals. If that is the case, we should overimitate, even when we know that there is a more efficient way to reach a goal. Furthermore, we should imitate ritual-like actions (not involving physical contact with the reward-container) more frequently than non-functional pseudo-instrumental actions (perceivably irrelevant, involving physical contact with the reward-container, similar to actions that lead to effects). In the present study, we investigated if overimitation maintains in german five-year-olds, when they see an inefficient and also an efficient strategy to extract a reward from a puzzle-box, i.e. when it was ensured that children knew about the irrelevancy of demonstrated actions. We had one condition in which children saw equivalent demonstrations of the inefficient and the efficient strategy, before it was their turn, and one condition in which children saw a pedagogical inefficient strategy and a non-pedagogical efficient strategy. The inefficient strategy included ritual-like actions and pseudo-instrumental actions. We found that children had a stronger tendency to copy irrelevant actions if the efficient strategy was demonstrated in a non-pedagogical context and, contrary than predicted, that children copied pseudo- instrumental actions much more often as ritual-like actions, although they knew that they had no function. We introduce a dual-mode model for overimitation with two copying modes. Blanket copying is triggered when children observe only an inefficient strategy including pseudo-instrumental actions. Reflective copying is triggered (a) when children know that there is a more efficient strategy available and (b) by actions that do not involve physical contact with the reward-container. The presented study suggests that pseudo-instrumental actions are processed differently than other irrelevant actions and are imitated with higher rates.

Kathy Schick and Nicholas Toth

Cultural Evolution and the Archaeological Record

The prehistoric record provides more than 2.5 million years of archaeological evidence for hominin cultural evolution. Here we will review the major technological stages of hominid evolution and their associated behavioral patterns, and how these stages are correlated with major stages of biological evolution, especially the evolution of the hominin brain. We will note the first appearances of major emergent traits throughout the course of human evolution. We will examine modern ape culture, pre-Palaeolithic hominins, the Oldowan, the Acheulean, Middle Stone Age/Middle Palaeolithic, Later Stone Age/Upper Palaeolithic, and recent prehistoric cultural patterns. We will show the value of experimental archaeology and brain imaging in our understanding of evolutionary technological stages.

Øivind Schøyen

What limits the powerful in imposing the morality of their authority?

This paper models a game between an authority, seeking to implement its preferred morality, and a parental generation, seeking to socialize a younger generation into the their own morality. The authority

chooses a coercion level for adhering to the non-state morality, whereupon the parental generation chooses whether to insurrect and, if not, how much to invest in socialization. The novel feature of this paper is that we formalize and explore the consequences of an intrinsic negative reaction to coercion: coercion resentment. The key result is to show the necessary micro Level assumptions for an inefficient interval of coercion that can account for authorities choosing to restrain their use of coercion. Furthermore, the paper characterizes the socialization and insurrection preferences needed for the long run equilibrium to be path dependent. Two historical periods are presented through the lens of the model: the Counter-Reformation in early modern France and the Holy Roman Empire (1517-1685) and the Soviet Secularization project (1922-1991).

Øivind Schøyen

Morals favored by previous moral choices are always safer

This paper develops a framework to analyze how actions are perceived to be legitimate based on previously observed behavior. Legitimacy refers to actions that are considered morally adherent to some defined moral code. The framework has two key features. 1) Acting in a legitimate way can be understood as acting relative to some internalized moral code. This moral code is understood as a set of moral principles, which assigns moral value to actions. Moral principles are incompatible in many choices of actions, it is impossible to fulfill them all. Hence, individuals need to understand how their relevant in-group weighs the relative importance of different moral principles to determine how well actions fulfill the overall moral code.2) Agents use a combination of the information from these moral codes and the weighing assessments implied by the actions of fellow in-group members. This enables the group to coordinate on what actions that should be considered pro-social. The theory focuses on how binary choices of actions reveal information on the weighting of the moral principles. The paper develops three results: Firstly, ambivalence behind moral motivation always will favor values previously choosen in new moral choices. This explains the commonly observed path-dependency feature that conditions in the past affect the norms of the present purely as an informational effect. This theoretical result of different cultural developments among rational pro-social actors purely arising from informational differences gives rise to what is, to the author's knowledge, an undescribed micro-mechanism behind cultural inertia and cultural persistence.Secondly, the framework gives a concrete definition to the possibility space of norm development; actions that can be considered legitimate must have positive probability coinciding with the moral choices of the past. Thirdly, I analyze which conditions lead to formal notions of extremism and what conditions lead to liberal tolerance.

Jonathan Schulz, Joe Henrich, Duman Bahrami-Rad and Jonathan Beauchmap

The origins of WEIRD people

Recent research not only confirms the existence of substantial psychological variation around the globe but also highlights the peculiarity of populations that are Western, Educated, Industrialized, Rich and Democratic (WEIRD). We propose that much of this variation arose as people psychologically adapted to differing kin-based institutions—the set of social norms governing descent, marriage, residence and related domains. We further propose that part of the variation in these institutions arose historically from the Catholic Church's marriage and family policies, which contributed to the dissolution of Europe's traditional kin-based institutions, leading eventually to the predominance of nuclear families and impersonal institutions. By combining data on 20 psychological outcomes with historical measures of

both kinship and Church exposure, we find support for these ideas in a comprehensive array of analyses across countries, among European regions and between individuals with different cultural backgrounds.

Arturs Semenuks

What makes a language violate universals? Correlates of linguistic rarities and their importance in studying linguodiversity

Over the last decades, many absolute linguistic universals (ALUs) - features supposedly true of all languages - have been proposed. ALUs would be useful as explanatory posits in studying cultural evolution: they would strictly delineate what structures human languages could and couldn't have, which would have important consequences for understanding how languages change and the mechanisms recruited in their transmission and learning. However, even though their existence would be theoretically useful, are there any (non-trivial) ALUs? There are at least two reasons for doubts. First, many previously proposed ALUs turned out to be only strong statistical tendencies when more languages were investigated (Dryer, 1998; Evans & Levinson, 2009). Second, computational modeling suggests that due to sampling limitations rarely can positive typological evidence alone warrant considering a pattern an ALU (Piantadosi & Gibson, 2014).Thus, the debate over the existence of ALUs persists. In my presentation I will describe a project that advances this discussion by analyzing what types of languages tend to have linguistic rarities violating previously proposed ALUs, specifically focusing on investigating whether ALU violations are distributed randomly among the world's languages in terms of their sociogeography and phylogeny or not. If the latter is the case, it would suggest that presumed ALUs aren't strict rules languages abide by, but by-products of the sociogeographic and linguistic histories of the languages most available for study today. I analyze the Konstanz Universals Archive (Plank & Filimonova, 2000), and using Monte Carlo simulations find that languages with more speakers, certain language families, including Indo-European, and language isolates tend to violate ALUs more often than expected. I argue that this suggests that linguistic diversity is underdescribed, and that many ALUs are put forward due to an underestimation of the space of possible structures languages could occupy because of various sampling biases by researchers.

Catherine Sheard, Sally E Street, Mary C Stoddard, Camille Troisi, Andrew Clark, Susan D Healy and Kevin N Laland

The evolutionary flexibility of animal construction: the co-evolution of bird nests and bird eggs

Cultural evolution allows humans to dramatically modify their own selective environment (e.g. building shelter). A lack of similar species makes studying the dynamics of niche construction (Odling-Smee et al 2003) in humans difficult, though comparative studies of traits in other species can help. A classic non-human example of niche construction is avian nest building, which recent evidence in both the lab and the wild has shown can be a socially-transmitted trait (Breen et al 2016). Here, we present a database of nest structure and location for 8,231 species of birds, which we combine with a new database of egg colouration for 4,762 species and previously-published information on the egg shape of 1,400 species (Stoddard et al. 2017). Using Bayesian phylogenetic comparative methods, we show that nest structure and location is correlated with egg size, shape, colouration, and patterning. In many cases, however, it is the egg trait that evolves first, followed by a corresponding change in the nest characteristic. On a global

scale, these egg traits are related to a variety of intrinsic and extrinsic factors. It has been previously shown that egg size is tightly correlated with body mass and that egg shape is related to adaptations for flight ability (Stoddard et al. 2017); we additionally demonstrate that egg colour and patterning is correlated with environmental variables and body mass, finding no support for traditional hypotheses related to brood parasitism or sexual selection. Taken together, this evidence runs against the conventional view of nests as highly conserved constraints on avian reproduction and instead suggests that nest construction is a flexible behavioural trait that can quickly respond to ecological pressures, further underscoring the ecological and evolutionary parallels between human and animal construction.

Andrew Shtulman, Cara Neal and Gabrielle Lindquist

Children's Ability to Learn Evolutionary Explanations for Biological Adaptation

Evolution by natural selection is often relegated to the high school curriculum on the assumption that younger students cannot grasp its complexity. We sought to test this assumption by teaching US elementary-school-aged children (n = 96) a selection-based explanation for biological adaptation and comparing their success to that of US adults (n = 30). Participants provided explanations before and after a ten-minute tutorial illustrating the concepts of variation, differential survival, differential reproduction, inheritance, and population change. These concepts were conveyed through two illustrated stories of how particular animals came to have particular traits (e.g., how Artic hares came to have white fur). Participants' understanding of the target concepts was assessed by their ability to articulate those concepts at training and by their ability to apply those concepts to new instances of adaptation—instances that varied in the types of traits acquired and the types of animals that acquired them. All explanations for biological adaptation were elicited with the simple question, "How did [this animal] come to have [this trait]?" We found that younger children (aged 4 to 6) showed minimal evidence of learning evolutionary concepts, but older children (aged 7 to 12) showed robust evidence of doing so, learning them at rates equivalent to adults. Participants of all ages, however, also typically provided non-evolutionary explanations for biological adaptations—explanations that referenced an animal's needs, an animal's growth, or divine creation—at both pretest and posttest. These results suggest that older elementary-school-aged children can be taught evolutionary concepts but that learning such concepts does not lead to the automatic replacement of non-evolutionary views of biological adaptation, which must be addressed separately. They also suggest that the widespread practice of delaying evolution education until the second decade of life is misguided and may actually exacerbate cognitive obstacles to learning evolution.

Manvir Singh

Magic, explanations, and evil: On the origins and design of witches and sorcerers

In nearly every documented society, people believe that some misfortunes are attributable to malicious group mates employing magic or supernatural powers. Here I report cross-cultural patterns in these beliefs and propose a theory to explain them. Using the newly-created Survey of Mystical Harm, I show that several conceptions of evil, mystical practitioners recur around the world, including sorcerers (normal humans who use learned spells and charms), possessors of the evil eye (people who transmit injury through their stares and words), and witches (quasi-humans who possess superpowers, engage in

secretive conspiracies, and consume human flesh, among other atrocities). I argue that these beliefs develop from the interaction of three cultural selective processes – a selection for effective-seeming magic, a selective for plausible explanations of impactful misfortune, and a selection for demonizing myths that justify mistreatment – which are rooted in shared psychological capacities. Individually, these selective schemes produce practices and beliefs as diverse as gambling superstitions, shamanism, conspiracy theories, and campaigns against heretics – but around the world, they jointly give rise to the odious and feared witch. I use the tripartite theory to explain why beliefs in mystical harm take the form that they do and outline twenty predictions for how shifting social, psychological, and material conditions should affect those beliefs. Societally-destructive beliefs can persist when they are intuitively appealing or serve some believers' agendas.

Paul Smaldino, Aaron Lukaszewski, Christopher von Rueden and Michael Gurven

A socioecological model of personality trait distributions

Personalities are persistent patterns of manifest cognition, emotion, and behavior exhibited by specific individuals within or between contexts that can be used for description and prediction. Contrary to the beliefs of some psychologists, the nature and distribution of personalities in a population are not consistent across cultures. Two results in particular stand out. First, while the Big Five model, in which personality differences cluster along the five dimensions of openness, conscientiousness, extraversion, agreeableness, and neuroticism, appears fairly robust in WEIRD cultures, it does not replicate in small-scale foraging societies. Among the Tsimane of Bolivia, for example, personality differences were explained by only two factors (Gurven et al. 2013). Second, a recent analysis of participants from 55 industrialized nations found that the degree of correlation between personality factors (as determined by the Big Five inventory) was negatively correlated with the socioeconomic complexity of the individuals' home nations (Lukaszewski et al. 2017). Here, we explain these results with a simple computational model formalizing the socioecological complexity hypothesis. In this model, agents assort into socioeconomic niches and adjust their traits to better match those best suited to their chosen niche. Social complexity is operationalized by the number of available niches. We show that our model captures the highlighted empirical results and also raises novel empirical questions. Our results have broad implications for understanding the feedback between individual psychology and cultural complexity.

Kristopher Smith, Tomas Larroucau, Ibrahim Mabulla and Coren Apicella

Hunter-gatherers maintain assortativity in cooperation despite high-levels of residential change and mixing

Widespread cooperation is a defining feature of human societies from hunter-gatherer bands to nation states. But explaining its evolution remains a challenge. While positive assortment – of cooperators with cooperators – is recognized as a basic requirement for the evolution of cooperation, the mechanisms governing assortment are debated. Moreover, the social structure of modern hunter-gatherers, characterized by high mobility, residential mixing and low genetic relatedness, undermine assortment and add to the puzzle of how cooperation evolved. Here, we analyze four years of data (2010, 2013, 2014, 2016) tracking residence and levels of cooperation elicited from a public goods game (PG), in Hadza hunter-gatherers of Tanzania. Data were collected from 56 camps, comprising 383 unique

individuals, 137 of whom we have data for two or more years. Despite significant residential mixing, we observe a robust pattern of assortment necessary for cooperation to evolve: In every year, Hadza camps exhibit high between-camp and low within-camp variation in cooperation. We further consider the role of homophily in generating this assortment. We find little evidence that cooperative behavior within individuals is stable over time or that similarity in cooperation between dyads predicts their future cohabitation. Both sets of findings are inconsistent with homophilic models that assume stable cooperative and selfish types. Consistent with social norms, culture and reciprocity theories, the data suggest that the strongest predictor of an individual's level of cooperation in any given year is the mean cooperation of their campmates in that year. These findings underscore the adaptive nature of human cooperation ¬– particularly its responsiveness to social contexts ¬– as a feature important in generating the assortment necessary for cooperation to evolve.

Marco Smolla and Erol Akcay

How cultural dynamics affect population structure

Cultural evolution relies on the social transmission of cultural traits (knowledge, believes, ideas, skills) across a population. Cultural traits diffuse along the edges of social networks that emerge from the non-random interactions between individuals. While previous studies have shown that the structure of interaction networks affects information spread in a population, and thus its ability for cumulative culture, it remains largely unclear how the network structure itself is driven by population-culture co-evolution. Using a simple but realistic model of complex dynamic social networks, we investigated how populations negotiate the trade- off between acquiring new skills and getting better at existing skills, and how this trade-off, in turn, shapes the social structure of the population. Our results reveal unexpected eco-evolutionary feedback from culture onto social network structure. We find that selecting for skill breadth (generalist world, favouring the maintenance of new innovations in the population) results in sparsely connected networks with high diversity between individuals' skill sets, whereas selecting for skill depth (specialist world, favouring high proficiency in a given skill) results in densely connected networks and a population that specializes on a few skills on which everyone is an expert. Interestingly, we find that the latter scenario can act as an ecological trap where it can take a long time for a specialized population to switch to new skills and adapting to a generalist world once the selective environment changes. Our model advances our understanding of the complex feedbacks in cultural evolution and demonstrates how individual-level behaviour (trait acquisition) can lead to the emergence of population-level patterns (population structure).

Marius Somveille, Joshua Firth, Lucy Aplin, Damien Farine, Ben Sheldon and Robin Thompson

Movement and conformity interact to establish local behavioural traditions in animal populations

The social transmission of information is critical to the emergence of animal culture. However two processes are further predicted to play key roles in whether socially-transmitted information will establish in groups to form persistent traditions that are resistant to invasion by other behavioural variants: the movement of individuals across the landscape and conformist social learning. We first develop a model where a new foraging resource can be accessed in one of two ways, and individuals learn the new behaviour from knowledgeable individuals with varying strengths of conformist bias

guiding their solving preference (conformist bias measured as a sigmoidal relationship between the probability of adopting a behaviour and its frequency in the group). The population is composed of several spatially distinct sub-populations, and individuals move between sub-populations with a variable movement rate. Our results reveal a strong interplay between movement rate and conformity for determining whether local traditions establish across a landscape, or whether a single preference dominates across the whole population. We then apply the model to real-world cultural diffusion experiments in great tits, Parus major, where wild studies showed that birds exhibited a conformist bias when social learning how to access a new foraging resource. In addition, birds tended to switch their behaviour to that of the local majority when moving between sub-populations. Our model is able to replicate the patterning of emergent traditions observed in this empirical experiment, allowing for a range of predictions to be made for the emergence of animal culture under various initial conditions, habitat structure and strength of conformist bias. Finally, our work highlights that the interactions between multiple factors are likely to underpin observations of behavioural variation in natural populations.

Mark Stanford

Religious orthodoxy and folk traditions sustain complementary forms of co-operation: Evidence from Burmese Buddhists

Anthropologists have long debated how best to characterise the relationship between religion as defined by high orthodoxy and the 'folk' traditions which stubbornly persist alongside. In the case of Theravada Buddhism, this debate has taken the shape of theoretical disputes over distinctions between Buddhism and the 'animistic' religiosity which invariably accompanies it. This paper suggests that cultural evolutionary theory may provide a fruitful framework for revisiting this debate. Based on large-scale psychometric studies conducted in Myanmar in 2017 and 2018, the paper argues that there do appear to be two nearly orthogonal dimensions of Burmese Buddhist religiosity, but that they correspond not to Buddhism and animism, but to groupish and personalistic modes within both. It suggests that the apparently complementary moral role of the two goes some way to explaining the coexistence of so-called 'big' and 'little' traditions, and that there is reason to think this may have an evolutionary basis. If 'big' religious traditions spread in part by facilitating co- operation beyond interpersonal relationships, they must arguably strike a balance with forms of religiosity which promote reciprocity, lest they crowd out co-operation sustained in this way.

Sally Street

Cultural evolution operates distinctly in the musical domain

Understanding how cultural evolutionary processes operate across diverse domains is essential for a general theory of cultural evolution. However, arts and especially music are under-investigated in cultural evolution relative to language and technology, perhaps partly because their function is comparably less straightforward. This project investigates how far predictions based on language and technology apply to music, using an online dataset of ~15,000 tunes from the Irish folk session tradition. This tradition is ideal for investigating how cognitive factors shape cultural variation because session musicians play tunes from memory. Two pairs of opposing predictions are tested: i) popular tunes are more diverse due to greater opportunity for innovation or copying errors, versus less diverse due to

more standardisation ii) shorter tunes are more popular due to memory constraints, versus less popular due to an aesthetic preference for complexity. Popularity is measured as how often tunes are added by musicians to online 'tunebooks', diversity as the number of different tune versions available and tune length as the number of bars. Tune diversity increases with tune popularity, suggesting that frequently played tunes have more chance to diversify into novel tune variants. Thus, more similarly to technology than to language, larger cultural populations appear to support more diverse cultural repertoires in music. Tunes of intermediate length are the most popular: popularity increases with tune length up to around 16 bars, after which it decreases. Therefore, cognitive constraints likely limit the popularity of longer tunes as they do for words. Unlike language, however, an aesthetic preference for complexity for its own sake may explain the unpopularity of shorter tunes. Together, these findings show that cultural evolutionary processes operate distinctly in music compared with language and technology. This work highlights the value of including diverse domains in cultural evolutionary research for developing more comprehensive theory.

Francys Subiaul

Summative learning as a mechanism for cultural evolution

Many believe that cultural evolution depends on two engines, innovation and social learning. However, whereas, humans' social learning abilities are exceptional, humans' ability to innovate is comparatively limited. Given this, how do human cultures evolve? One possibility is summative social learning, the aggregation of socially-learned skills. Prior research has shown that preschoolers combine different responses shown by 2 different experimenters in a well-structured problems (a puzzle box). Follow- up studies have shown that 4-5 years old also combine different imitated responses to build an optimally sized tower, an ill-structured problem. However, it's unknown whether summative learning may occur through emulation as well. To answer this question, 120 preschool age children (4-6 years) were randomly assigned to one of the following conditions prior to being tested on a novel tower building task: Baseline, where children were given the tower pieces and instructed to build the tallest possible tower without any prior demonstration; Imitation: where children observed one model stack cubes—Base—and another model combine squares—Apex—prior to testing; Emulation: same as Imitation, except that the model combined squares or stacked cubes behind an occuler. Children in the social conditions (imitation and emulation) produced taller towers than children in Baseline (all ps < .05). Children in the social conditions produced more target responses, than children in Baseline (all ps <.05). More children in the imitation condition evidenced summative learning than children in Baseline ($p < .001$) and emulation ($p < .005$) conditions. These results corroborate prior work showing that children can innovate by faithfully combining others' responses. This challenges our conceptualization of innovation as arising from purely asocial cognitive processes. Instead, many (perhaps, most) innovations may result from social learning.

Masanori Takezawa and Seiya Nakata

Does teaching promote the cumulative cultural evolution?: Agent-based simulations with computational models of teaching

It has been argued that a critical factor for the successful cumulative cultural evolution is transmission fidelity, and teaching is considered to play a critical role in sustaining a faithful transmission. Although an

experimental study showed that teaching promotes faithful transmission of complex skills, it has not yet been explicitly demonstrated that teaching promotes the cumulative cultural evolution of better skills. In this study, we first constructed a computational model of teaching complex skills in which learning a skill (e.g., knotting) is formalized as searching a minimum path between two nodes in a complex network by a reinforcement learner, and teaching is formalized as the exact mapping of actions of a demonstrator by a learner (i.e., apprenticeship learning in machine learning literature). First, using agent-based computer simulations with a single transmission chain design, we found that teaching promotes the cumulative evolution of better skills measured as the decreasing average number of steps from a start-node to a goal-node across generations. Second, we found that the accumulated performance gets better as learners engage in longer social learning periods at the sacrifice of individual learning periods. However, there is a trade-off between the amount of time individuals can spend on social learning and the amount of time for individual learning. Hence, shortening the times for individual learning should suppress the cumulative evolution of sophisticated skills in our simulations. Interestingly, we found that the teaching creates a system of efficiently transforming information individuals acquired during individual learning periods into better performance at a collective level. This is the reason why more extended teaching (social learning) periods tended to promote the speed of cumulative cultural evolution in the current setting. We will further discuss the necessity of rigorous computational models of teaching (e.g., Whalen et al., 2015).

Monica Tamariz

Cumulative culture = Darwinian cultural evolution

It is generally accepted that cumulative culture (henceforth, CC) is typically human, and is characterized by sophisticated cultural traits that could not have been devised from scratch by a single individual. Traits are passed on faithfully, unchanged, to new individuals, who can later use them as the basis for innovation. A puzzle arises: How can we reconcile the two cognitive traits that underlie CC --on one hand the rigid adoption of cultural traits without questioning whether they could be better, attempting to modify them or even understanding how they work, and on the other hand the creativity and intelligence necessary to elaborate, refine and combine those same traits? This puzzle is solved by a model of cultural evolution that highlights the distinctions between two non-orthogonal aspects of cultural transmission: Inheritance by naive learners. During imitation and over-imitation --which operate in pretend play, early language learning (babbling) and some forms of teaching-- actions are copied faithfully, but their associated normal, effective or conventional functions are not necessarily understood, intended or achieved. Content- indifferent copying by naive learners achieves the replicative cross-generational inheritance of actions. Usage by experts. Later, as learners infer the associations between the replicated actions and their outcomes and functions, mental cultural traits (knowledge, beliefs, values, skills) emerge. Inheritance gives way to usage and learners become experts who deploy actions with goals in mind. The interplay between replicated actions, goals and the material environment may spark innovation through modification or combination of existing actions. Innovations are put to the test in the arena of usage. This is selection. The fitness of an action variant depends on the desirability of its function, value or meaning. Corollary: Inheritance of cultural actions is replicative.

Inheritance of mental cultural traits are involves emergence through inference. Cumulative culture equals Darwinian cultural evolution.

Kohei Tamura and Takehiko Matsugi

Geometric morphometrics of keyhole-shaped mounds

Interaction among populations, including assimilation and conquest, has been an important driver shaping cultural diversity. Empirical studies on such interaction, or cultural macroevolution, have used archaeological data, often with a particular focus on the evolution of monuments to quantify political relationships among populations. Kofun, particularly keyhole-shaped mound, is a type of tombs of prestigious people, which characterize the Kofun period (from around 250 to 600 AD) or the period of the state formation in Japan. The mounds are distributed across Japan and the size is sometimes over 300 m, indicating a strong political power and a vast labour force. They have been a subject of intensive research because similarities in shapes of the mounds have been considered to be a proxy of political connections. However, the majority of the previous studies have several limitations such as being based on a few morphological attributes and over-dependence on typology. The present study analyzed the shapes of keyhole-shaped mounds by using methods in geometric morphometrics, which have been developed to analyze biological shapes in a quantitative manner. By using geometric morphometrics, we quantify and visualize spatial-temporal patterns of morphological changes of the mounds. Our results suggest a temporal trend in changes in the shapes of the mounds. The trend continues throughout the Kofun period across Japan, suggesting a large network of cultural transmission.

Irene Teixidor-Toneu, Jamie Thompson, Fiona Jordan and Julie Hawkins

Comparative phylogenetic methods and the cultural evolution of medicinal plant use

Human life depends on plant biodiversity, and the ways in which plants are used are culturally determined. Cultural evolutionary approaches to ethnobotany have to date focused on the drivers and dynamics of cultural transmission within communities, but studies of the patterns of plant use across ethnolinguistic groups have been uncommon. Meanwhile, the understanding of cross-cultural diversity in other domains has benefitted from the application of phylogenetic comparative methods (PCMs), and our understanding of the cultural evolution of (e.g.) political, religious, and social norms, as well as material culture, has become increasingly sophisticated. For ethnobotany, medicinal plants are of special interest because of their role in maintaining people's health across the world. Here we describe a framework for using cultural evolutionary theory and PCMs to study the diversity of medicinal plant applications cross-culturally, and to infer changes in plant use through time. As a new innovation, these methods can be applied to single medicinal plants as well as whole pharmacopoeias, and they account for the non-independence of data when testing for ecological or cultural drivers of plant use. We demonstrate this approach with data on medicinal plant use and plant names from seven Oceanic ethnolinguistic groups. We compare medicinal use, plant name, and floristic similarity with cultural-phylogenetic and geographic distance. Results demonstrate that while overall medicinal plant use is predicted by geographic distance and floristic similarity, cultural-phylogenetic effects may predict individual plants and their medicinal uses and naming patterns. Our framework therefore allows us to

identify the particular mixture of inherited, borrowed, and innovated elements in Oceanic pharmacopoeias.

Claudio Tennie

The best explanation for the stasis in early hominin stone tool forms is a lack of copying mechanisms

Cumulative cultural evolution requires copying social learning mechanisms. Given that behavior does not fossilize, our best hope to answer when these appeared in our lineage is to analyze early stone tools. It has been noted that these tool forms varied around static means – for hundreds of thousands of years. The prevailing claim is that these tools were based on copying social learning mechanisms. But a pattern of stasis looks much unlike the fast and ever-increasing levels of variation that is expected for cumulative cultural evolution. Here, I will detail an alternative approach (see Tennie et al. 2016; 2017). I will focus on two examples of stone tools with claims for the necessity of copying: the Oldowan and (early) Acheulean. After presenting new data and hypotheses that my group has derived from tests of modern non-human great apes, I will show that these early stone tools could very well have been innovated on the spot. This approach does not require that all members of a population innovated the tool completely independently and/or at the same time. Various forms of non-copying social learning (widespread in the animal kingdom) would have homogenized the innovation of these tools across connected individuals after some were quicker than others to produce them. Importantly, copying social learning mechanisms would not have been required, as each affected member would have had to reinnovate the necessary tool making behaviour her/himself. And so, early hominin stone tool culture (as well as ape tool cultures) were likely not examples of cumulative cultural evolution, instead they were socially mediated serial reinnovations (Bandini & Tennie 2017). Currently, this appears to be the most parsimonious explanation for early stone tools – and it moves the evidence for copying social learning mechanisms (and cultural evolution) in our lineage forward in time by millions of years.

Bill Thompson and Tom Griffiths

A Bayesian model of cumulative culture

Unlike other species, human populations naturally pool computation over generations. Our system for achieving this – cumulative culture – caches human innovations to construct a technology-rich environment that is increasingly adaptive, and increasingly peculiar: we are surrounded by technologies that are exceptionally complex and highly efficient, that almost nobody understands, and which no individual has designed. How do human technologies become so effective? We present a simple mathematical model of cumulative culture as transmission of a technology among populations of innovative Bayesian learners. By deriving a model of cumulative culture from a computational model of human cognition, we extend existing Bayesian analyses of social learning and cultural transmission to the cumulative case, and provide a formal connection between properties of individual cognition, technological fitness landscapes, and the accumulation of complexity. More generally, our analysis leads to an equivalence between Bayesian cumulative culture and a widely studied optimization algorithm from artificial intelligence. This demonstrates that there is a natural computational formulation of cumulative culture as an optimization algorithm executing in human populations, with well understood connections to evolutionary processes and a large existing literature characterizing it's behaviour under

varied conditions. We lay out the equivalence using the simplest possible model of cumulative culture, but show that more realistic models correspond to more sophisticated (and more efficient) versions of the algorithm. These analyses lead to predictions that we are in the process of testing experimentally.

Leonid Tiokhin, Minhua Yan and Thomas J. H. Morgan

Competition for Priority and the Natural Selection of Bad Science

It is becoming increasingly clear that many published findings do not replicate (i.e. the "reproducibility crisis") and these is a growing desire to understand how various factors affect scientific reliability. Among these, incentive structures are thought to be especially important. Here we develop an evolutionary agent-based model to test the effect of incentive structures on the reliability of scientific findings. Specifically, we consider an incentive structure that rewards priority of discovery. In our model, pairs of scientists investigate a phenomenon and compete to be first to obtain a statistically significant result. Scientists can increase statistical power by using larger samples, but this takes more time and so increases their risk of being "scooped". We find that competition for priority causes populations of scientists to evolve towards lower sample sizes and, in turn, statistical power. This mirrors the results of previous models about the natural selection of bad science. However, we also find that increasing the startup costs of a single study reduces the negative effects of competition, increasing equilibrium sample size and statistical power. This occurs because startup costs lower the relative payoff of pursuing a "quantity" strategy by conducting many low-quality studies. We discuss the implications of these findings for preventing low-quality research and use them to evaluate the effectiveness of proposed reforms to scientific practice (e.g. registered reports).

Peter Todd

Searching cultural spaces with evolved cognitive mechanisms

Humans and other organisms face the challenge of adaptively trading off between exploring and exploiting their environment to obtain the resources they need. This should apply to whatever space they are searching: whether the external spatial environment, looking for patches of food; the internal information environment, seeking concepts in memory; or the external constructed environment, seeking information, goods, or entertainment. Similar evolved cognitive search mechanisms may be used to address the explore/exploit tradeoff in each domain, leading people to behave as predicted by optimal foraging theory. In this talk, I will describe our research on how people search for concepts in their semantic space (e.g., foods or animals) and for artists to listen to in music space, pointing to possible evolved commonalities between mechanisms underlying spatial foraging and other forms of search in cultural spaces.

Cameron Turner

The coevolution of adaptations for social learning

Learning from others is an important method to acquire behaviours, and animals possess adaptations supporting such social learning. Formal theory has focused on strategies social learners may deploy to deal with unreliable information. However, animals also face selection when they are learned from, and may bolster or degrade social learning. First, we provide a model clarifying the conditions favouring adaptations for (asocial) learning from any environmental source. We then present a general model examining when both senders (sources of learning) and receivers (learners) are selected to affect the

reliability of social learning. Given common interest, the burden for ensuring social learning is taken by the party whose fitness benefit is larger, compared with the cost of adaptations. Analogously, given a conflict of interest, the party who benefits more will skew the probability of social learning in their favoured direction. Asocial learning reduces selection on adaptations for social learning in both cases. Our results provide new understanding of trends observed in nature, including when teaching and concealing behaviour should be observed. We further consider scenarios leading to human cumulative culture, and thereby help to resolve a recent debate regarding the centrality of social learning strategies to its evolution.

Matthew A. Turner and Paul E. Smaldino

Cultural polarization depends on whom we learn from, when we learn, and how well we communicate

Cultural polarization is a potentially troublesome outcome of cultural learning. We studied an agent-based model of opinion dynamics to determine which cultural learning conditions lead to either centrist consensus, extremist consensus, or extremist polarization. In the model, individuals are vertices on a regular network or a small-world network. Each individual has publicly-known opinions on a number of cultural issues. Agents update their opinions by observing neighbors' opinions: agent opinions move towards sufficiently similar opinions and away from sufficiently different opinions. Our analysis reveals a number of cultural factors that predict the final cultural polarization. First, initial polarization is weakly correlated with final polarization. Second, when initial extremism is sufficiently limited, polarization does not emerge in the absence of communication noise. However, sufficiently high levels of communication noise can break centrist consensus, resulting in either extremist consensus or extreme polarization. Cultural complexity tends to decrease polarization. Small-world network configurations lead to more cultural polarization on average than regular networks. We also find that the exact degree of polarization was highly path dependent, a fact we also explore. Our results suggest novel empirical studies of cultural polarization in which initial extremism, miscommunication, network structure, and timing of opinion updates are varied. Though our work was intended to address opinion dynamics, agent "opinions" could also be interpreted as other, more general, individual traits, such as beliefs, technological know-how, or language features, and thus has implications for the studies of these features.

Ryutaro Uchiyama and Michael Muthukrishna

General intelligence as an emergent product of cultural complexity: explaining the Flynn effect

Intelligence is difficult to define, but is often linked to primitives like processing speed and working memory capacity. The rapidly growing literature on heritability in cognitive ability and educational attainment reinforces the assumption of genetically encoded neurocognitive phenotypes explaining most of the population variability in intelligence. Here we argue that human intelligence, and especially variability between-groups and over time, including the famous Flynn effect, are best understood by understanding the role of culture in shaping the cognitive tools that constitute intelligence. That is, IQ and IQ tests are best seen as a measure of cultural complexity rather than a product of innate neurocognitive traits. We discuss how this perspective resolves many inconsistencies in the existing

intelligence literature. Moreover, we test the causal relationship between the Flynn effect, sociality, and various measures of cultural transmission (e.g. formal education) and cultural complexity. These data support the notion that our societies and collective brains are becoming more culturally complex and increasing our cognitive ability.

Natalie Uomini and Russell Gray

Cumulative and mosaic tool evolution within New Caledonian crows

The New Caledonian crow (Corvus moneduloides) is the only bird species that manufactures tools using long action sequences, and the only bird species that matches templates to produce standardized tool shapes. Although genetic data show the crows are one continuous population with gene flow between groups, there is discrete cultural variation in tool traditions with high site fidelity. These tool designs have no obvious environmental correlates. The crows craft at least five types of hooked tools from Pandanus leaves, modified twig tools, and unmodified tools from other plant materials like leaf-stems and grass-stems. Each tool type has simpler and more complicated designs involving variable numbers of actions. However, the origins and evolutionary trajectories of the crows' present-day tool-making behaviors are unclear. Previous research suggests that pandanus tools might have evolved cumulatively, and raises the possibility that twig tools did as well. To test this possibility, we asked which features of twig tools are subject to cultural variation. We analyzed 63 tool-making sequences that we video-recorded during spontaneous tool manufacture by a new group of wild, free-flying birds in New Caledonia. In addition, we analyzed published tool-making sequences from another group. Sequences consisted of 1 to 21 actions each, with 22 possible actions in total. We show that: (1) tool-making action sequences are flexibly composed of actions in variable orders, not rigid pre- determined sequences, (2) each of the two groups has a different, preferred ordering of actions that is used more frequently, (3) certain design features of tools can occur independently of each other, not together as predicted by previous research. Results are consistent with a mosaic evolution of tools in which crows make flexible, creative combinations of actions from their learned repertoire.

Bruno Vilela, Trevor Fristoe, Ty Tuff, Michael Gavin, Patrick Kavanagh, Hannah Haynie, Russel Gray and Carlos Botero

Domesticates ecological niches limited the historical transmission of farming

Acquiring the knowledge and technology necessary for the domestication of wild species was a key event in human history, allowing societies to transition from foraging to farming. Farming subsequently expanded to become the predominant mode of human subsistence, suggesting that it provides a clear advantage over foraging. However some societies never adopted farming, only partially adopted farming, or even reverted back into foragers. Although these examples imply that in some regions ecological conditions may have interacted with historical mechanisms of ideas transmission to dictate the spread of farming, there is currently no consensus on how or to what extent ecological factors may have influenced this historical event. We used a global dataset of 1253 human societies to develop a single statistical model that reveals how horizontal (neighboring effect) and vertical (ancestral legacy) transmission have unfolded within constraints imposed by domesticated species' climatic tolerances and dispersal limitations to determine the spread of farming. Specifically, we employed ecological niche

reconstruction and current anthropological evidence for the geographic origins of domestication to estimate the potential number of domesticated species that could be historically available to each society. Overall, our model explains 82.18% of the variation in a continuous farming index that indicates how much a society diet depend on farming. Details of the model results also provides evidences for an intuitive mechanism of cultural spread: while farming was primarily inherited through ancestral legacy and learned from neighbors speaking similar languages, ecological boundaries prevented its persistence in climates unsuitable for growing geographically accessible domesticated species.

Burton Voorhees

Human reasoning

The capacity for reason has often been used as the defining characteristic of human beings and, as such, the nature of reason has been a perennial question. In a recent book, The Enigma of Reason, Hugo Mercier and Dan Sperber propose that the driver for the evolution of reason during the Paleolithic was the need to support communication, coordination, and cooperation in small human groups. They also emphasize the retroactive function of reason in offering post hoc explanations. While these basic ideas are sound, their overall theory can be criticized on several points, in particular: (1) their use of a strongly modular model of cognition is unrealistic; and, (2) their assumption that reason depends on language is overly limiting. As an alternative, I use a model of cognition based on neural dynamical systems and pattern recognition. Within that framework I propose a view of reason based on pattern recognition, matching, and completion that shows how human reason is evolutionarily connected to pattern recognition processes found in other animals. This approach separates the evolution of reason into a biological part—the evolution of the neuro-cognitive foundations required for reasoning—and a cultural part—the cultural evolution of forms for making accurate use of the capacities made possible through biological evolution. Human reasoning is then characterized as a goal directed process of pattern matching and construction in which elements of thought are fit together according to domain dependent rules of composition and criteria for what constitute a good fit. This view of reason is contrasted with the Mercier-Sperber picture to highlight both similarities and differences and, perhaps, suggest a more complete understanding of reason as a culturally shaped product.

Timothy Waring, Taylor Lange, Afton Hupper and Ethan Tremblay

Ephemeral cooperation in the evolution and development of food cooperatives

Although cooperation would seem to be fundamental requirement for human organizations, organizational research has made little use of it. We explore the role of cooperation in the development and evolution of cooperative food organizations through a five-year, multi-method case study. Cooperatives are organizations that share responsibility, ownership, and decision-making among members. As such, cooperatives are expected to rely upon cooperation among members and therefore be vulnerable to the free- riding problem. This poses an adaptive challenge: cooperatives must maintain cooperation to survive. We present evidence from interviews, surveys, simulation, behavioral experiments, historical research and social network analysis which implicates cooperation in organizational change. Results suggest that: (a) cooperatives rely on cooperation, (b) free-riding is a perpetual problem for cooperatives, (c) successful cooperatives often overcome the free-riding problem

by minimizing their reliance on cooperation, (d) institutional adaptations which help solve the free-rider problem have emerged and spread in the last 150 years. We conclude that cooperation plays a defining role in the ontogeny and phylogeny of cooperatives and speculate that similar patterns exist for many organizational types.

Stuart Watson, Jutta Mueller, Shen Yang Chong, Susan Lambeth, Steven Schapiro and Simon Townsend

Non-adjacent dependency processing in humans, apes and monkeys using an artificial grammar paradigm

Non-adjacent dependencies ('NADs'), a key feature of syntax, are sequences where two dependant elements are separated by a string of other elements (e.g. 'The big fluffy dog' – 'AXXB'). Such constructions have received particular interest because are more cognitively demanding and mastered later in infancy than adjacent dependencies (e.g. 'The dog' – 'AB'). While there is evidence of adjacent dependencies in the vocal communication of some non-human animals, there is currently no evidence of NAD production. This has been argued to represent a key discontinuity between the communicative abilities of human and non-human animals and has, therefore, attracted a considerable amount of research. Using artificial grammar learning paradigms, prior work does however suggest that some species (e.g. tamarin monkeys) are capable of processing NADs in auditory and visual domains. However, devising grammars that effectively rule out lower-level explanations has proven problematic. Moreover, synthesising results across species is challenging due to widely varying experimental paradigms and grammars. Our project sheds light on the evolutionary history of NAD processing by applying a novel artificial grammar learning paradigm to a broad range of species (humans, chimpanzees and marmosets). Unlike previous work, which primarily used spoken syllables as grammatical elements, we utilise categories of computer-generated sounds, each of which is comprised of 10 pitch-shifted variants. Additionally, our paradigm explores the use of pupillometry-based responses as a non-explicit measure of grammar-parsing in humans. Here, we report our findings from ongoing experimental work with humans, chimpanzees and marmosets.

Stuart Watson, Gillian Vale, Lydia Hopper, Lewis Dean, Rachel Kendal, Elizabeth Price, Sarah Davis, Steven Schapiro, Susan Lambeth and Andrew Whiten

Chimpanzees demonstrate individual differences in social information use

Studies of transmission biases in social learning have greatly informed our understanding of how behaviour patterns may diffuse through animal populations, yet within-species inter-individual variation in social information use has received little attention and remains poorly understood. We have addressed this question by examining individual performances across multiple experiments with the same population of primates. We compiled a data set spanning 16 social learning studies (26 experimental conditions) carried out at the same study site over a 12-year period, incorporating a total of 167 chimpanzees. We applied a binary scoring system to code each participant's performance in each study according to whether they demonstrated evidence of using social information from conspecifics to solve the experimental task or not (Social Information Score – 'SIS'). Bayesian binomial mixed effects models were then used to estimate the extent to which individual differences influenced SIS, together

with any effects of sex, rearing history, age, prior involvement in research and task type on SIS. An estimate of repeatability found that approximately half of the variance in SIS was accounted for by individual identity, indicating that individual differences play a critical role in the social learning behaviour of chimpanzees. According to the model that best fit the data, females were, depending on their rearing history, 15-24% more likely to use social information to solve experimental tasks than males. However, there was no strong evidence of an effect of age or research experience, and pedigree records indicated that SIS was not a strongly heritable trait. Our study offers a novel, transferable method for the study of individual differences in social learning.

Joseph Watts, Oliver Sheehan, Russell Gray and Joseph Bulbulia

The evolution of secular and religious leadership were tightly coupled and mutually reinforcing in early Austronesian societies

Accounts of human cultural evolution differ over how and why leadership emerged in human history. Some accounts argue that the first leaders emerged to coordinate secular activities such as warfare and resource management, and that religious leadership emerged to legitimize these secular leaders. Other accounts argue that the first leaders emerged to coordinate community ritual activities such as feasts and sacrifices, and then extended their domain of authority into secular matters. Here we use a Bayesian phylogenetic comparative method to test how religious and secular community level leadership co-evolved in a sample of 92 historical Austronesian speaking societies. We find that of these 92 societies, 76 (82%) had either both forms of leadership or neither, showing that religious and political leadership were tightly coupled in early Austronesian societies. The results of our analyses strongly support the co-evolution of religious and secular leadership, with both forms of leadership helping to build and sustain one another. However, our results also indicate that religious leadership did not reliably emerge before secular leadership, nor did secular leadership reliably emerge before religious leadership. Our findings show that secular and religious leadership were remarkably interdependent in the history of Pacific cultures, and that such dependencies held across wide-ranging ecological conditions. We infer that the human cultural capacity for community-wide leadership evolved to rely on mutually reinforcing institutions of civic and sacred authority, neither of which could be explained without reference to the other.

Nicole Wen, Jennifer Clegg, Stephanie Estrera and Cristine Legare

Between- and within-population variation in beliefs about children's competency and conformity

Childrearing beliefs and practices are highly variable across cultures (Keller & Kärtner, 2013; Little et al., 2016). Between- and within-population comparisons provide critical insight into the extent and cause of cultural variation (Legare & Nielsen, 2015; Nielsen et al., 2017). We compared adults' judgments of children's conformity behavior in relation to beliefs about intelligence in two populations (U.S. and Vanuatu) that differ in child socialization goals. Although U.S. adults favor self-confidence and independence in thinking over obedience and conformity (Paguio et al.1987), child socialization in Vanuatu is based on fostering collective and cooperative values emphasizing social conformity (Peck & Gregory, 2005). Study 1 (n=384) compared judgments of children's conformity behavior and beliefs about intelligence in the U.S. and Vanuatu (Clegg et al., 2017; Wen et al., 2018). Using a novel

methodology based upon multivocal ethnography (Tobin et al., 1989), we assessed beliefs about children's traits from their own and a comparison population. This revealed differences between the U.S. and Vanuatu in the value of conformity for conceptions of children's intelligence, but only when evaluating their own population. In the U.S., creativity is viewed as a sign of intelligence, whereas Ni-Vanuatu endorsement of high conformity is consistent with ethnographic assessments of what constitutes intelligence in conformist-based societies. Study 2 (n=239) examined within-population variation in the U.S., revealing adults evaluated low conformity behavior as evidence of intelligence when they rated independence as more important and interdependence as less important for child socialization goals. These studies demonstrate that beliefs about the relationship between intelligence, conformity, and creativity vary between- and within-populations and are mediated by differences in expectations for in-group members. They highlight the importance for conducting both between- and within-population comparisons in examining continuity and variability in beliefs about intelligence.

Cindel White and Ara Norenzayan

Mental models of supernatural morality

Cultural evolutionary theories have proposed that religious traditions facilitate societal complexity and large-scale cooperation among strangers through the culturally-transmitted belief that supernatural entities care about and respond to human behaviour. Many studies have documented an association between reminders of religious concepts and increased prosocial behaviour, but fewer studies have directly examined the content of these religious concepts and how concepts of supernatural morality are predicted by cognitive and cultural variables. Using an open-ended free-list task, we investigated participants' mental models of which human behaviours are rewarded and punished by two different supernatural entities (God and Karma) among samples from the USA and India, including Hindu, Buddhist, Christian, and non-religious participants. We explored how beliefs about the moral concerns of supernatural entities are predicted by (1) behaviour's relevance to interpersonal cooperation, consistent with cultural evolutionary accounts of religious prosociality; (2) individual differences and cross-cultural differences in moral judgements, supporting an association between secular moral judgments and the specific concerns supernatural entities; and (3) target-specific differences between mental models of God and Karma, consistent with psychological differences between the features ascribed to supernatural agents (God) and non-agentic supernatural forces (Karma). Finally, we investigated whether the salience of generosity in participants' mental models of supernatural morality predicts generosity in the dictator game.

Andrew Whiten and Stuart Watson

Conformity: Comparative and evolutionary studies of primates and other animals

This presentation offers a brief introduction to the topics addressed by the four papers in this themed session, then describes results of our recent experiments on the question of conformity in non-human primates. The concept of conformity has played a major role in cultural evolution theory since the early collaborative work of Boyd and Richerson, with conformity defined as an exaggerated tendency to adopt the preferences of a majority of others. Before that, conformity was much studied from the perspective of social psychology but with a different emphasis on abandoning personal preferences in conforming to

alternative options displayed by others. These two 'forms' of conformity have both now been studied in other species, along with the more basic rule to 'copy the majority', neglecting the above two more specific criteria. In recent years these studies have yielded exciting but controversial findings on all three of these senses of 'conformity', which this themed session will illustrate. Our observational and experimental studies with wild vervet monkeys and captive chimpanzees have also addressed these three forms of conformity, but recently drawn in yet another, related, conception of 'quorum sensing'. In this study, captive chimpanzees first learned to use one of two alternative actions that would extract food rewards from an artificial foraging device, and were then exposed to small groups of others who unanimously displayed the alternative option. Results revealed a conformist tendency of the immigrants to switch options; however perhaps surprisingly, they did so before having observed what all their new companions did. We have found related observations in the animal literature described as 'quorum sensing', where rather than confirming what 'everybody else' does, animals perceive enough unanimity in a sample to decide to switch options. We propose incorporating this effect into conformity theory in cultural evolution studies.

Charlotte Wilks, Gemma MacKintosh, Eva Rafetseder, Elizabeth Renner and Christine Caldwell

Find the treasure: Children's use of social information in a Stimulus Selection Task

Humans appear to be unique in their ability to accumulate beneficial modifications, over generations of learners, through social transmission. This has been termed the ratchet effect. It has been demonstrated experimentally in adult human participants, but it is currently unknown at what age children develop the ability to produce such an effect. We investigated potential for ratcheting (PFR) in 160 UK children (aged 3-6) by exposing them to social information (provided by a parrot puppet) in a treasure-island themed Stimulus Selection Task. Over three rounds, social information contained different numbers of correct and incorrect selections, enabling us to examine PFR from the data of individual participants. We were interested in children's ability to remember and use this information, to inform their own search. We therefore analysed performance following correct/incorrect demonstrations when visual working memory was, or was not, taxed. When accurate performance was memory-dependent, error rates for correct trials varied between 53% (age 3) and 17% (age 6). However, upon virtually eliminating this memory load (transparent condition), even the youngest children used both correct and incorrect social information almost at ceiling level. Additionally, we used children's scores on the three rounds to assess their PFR according to defined criteria. We again found evidence that performance was linked to task memory load: over 85% of children displayed PFR from age 3 in our transparent condition, but the point at which most children displayed PFR shifted to age 5 when memory was taxed. We conclude that constraints on visual working memory may limit the contexts in which children exhibit PFR. Social information is often available for a limited time, so demands on memory may mean nonhumans (and

young children) fail to benefit from potentially useful information. Memory may have been overlooked as a key requirement for many examples of cumulative cultural evolution.

Aiyana Willard, Joanathan Jong and Harvey Whitehouse

Rewarding the Good and Punishing the Bad: the moral importance of karma and afterlife beliefs in Singaporean Chinese culture

Research on the cultural evolution of religion has found that beliefs in supernatural punishment are effective in enforcing normative behaviours. Much of this work has focused on preventing proscribed behaviour, yet, many morally concerned religions hold additional beliefs about supernatural rewards for prescribed behaviours, such as charitable giving. Belief about the mechanism of supernatural reward and punishment differ across religions but little research has considered the effects of such differences on behaviour. The Buddhist belief in karma, for example, allocates merit for positive behaviours and demerit for negative ones, thus determining their standing in the next life. Unlike all or nothing outcomes such as going to heaven or hell, karmic standing allows for changes in outcome to be incremental, and may lead to an emphasis on doing good as well as not doing bad. In a sample of Singaporean Chinese (N = 582), we examine if affiliation as Christian, Taoist, Buddhist, or non-religious affects how people think about reward and punishment in this life and the afterlife/next life. In a pre-registered analysis, we found that all groups believed a person who had stolen or harmed another would suffer punishment in both this life and the next. Taoist and Buddhists were more likely than Christians to claim a person who had helped or been charitable would be rewarded in the next life. Buddhists were also more likely than Christians to be concerned about the impact of their own good and bad behaviour. In open-ended free-list questions, Buddhists were more likely than Christians to claim good and bad behaviours as leading to both immediate reputational effects and supernatural costs or benefits. This suggests that karma, and similar beliefs, may be better at promoting good behaviour while still preventing bad. These good behaviours may further promote success of the group.

William Wimsatt

Three connected problems in theories of cultural evolution: population structure, development, and technology

Traditional theories of population genetics (pace Sewall Wright) accepted panmixia, ignoring population structure. They have since incorporated it, increasing their applicability and power. For cultural evolution, moves to incorporate population structure have come only lately. But the nature of cultural inheritance and the resultant possibilities for cultural differentiation enormously expand the varieties and importance of population structure. Ignoring them seriously distorts processes of cultural evolution. Learning is a sequential process, especially notable for complex skills, which are crucially important elements of culture. These range from modes of social interaction to crafts and knowledge. Simpler elements are learned, and then integrated in complex structured elements, that may themselves be hierarchically aggregated recursively. The sequential character of our complex skills generates naturally structured breeding populations of cultural information for successive levels and diverse kinds of expertise, and keys into supporting institutions for teaching them, such as schools and curricula, and midwifing interest groups. This suggests a need for age and expertise structured models, which are more complex than our current models and present particular difficulties, but give a new and richer conceptual geography for our theories by articulating with psychological, sociological, and political categories. In these structures, later skills and technologies depend upon the mastery of earlier ones, so

our culture is literally cumulative, in individual, institutional, and organizational development, and these earlier skills can become, in different degrees, frozen accidents, which are difficult to impossible to change, and whose rare successful change results in revolutionary transformations. This differential entrenchment generates a new dynamics for cultural change widely exhibited in our science and technology. Furthermore, our means of learning, acquiring information, and tools for problem-solving are being transformed by our technology, which thus must be regarded as a formative element in our cognition, and not just as transmitted knowledge or material resource.

James Winters and Thomas Müller

The emergence and evolution of structured patterns in a large-scale online collaborative art project

Cultural evolutionary theory provides a framework for explaining change in population-level distributions (Henrich et al., 2008). Gaining traction is the idea that multiple transmission episodes shape a distribution of cultural traits to become more compressible, i.e., a set of derived traits are more compressed than their ancestral forms (Culbertson & Kirby, 2016; Kirby et al., 2015; Tamariz & Kirby, 2015). This amplification of compressible patterns can become manifest in two ways: either via the homogenisation of variation or through organising variation into structured and specialised patterns. Using a novel, large-scale dataset from Reddit Place, a collaborative art project involving over 1 million participants, we investigate the de novo emergence and evolution of pixel artworks on a 1000x1000 pixel canvas. All Reddit users could select a single coloured pixel, place it on the canvas, and then wait for a fixed period of 5 minutes before placing another pixel. Having a finite space allows us to investigate how the density of the canvas interacts with cultural evolutionary dynamics in shaping the distribution of pixel placements. From a non-structured state, where individual artworks exist relatively independently from one another, Place gradually transitions to a structured state where pixel placements form specialised, interdependent patterns. We provide three lines of evidence for this. First, the canvas follows a quadratic trajectory for compression, with Place initially decreasing in compression and then increasing in compression after reaching a peak at around the 30-hour mark. Second, this increase in compression at the latter stages cannot be explained by changes to the frequency distribution of coloured pixels, ruling out the spreading homogeneity as an explanation. Lastly, when contrasting measures of local and global entropy, local patterns of pixel placements tend to become more predictable after the canvas is saturated with artworks, whereas globally the entropy remains high and unpredictable. Taken together, our findings suggest Place reaches a state where variation is being maintained at a global level and organised into structured patterns at a local level.

James Winters, Piers Kelly, Helena Miton and Olivier Morin

Compression effects in the cultural evolution of the Vai script of West Africa

As a potential mechanism for change in human culture, the effects of social transmission have been fruitfully explored using diffusion chain experiments (Kirby et al., 2008). In the simplest versions of these tasks, an individual produces a behaviour, and this behaviour becomes the input for a second individual who in turn produces the input for a third individual, and so on. A robust finding of these experiments is that behaviours become optimised for efficiency in terms of information storage, retrieval, and

reproduction by human agents, resulting in a set of behaviours which are more compressed than their ancestral forms (Tamariz & Kirby, 2015). It is tempting to argue that these compression effects are at work in the evolution of writing systems (Garrod et al., 2007). However, there are two issues in generalising from diffusion chain experiments to real-world scripts. First, other than anecdotal evidence, we do not know if writing systems are becoming increasingly compressed over time. Second, the task constraints in these experiments are of questionable ecological validity when compared to the real-world constraints of learning and using writing. To address these concerns, we test for the effects of compression on Vai: an emergent writing system from Liberia created by non-literate individuals (Tykhostup & Kelly, 2018). What makes Vai special is that the script has been independently documented on fifteen separate occasions between 1834 and 2005. By measuring the descriptive and perimetric complexity of the Vai characters, our study predicted and found that: (i) Overall visual complexity decreases over time; (ii) The complexity of characters with higher visual complexity decrease more than characters with initially low visual complexity; (iii) Variance in complexity among characters decreases with successive versions of the script. Together, our findings provide real-world evidence for the idea that compression effects are at work in shaping the evolution of writing systems.

Alden Wright and Cheyenne Laue

Inter-group cultural transmission and cumulative culture

Understanding the emergence and maintenance of cultural and technological complexity are critical topics in the study of human evolution. Many models of cultural complexity have focused on demographic factors like population size and density while others highlight aspects of social learning, such as the retention of cultural variants or the fidelity with which these variants are transmitted. Other studies point to environmental variation and risk as important factors in facilitating the emergence of complex cultural and technological traits Here we examine the interaction between demographic patterns such as population size and structure, inter-group social learning, and temporal environmental variation. Using simulation and a model of continuous cultural traits and imperfect cultural replication, we show that populations can compensate for small size and environmental change by participating in cultural transmission with other cultural groups. Critically, our simulations show that when a subpopulation loses a trait due to drift or environmental change that trait can be recovered by engaging in cultural transmission with another subpopulation. Further, we show that the overall metapopulation retention time is longer when the metapopulation subpopulations communicate and that this effect is much stronger when transmission between subpopulations is success biased. Based on these results we suggest that success-biased social learning occurring between subpopulations is likely a critical factor in the capacity for cumulative culture and ultimately cultural complexity.

Alden Wright and Cheyenne Laue

Smart intergroup horizontal transmission and retention of complex technological traits under environmental change

Explaining the emergence of complex societies and the accumulation of complex technologies that they seem to support has become a focal point in archaeology. However, nearly two decades of research has led to ongoing debates rather than consensus on the primary drivers of cultural and technological complexity. Current research suggests that factors such as demography, the fidelity of cultural

transmission, pedagogy, variant retention, and environmental risk may all be critical to the emergence and maintenance of complex technologies. Using computer simulation and a continuous trait model we investigate the interaction between temporal environmental change and the process of intergroup cultural transmission. Our results show that when cultural groups inhabit a temporally varying environment and intergroup transmission is random the retention of complex technologies is strongly dependent on population size. However, when intergroup transmission is selectively biased the retention of complex variants is much more dependent on this process than on demography. Thus, we conclude that with smart intergroup cultural transmission, fidelity is much more important than population size for predicting the retention of complex traits.

Mason Youngblood

The cultural transmission of sampling traditions in a network of musical collaborators

The role that demographic variables play in biasing cultural transmission remains one of the most critical questions in the field of cultural evolution. Network-based diffusion analysis (NBDA) is a recently developed statistical tool used to determine whether network structure biases the emergence of a novel behavior in a population. As NBDA is most useful in identifying social learning, a trait that is assumed to be present in our own species, it has been primarily applied to non-human animal models such as birds, whales, and primates. Despite this, the ability to include demographic variables in NBDA makes it uniquely suited to determining what factors bias information diffusion more broadly. The aim of the current study was to determine what demographic variables bias the diffusion of a sample through a network of musical collaborators, utilizing an extensive dataset mined from crowd-sourced, online databases. Sampling, or the adaptation and recycling of recorded material in a musical composition, is a nearly ubiquitous practice among hip-hop and electronic music producers. It provides an ideal research model for this question because of (1) the high copy fidelity of sampled material, (2) the reliable documentation of transmission events, and (3) the availability of demographic data for the artists involved. We conducted a case study of all documented transmission events involving Amen, Brother by The Winstons, which is thought to be the most sampled song of all time. We found that first-time sample usage was biased by the structure of the collaboration network, and that transmission was influenced by the popularity and geographic location of the artists involved. These findings further illustrate the role that demographic variables play in biasing cultural transmission, and lay the methodological groundwork for future studies utilizing large datasets mined from the internet.

Mason Youngblood and David Lahti

A bibliometric analysis of the interdisciplinary field of cultural evolution

The science of cultural evolution is a particularly interdisciplinary endeavor that has captivated researchers from a variety of disciplines. This emerging field is unified in its application of evolutionary logic to socially transmitted behavior, but diverse in methodologies and assumptions. Qualitative reviews of the subject demonstrate an effort to integrate cultural evolutionary studies by illuminating points of divergence and fostering interaction. This effort would be greatly enhanced by quantitative data on patterns of collaboration and idea sharing as represented in the literature. In the present study,

we apply a novel combination of VOS mapping and bibliometric analyses to an extensive dataset of publications on cultural evolution, in order to represent the structure of the field and evaluate the level of disciplinary integration. We first construct a co-authorship network and identify clusters of collaborators, which we consider as proxies for subdisciplines. We then use bibliometric analyses to describe each cluster and investigate overall trends in collaboration and productivity. Lastly, we assess the topographical distance and degree of citation sharing between clusters, and generate science overlay maps to evaluate the diversity of subject categories within clusters. Our results reveal an increase in productivity and collaboration over time, albeit a higher inequality in author productivity than expected. Our structural approach reveals research subcommunities with differential levels of integration, citation sharing, and subject diversity. These findings confirm the emergence of a vigorous and growing interdisciplinary field, and indicate ways to drive targeted efforts to foster integration and synthesis in the study of cultural evolution.

Matthew Zefferman and Sarah Mathew

Gene culture coevolution of combat stress

To what extent is combat stress a universal part of human psychology and to what extent is it dependent on cultural context? We posit a gene-culture coevolution theory of combat stressed based on evolutionary models of cooperation in human warfare. We support this theory with a study of 213 Turkana pastoral warriors and our findings that the Turkana have similar levels of some PTSD symptoms as American combat veterans, but lower levels of others. We argue that this difference is due to institutions that limit moral injury in the Turkana. Moral injury is an emerging construct in clinical psychology where individuals suffer from violations of deeply held moral beliefs. We argue that moral injury results from norm psychology that evolved to avoid the harm of social sanctions. We show that sanctioning institutions in the Turkana likely limit moral injury in combat.