TRANSMITTING SYMBOLIC CONCEPTS FROM THE PERSPECTIVE OF CULTURAL COGNITION – THE ACQUISITION AND TRANSFER OF FOLK-BIOLOGICAL KNOWLEDGE

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Introduction

I begin with two apparently contradictory observations. The first is that all papers included in this volume (and its companion) concern the transmission of complex sets of ideas (scribal knowledge such as of the Talmud, Byzantine astronomy, early Christian and medieval eschatology, Scandinavian myth, the moon in texts). Indeed, such ideas are so complex and diverse that we must expect that often it will be difficult to draw comparative generalizations about the dynamics of how particular bodies of knowledge are acquired and transferred. The second observation is that issues relating to how knowledge moves around the anthroposphere are much the same, regardless of whether we are dealing with movement across the generations (temporal change) or between different groups separated geographically (spatial change).

To provide a framework that might start to make sense of very different sets of ideas about humans and the natural world using analytical concepts that have the greatest potential comparative purchase, it would be helpful to examine a conceptual domain that permits the *radical simplification* of data, and which might, therefore, clarify the main methodological issues involved. One such domain is how people classify and organize knowledge of bio-diversity, including how different peoples understand life processes. It is no

accident that those studying cross-cultural cognition have repeatedly found suitable examples in ethno-biological classification. If we can construct an analytical apparatus to understand the acquisition and transfer of knowledge about plants and animals, where there is some evidence for cross-cultural similarities in linguistic and classificatory organization, we might be able to test their usefulness against more complex semantic domains. The simplifications we find in the organization of biological knowledge are in part a reflection of underlying cognitive and perceptual strategies and modes of bodily interaction, but also of widespread ecological similarities which permit existence of the same life-forms with particular kinds of characteristics.

First, I offer some remarks on how technical knowledge is culturally embedded (since this might be thought to constrain the extent to which data can be simplified). I then discuss how the movement of knowledge has been modelled, focussing on the contrast between vertical (temporal) and horizontal (spatial) transmission, the matter of scale and measurability, on how life-cycles and generations constrain oral knowledge while social storage (as through writing) expands and transforms it, and the sometimes unintended consequences when knowledge moves from one context to another. Finally, I explore an extended example: how Nuaulu people in eastern Indonesia acquire new plant knowledge and the way this is absorbed within existing classifications, is modified, and challenges ruling botanical ontologies.

The Embeddedness of Technical Knowledge

Analyses of knowledge systems have often made a distinction between technical (or exact) and symbolic knowledge, for example in the way animals are classified on the basis of morphology for utilitarian purposes, and how they might be used metaphorically, as when they become terms of abuse. It is features of the first kind that make biological knowledge so amenable to radical simplification, but this should not mislead us into concluding that it is somehow not "symbolic", or that it lies outside the complex cultural matrices of the kind discussed in other papers in this volume. Indeed, the cognitive uniformities that arise from these patterns are necessarily expressed through very varied cultural contents and are influenced by equally varied cultural contexts. There is no conceivable empirical biological fact that is not also meta-

phoric or symbolic: for example, plants used to treat illness are never "natural herbs" but have become cultural artefacts.[1]

All technical knowledge is embedded in an interpretative symbolic framework; every material object is encapsulated within its own knowledge penumbra. When plant and animal species move through social and geographic space, the relationship between the material object and the knowledge concerning it alters. In some cases, most knowledge connected with the object in its original context is lost entirely during transit, while comparable functional knowledge is re-invented by the people who receive it, reflecting their own ecology and in relation to their cultural content. This was the case with the introduction of cassava (*Manihot esculenta*) from western Amazonia to eastern Indonesia,[2] a process begun by sixteenth-century Portuguese and Spanish traders and completed by Dutch colonial administrators and local farmers. In other cases, an attempt is made to deliberately transfer the knowledge relevant to the source ecology and practices to the new situation. But because both ecology and cultural frameworks are different, this is not always successful. A good example of this is the first attempts to introduce *Hevea brasiliensis* rubber, again from Amazonia, to the Malay Peninsula, via Kew Gardens.[3] Amazonian and Kew-based knowledge did not translate well into the biocultural context of Malaya, and it was not until a new local knowledge had developed that the crop was successfully adopted.

It is because classifications of biota are transmitted within envelopes of cultural content and context that it is in a continuous state of flux as it transfers between individuals; and yet, in order to serve the purposes attributed to it as a cultural resource, it must remain "sufficiently" coherent to work. Categories and models that constitute the biological knowledge of any one culture are not transmitted directly from brain-to-brain (or indeed from mind-to-mind), nor are they simply "replicated" or "reproduced" on the analogy of, say, a gene, but are continuously re-constituted – and in some cases re-discovered – in every generation.

The last twenty years have seen the growth of evolutionary approaches to the study of cultural transmission, and the re-emergence of studies of diffusion, especially those drawing on models of contingency derived from natural history, and which have models of cultural selection, co-evolution, biocultural

1 HSU, 2010, p. 38.
2 ELLEN/SOSELISA/WULANDARI, 2012.
3 DOVE, 2000.

diversity, and "the epidemiology of ideas" built into them. Such models are based on Darwinian "descent with modification", using phylogenetic techniques to explain what happens when the aggregated transmitted cultural knowledge and practice, along with the potential for enculturation, meet ecological barriers, constraining land-masses, and carrying capacities. These approaches have displayed some diversity, but all are inspired by the application of techniques and models developed in the field of theoretical biology using large spatio-temporal data-sets and include much cultural variability.[4]

How Knowledge Moves Through Time and Space

Before illustrating how knowledge of biota is acquired and transmitted between individuals and different cultural populations, I need to expand upon my second initial observation: that spatial and temporal movement of ideas are part of a single continuous dynamic. Historically, investigations of cultural transmission through time and space have been kept artificially separate: the first being described as learning and teaching, the second part of a discourse on diffusion and the spread of innovations; the first the domain of psychologists and educationalists, the second that of archaeologists, geographers, and historians of ideas. This distinction is perpetuated in the model of epidemiology that has come to dominate the literature on cultural transmission theory. We find it in the contrast between the stereotypes of vertical transmission from parent to child, and horizontal or "contagious" transmission between unrelated others. A second distinction is made between one-to-many transmission (e.g., teacher → class) and many-to-one (e.g., choir → listener). These modelling assumptions have been made popular particularly through the work of Luigi Cavalli-Sforza,[5] but are also problematic.

Let us look, for example, at transmission processes over the short-term in a small field site of the kind common in ethnographic fieldwork. Here we generally find that cultural transmission is not obviously either simply vertical, horizontal – or indeed "oblique". This is so for several reasons: because of the role of ego-centred learning through re-discovery, because learning is situational, not wholly reciprocally dyadic or ecologically constrained, and

4 CAVALLI-SFORZA/FELDMAN, 1981; BOYD/RICHERSON, 1985; DIAMOND, 1998.

5 E.g., CAVALLI-SFORZA/FELDMAN, 1981; HEWLETT/CAVALLI-SFORZA, 1986; see ELLEN/LYCETT/JOHNS, 2013.

because of the evidence for multiple temporal reinforcement. Core behaviours, concepts, and skills may initially pass vertically, but only be instantiated through horizontal sharing, while stories are told many times in different ways. Similarly, knowledge that passes vertically may do so (counterintuitively) from a child to an adult, as where children acquire competence in modern digital technologies quicker than their parents and become the transmitters of practical skills (e.g., texting). Learning is neither a one-off nor a uni-directional act. Moreover, although there are many cases in "traditional" small-scale human societies of transmission between non-genetic parents and children; as societies become more complex with specialized divisions of labour, so an increasing amount of transmission occurs between non-kin. In such cases, identifying the vertical line of "descent" is difficult. Thus, while such assumptions have been used in knowledge erosion studies, they raise methodological issues.[6] For example, it is common to overestimate the vertical and oblique at the expense of horizontal peer influences. As our data-sets become increasingly aggregated, both temporally and geographically, we might expect that it would become easier to distinguish between the horizontal and the vertical, and to ignore the oblique altogether.[7]

These are essentially problems of representation, indeed of diagramming. For Cavalli-Sforza, the model derives from his experience as a biologist working on human population variation, but it might equally have been drawn from anthropological studies of kinship. The basic model here is shown in Figure 1, where we can see various alternative uses of the vertical–horizontal distinction.

6 E.g., McElreath/Strimling, 2008.
7 Ellen/Fischer, 2013, 1-54.

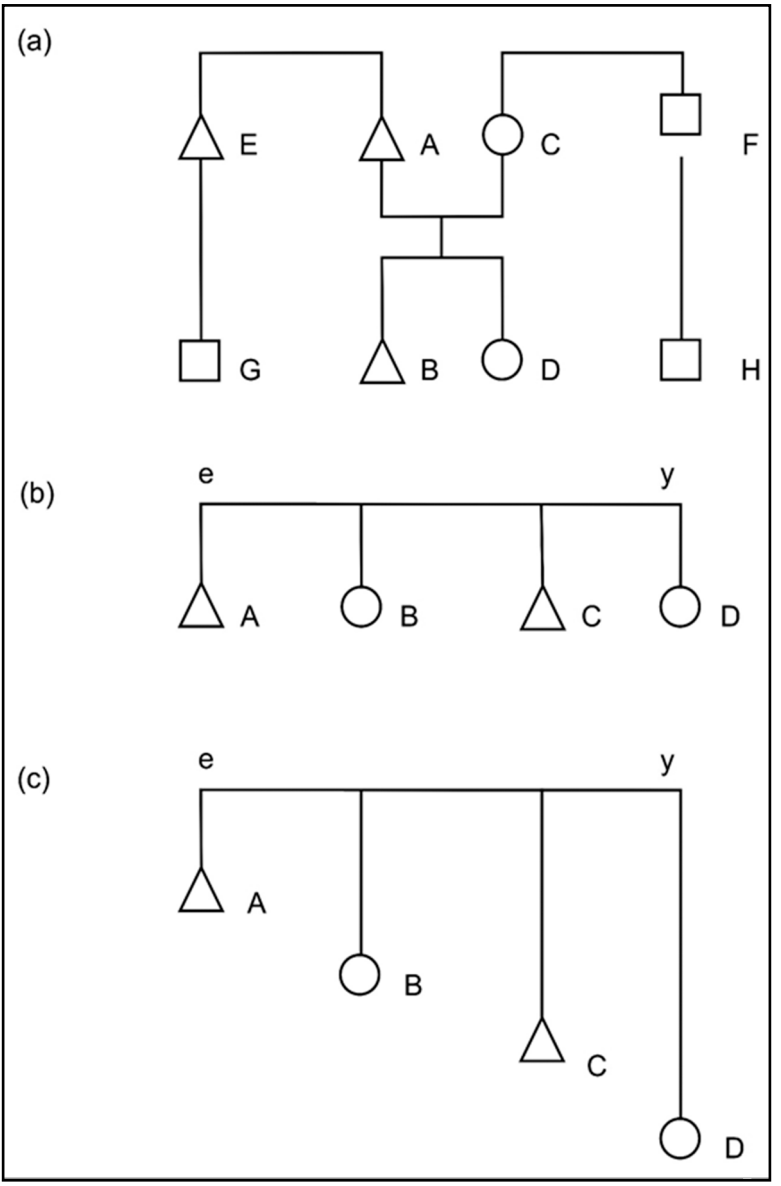

Figure 1: Modelling knowledge transfer using the analogy of kinship (© Roy Ellen, after ELLEN/FISCHER, 2013, p. 30).

In diagrams 1a and 1b we might say that A to C is horizontal transmission, whereas in diagrams 1a and 1c A to B is vertical transmission. But how then do we describe transmission from E to B in diagram 1a? Is this vertical, or oblique? It is even more difficult to describe transmission from G to B in the same diagram. Is this horizontal because it may be acquired from individuals in the same generation and of the same age, or is it vertical because the knowledge may ultimately have descended through a sibling of a parent who has acquired it from common parents? It might be thought safer to distinguish any transmission through kin (all being vertical) from transmission from unrelated individuals; but does it then make any difference whether they are of the same age or cohort, or from an older person or cohort? In part, this is a terminological problem: whether we are referring to horizontal and vertical transmission between individuals (as the terms were originally intended) or between groups (e.g., over time versus space). Figure 1 also illustrates another problem linked to diagramming conventions. Both diagrams 1b and 1c relate to the same genealogical relations and biological individuals. However, those on the left are the older siblings of those on the right. In 1b, learned culture passing from A to B, either directly or indirectly, might be seen as horizontal. In 1c, when we lengthen the vertices to indicate relative age, the transmission might be seen as vertical, or at least oblique.

Let us take an example from my own long-term work amongst the Nuaulu people of the island of Seram in eastern Indonesia. When a girl is learning how to make a basket,[8] she will do so in the context of having watched other adults and girls making baskets, though the statistical likelihood is that she will have spent more time watching her mother and older sisters in her own household than both adult and immature girls from other households, to whom she is less likely to be related genetically. Her mother will begin to instruct her, and she will ask her mother how to perform certain tasks, and although these interactions are most likely to be the predominant ones involved in the learning process, she will also receive instruction from aunts, grandmothers, and older female siblings. She will also interact with other girls of a similar age making baskets, some of whom are from her own house and some of whom she is only distantly related to. She will also spend a lot of time by herself, when she is learning certain procedures, not by rote instruction, but through independent problem solving based on knowledge of the end product. In other words, she is engaged in "reverse engineering". We might portray these relations, as I have

8 ELLEN, 2009.

done in Figure 1, by determining which lines are vertical and which horizontal, and whether either are sufficient to characterize the process of transmission. Looked at another way, however, what we have is a network, which can be described in terms of horizontality and verticality, depending on what we wish to emphasize. Topologically, or in terms of graph theory, it does not matter what is "vertical" and what is "horizontal"; all that matters is the direction of aggregate flow between nodes.

Outside the arena of kinship, we would ordinarily see transmission from teacher to child and from artisan to apprentice as vertical, but in relation to descent through kinship they might be seen as horizontal or oblique. Consider also the acquisition of cultural practices by children. Is the transmission of a rhyme between two six-year olds to be counted as horizontal, and that between a seven-year old and a six-year old as diagonal or oblique? Perhaps diagonal transmission between individuals in the same age class but with non-contiguous life cycles is a strong component. Iona and Peter Opie,[9] in their classic work on the lore and language of British school children, make a distinction between rhymes learned in the nursery and those learned in the playground. While we may speculate how best to describe what is happening in the playground, in the nursery the rhymes invariably pass from parents or alloparents (that is an individual other than a biological parent who performs the parental role) to very young children. These in turn may pass on those rhymes to their children or allo-children twenty years later. I have myself been engaged in a study of transmission of knowledge of plants amongst Kentish allotment-holders, where knowledge passes from more experienced to less-experienced growers.[10] Are we to describe this as horizontal or oblique?

Then there is the question of scale. If we look at transmission at the inter-personal level, we see a network of lines of causation and reinforcement. At a macro-level, this might look like simple vertical transmission. Thus, returning to our kinship diagrams, what looks like horizontal transmission from a father's brother, looked at in another way can be represented as vertical transmission from a father. What looks like a tangled network of flows of information at one level may look like a straightforward line of transmission at another. But inter-personal relations of learning do not exist in a social vacuum, and their context may affect the content, form, and rate of transmission, while processes and cycles of socio-cultural reproduction in emergent

9 OPIE/OPIE, 1959, pp. 7f.
10 ELLEN/PLATTEN, 2011; PLATTEN, 2013.

systems display properties that are more than the sum of their parts. Individual actions are constrained by the systems in which they are situated, and at the same time provide the context for other individual actions. As societies complexify, so different contexts emerge in which transfer can take place. Thus, in the study of allotment-keepers referred to above, we found that transmission events were set in a context of complex relations of exchange and self-discovery, of plants and knowledge about plants.

The transmission of institutional arrangements, therefore, cannot simply be modelled as the aggregation of more specific cultural components. We can see this in relation to gender. Much core knowledge will always be gender neutral, but some is strongly gender linked, either because the opportunities are constrained by patterns of gender-biased interaction, or because specific cultural rules apply. Turkmen weaving skills pass from mother to daughter, while Nuaulu basket-making from mother and elder female siblings to daughters and younger female siblings.[11] Alternatively, there may be gender-specific institutions constituted independently of kinship descent, as in a nunnery, or in a Moroccan wood-carving guild,[12] or among Yemeni minaret-builders.[13] A similar situation applies to other divisions of labour. Specialists will by definition always be a smaller part of the whole, and therefore opportunities for transmission are reduced in a population as a whole.

Patterns of descent and inheritance may influence transmission of particular kinds of knowledge or practice, irrespective of the gender of individual recipients. So, knowledge may pass through patrilines to males, or to males and females of the same patrilineage, as is the case with much Nuaulu sacred knowledge. In matrilineal societies, it may be the opposite, with men acquiring knowledge through the female line, as in the case of Sumatran Minangkabau elder brothers playing a crucial role in instructing the younger generation within the matrilineage. In their work on Turkmen textile design, Collard and Tehrani[14] suggest that, where their cladogram data are inconsistent with historical accounts this may be explained by textile design being inherited through the female line in an otherwise patrilineal society. Residence linked to patterns of descent may be important, with endogamy and marriage alliances determining inter-group and intra-group movement. Recipes for medicines and magic,

11 COLLARD/TEHRANI, 2005.
12 KALETA, 2008; see also COY, 1989.
13 MARCHAND, 2001.
14 COLLARD/TEHRANI, 2005, pp. 128f.

combining both symbolic and technical elements, are often owned by particular descent groups, such that their transmission is skewed by descent. Such non-measurable institutional phenomena are always present, influencing the conditions of transmission in significant ways.

The transmission of esoteric symbolic knowledge may be constrained no differently from the acquisition of technical craft knowledge. Just as craft knowledges require specific opportunities for transmitting practical information, such that hunting skills can only be completely acquired when opportunities present themselves, so symbolic knowledge and ritual practice may be even more intermittent in providing opportunities. Certainly, how to perform a ritual can be learned in the abstract, but competence can only be acquired in practice. Many rituals occur with considerable frequency, so that opportunities to ensure fidelity of transmission are numerous, but some rituals, especially in small populations, may occur with remarkable infrequency, and participants may be faced with major problems in replicating correct performance and utterance.[15] No wonder then, that such infrequent rituals give rise to problems, and where there is a cultural insistence on fidelity, sacred sanctions may place pressure on performers to conform. There are many ethnographic examples of prescriptive institutionnally-sanctioned "conformist bias" from studies of ritual and art, and in particular of the production of art objects in the context of ritual,[16] and perhaps in its most developed form in Orthodox Christian icon painting.

Conversely, we might imagine that infrequent rituals provide precisely the opportunity in which change will most likely occur, compared with rituals or cultural events occurring more frequently, where experience and memory are more reliable. In some cases, the institutional context is quite prescriptive, requiring tight rote-learning of particular linked cultural components, as in Jewish Torah or Muslim Koranic learning regimes. In other cases, the institutional constraints will be weak, allowing for variation and overlap in what is transmitted. Sometimes, elements may be freely transmitted between individuals, but it may be also the case that bundles of the same elements are transmitted within specific institutional contexts. We acquire the competence to participate in rituals not only by witnessing them and hearing about what happens out-of-context, but also by drawing common elements and analogies from other rituals. Rituals are not transmitted as fully-formed wholes, but in

15 ELLEN, 2012.
16 FORGE, 1967; ELLEN, 1990.

fragments, which only come together through social interaction on particular occasions.

A Matter of Scale and Measurement

In studying the transmission of knowledge, we have therefore to consider data over a series of levels. We can distinguish between: (a) the micro-level, applying to the cognitive processes of learning and to interpersonal interaction; (b) the middle-range level, at which social institutions serve as contexts for perpetuating transmission and ensuring its fidelity; and (c) the macro-level, addressing issues of cultural history, adaptation, phylogeny, diversification, and spatial diffusion. We may be interested in transmission between individuals, between households, between villages, between other sub-sets of societies, and between populations, societies, or cultures.

Moreover, learning is not only a continuous process of accumulation, unlearning, rethinking, and reinforcement, but is phase-dependent. It occurs in different ways at different stages of the life cycle. When we group more-or-less contemporaneous life cycles together we often speak of "generations". Cultural knowledge and practice are routinely reported as having been transmitted from one generation to the next. Here, the word "generation" is usually understood as referring to individuals of an approximately equal relative age, ideally encapsulated in the idea of siblinghood. Members of the same generation are assumed to associate, and through association reinforce existing practices, or confirm innovatory ones; to receive cultural information from, and be subject to, the social control of ascendant generations, and to transmit cultural information and exercise social control with respect to descendent generations. The generation has become the unit by which we measure and configure processes of cultural transmission in terms of diachronic movement, over and above the individual dyad. However, as an empirical construct it can be as elusive.

When looked at over time, it is often assumed that knowledge moves collectively, from one generation to another, rather than from one individual to another. While the process does indeed take place in a socio-ecological context that comprises, amongst other things, multiple individuals, single individuals are always the ultimate vectors of acquisition and transmission. But theories that are appropriate for understanding how knowledge is innovated or trans-

mitted from one individual to another are not necessarily those best suited for understanding the dynamics of what happens once patterns are established and how they might change through spacetime. As our data-sets become geographically and temporally larger, so the untidy, dynamic, interactive, contingent character of cultural learning gives way to a process that can more easily be described through notions of flow and transmission. The irregularities of small data-sets are statistically normalized in larger ones. Interpersonal transmission in the short-term may look very messy; over the longer term, we may legitimately simplify to lines of vertical or horizontal transmission. In other words, the issues of verticality and horizontality look different depending on degree and mode of data aggregation.

It is no accident that studies within a cultural evolutionary framework disproportionately rely on either linguistic or material culture data, where large data-sets are relatively easy to assemble and where problems of measurement are more straightforward. Applications to people, social behaviour, and abstract non-material knowledge rather than to artefacts have so far focused on small-scale societies, classrooms, or laboratory situations,[17] or on secondary data,[18] where the quality of data has permitted more confident quantification.

In the cultural evolution model, understanding transmission requires some identification of "units", real or virtual. This is either because observers assume that the mind organizes knowledge into "bits" to better effect its use and replication, or because it can only be scientifically measured through recognition of such units. These units may be words, stretches of meaningful language combining words (phrases, sentences, stories) – such as Lévi-Strauss's "mythemes"[19] – or their instantiated material analogues (graphemes and texts);[20] or they may be artefacts that result from manufacturing activity, or descriptions of patterns of activity, social interaction and relationships. The ease of identifying discrete units varies between domains of cultural knowledge and practice, and whether we are dealing with material culture, language, social practices and relationships, or ideas. The approach to cultural transmission exemplified by Cavalli-Sforza relies on the assumptions of digital (presence/absence) recognition of a discrete element or digital measurability

17 E.g., CHEN/CAVALLI-SFORZA/FELDMAN, 1982; EFFERSON et al., 2007; INMAN et al., 2007.
18 E.g., SOLTIS/BOYD/RICHERSON, 1995.
19 LEVI-STRAUSS, 1963, pp. 206-231.
20 E.g., POCKLINGTON/BEST, 1997.

on a continuous scale; it assumes that a trait will always be the same, and not transformed in the process of transmission. However, ideas rarely copy with anything close to absolute fidelity. As Atran[21] argues, because transformation affects ideas at a much greater rate than fidelity does, a selection bias cannot develop towards replicability. Descendant ideas cross and merge so quickly and thoroughly that there can be no identification of "species" or "lineages", only variably defined "influences".

Cultural traits are not basically mental phenomena that happen to have linguistic, social, and material expression.[22] They are, in part, constituted by complex modes of expression. Moreover, what is actually transmitted will vary from occasion to occasion and depending on the scale of the analysis. The empirical reality of knowledge transfer is that particular behaviours, ideas, and objects are parts of connected systems. If we take the case of horse-riding skills as an example, whether in the past, the deep past or the present, do we look at individual objects (bits, stirrups, bridles, and so on), or these items in relation to complexes of associated knowledge and practice? If the latter, then where do we draw the boundaries? Should we include the conditions of the manufacture of included material objects or of their use (for blacksmithing and leatherworking knowledge is not identical to horse-management knowledge), or should we look at the functionality of the "system" of material objects in its entirety, or to horsemanship as an overarching set of skills and knowledge? A similar example is the transmission of the interactive connected properties in the different components of the betel quid. The Nuaulu, like many traditional peoples in southeast Asia, chew betel nut (*Areca catechu*) as a mild stimulant, and the exchange of betel between humans, and between humans and spirits is a quintessential mark of social acceptance. But the chewing of betel chemically requires in addition the fruits or leaves of the betel pepper (*Piper betle*) and mineral lime. So, in understanding the transmission of the practice, should we look at the individual elements, or the practice as a whole? Likewise, in looking at text, is it the word that constitutes the unit or some different more inclusive or less inclusive unit, and do words and the behaviour to which they refer involve different entities?[23]

While in some cases the units we identify may translate into units that senders and receivers would understand as having some level of discreteness

21 ATRAN, 2001, pp. 356-357.
22 LYMAN/O'BRIEN, 2003, p. 226.
23 POCKLINGTON/BEST, 1997.

(as in, say, the names of useful plants in ethnobotanical studies), beyond this, those studying cultural transmission have devised units that divide-up the information transmitted in ways that enable measurement, especially at more abstract population and societal levels, but which may not make particular sense to those whose culture is being analysed, such as breaking a particular ritual into its components. These units may simply be "convenient fictions", while it is difficult to think of entire "religions" (rather than individual rituals) or "technological systems" (rather than individual tools) as "transmittable entities" in any easily measurable sense. Yet, we know that people convert from one religion to another and acquire competence in a new technological system over a relatively short period of time.

One concept that has acquired particular analytical purchase as a unit of transmission is the "recipe",[24] as for example in the instructions for preparing herbal treatments in both folk and scholarly systems of medical knowledge. However, what constitutes a recipe? Let us take the example of Mornay sauce, made famous by Dan Sperber and Tim Ingold. For Sperber,[25] the recipe includes everything you need to know to prepare the sauce in your own kitchen: all that is necessary to replicate it is to read it. However, for Ingold[26] the recipe can only be effectively replicated in the context of the reader's "prior experience of melting, stirring, of handling substances […]" and so on. The information in the recipe book is insufficient, and indeed there can be no form of knowledge transmission that is simple replication of what has been previously known or done. Because of this, there are always opportunities for minor correction loops and reflection, and indeed innovation. Despite this critique, objects, plant names, recipes for making, cooking, and healing all lend themselves to simple measurement and "descent with modification" models. Explaining the transmission of non-material social behaviours and abstract ideas in the same way is much more difficult, for as soon as we divide complex ideas and practices into smaller measurable units, we deny the systematicity and connectedness of knowledge. Cultural elements linked into systems of knowledge do not move around in the same way as their component parts, having emergent properties that must be explained differently.

24 LYMAN/O'BRIEN, 2003, p. 244.
25 SPERBER, 1996, pp. 61f.
26 INGOLD, 2001, p. 137.

Social and Material Storage

While core cultural transmission (say, that associated with early child learning) is still strongly correlated with biological relatedness, this markedly decreases as societies become larger and more complex, with divisions of labour, schools, writing, and mass media. But what also undermines simple models of knowledge transmission, even in non-literate small-scale societies, is the degree to which social storage of cultural information is important: the extent to which culture is preserved through distribution in the minds and practices of a large number of individuals. Although preliterate societies can often take advantage of various forms of social storage – knowledge devolved in others (particularly specialists), in objects, and in art – it is writing that has had the most significant influence on the human ability to store knowledge outside individual human minds, and after that, various other forms of mechanical recording of sound and image. Most folk knowledge of the natural world is transmitted through the oral mode, except when it is transformed through scientific and medical practices involving texts. But the introduction of writing can have major (if ambiguous) consequences on how knowledge systems are organized, together with forms of authority and legitimation.[27] Technically, writing knowledge down tends to freeze the content, which preserves the initial corpus. But writing down knowledge also entails simplification at the point of instantiation, when it often has to be selective, but – paradoxically – thereafter permits continual expansion that can lead to complexification within the text. Writing in two dimensions permits the making of new connections between elements, the use of devices such as tables, lists, and diagrams, with consequences for understanding causality; but it also denies other connections found in the oral mode due to loss of flexibility. And writing influences the way we use oral knowledge, giving rise to the social supremacy of what Maurice Bloch[28] calls the "linear-sentential" mode: dividing knowledge up into sentences and representing it in a textually-determined order. These effects are even found in societies with minimal literacy. Because literacy itself is a skill available to a small fraction of the population in many societies, and competence highly variable, it provides a new source of legitimacy: the authority of the book, which underpins, for instance, the Judaeo-Christian and Islamic traditions. As long as knowledge remains orally-articulated, or even

27 E.g., GOODY, 1977; ONG, 1982.
28 BLOCH, 1991.

devolved in non-linguistically coded tacit experience, it often poses obstacles to effective reproduction through the literate mode, inviting serious over-simplification, straining the limits of ordinary language as a medium of transmission, and giving rise to specialized forms of language (such as mathematical notation or theological reasoning), or devolved in practical interactive demonstrations of which language may be the lesser part. Consider, for example, how you would explain to a child how to tie a shoelace – over the telephone.

How knowledge practices are transmitted therefore depends on their form. While all cultural transmission relies on some kind of bodily interface, what varies is the extent to which, first oral language, and then written language are involved in the process. There are many bodily practices that are learned through self-discovery or copying, reinforced by parental actions or those of other significant persons. Much knowledge is what we might call "substantive", meaning that it may be quite complex and extensive but not in itself ordinarily committed to language, though it may emerge through performance. This is the case with much folk-biological knowledge, such as that concerning plant maturation and ecology. Think for example of knowledge of weeding, in which gardeners are well aware of the properties of individual weeds and the need to remove them, but do not always know their names. People acquire this knowledge through a combination of long-term experience and interaction with plants, and occasional social interaction; but, while bound by implicit rules or scripts, the knowledge is seldom systematically organized linguistically. By contrast, "lexical" knowledge is that part encoded in language, or where the language provides a key for accessing substantive knowledge that is not itself lexicalized.

One step up from lexical knowledge is textual knowledge, in which words are organized into sequences of utterance. To some extent, we acquire knowledge by mastering scripts that are in part encoded in language, as when Frake[29] famously invites us to consider "how to ask for a drink" in Subanun, a language of Mindanao. The oral texts that compress emergent consensus and rules may be in the form of narratives, e.g., myths, though they may also subsequently take on a more permanent written form. Each of these forms can be transmitted through mimicry, copying, or imprinting, but also through language-mediated instruction (telling), and text-mediated learning, through institutionalized teaching and learning (pedagogy, apprenticeship), and through

29 FRAKE, 1980.

a combination of these, such as informal learning in institutional contexts (e.g., in labs or offices), or the formal learning of religious liturgies. But transmission by example, which all of these exemplify, is not just a matter of simply copying, but rather involves the inculcation of a set of principles and practices that can be used to instantiate behaviour that is logically equivalent in a given context, rather than materially equivalent behaviour as copying implies. Formulaic sequences of lexical expressions are a proper subset of these, a sub-category rather than another category. Therefore, mimicry, copying, and imprinting have a role – dealing with the material manifestations or data that individuals require to induce knowledge – but do not copy the knowledge itself, simply producing exemplars of what the knowledge, once acquired, should be capable of producing. Moreover, if a text is written, the knowledge it contains may bypass the oral mode and move between individuals and social groups as an object, emerging in quite different contexts with different assumptions of interpretation.

But irrespective of the possible means of knowledge transmission, we must ask whether we get different patterns in different cultural domains. Are there differences between domains constituted largely through physical objects compared with those that are more abstract and ideational, such as religion? As Whitehouse[30] has shown, there may be several modes of transmission operating simultaneously in the domain of religion, with different cognitive architectures and emotional glue, whether liturgical or experiential. Humans absorb certain kinds of knowledge more readily than other kinds, even within the same cultural domain. Thus, explaining the transmission of cognitively costly aspects of religion may be very different from explaining transmission of language or minimally counterintuitive concepts. What we find is that the composition of different cultural domains, as they are conventionally and emically defined, depends on mixed strategies of transmission, although in urban-centred, literate, and globalized society, words and texts (whether written, spoken or electronic) increasingly come to dominate.

30 WHITEHOUSE, 2004, p. 58.

Speed and Velocity of transmission

Rates of cultural transmission also vary. To take another example from childhood culture. The Opies[31] note the remarkable stability of playground rhymes over a period of several hundred years, but equally the "miraculous" speed of innovation. "Hark the Herald Angels sing, Mrs. Simpson's pinched our king" appeared within weeks of the first public announcement of the constitutional crises in 1936, between November and December of that year.[32] Moreover, since nursery lore is transferred via adults to children, there may be a twenty- to seventy-year gap between learning and teaching, while playground lore may be retransmitted within the hour. Thus, over a period of 130 years a rhyme may have passed through 20 successive generations.[33] The interpersonal relationships involved in transmission, therefore, influence its speed. One-to-many transmission (as in book reading, classroom teaching, or internet communication) can result in rapid change or reinforcement, whereas many-to-one transmission generally favours cultural conservatism.[34] Looking at it differently, things that change quickly are most likely to result from individual choice, whereas things that change slowly are more likely to reflect collective choices. There is a body of evidence suggesting that substantive knowledge declines faster than lexical knowledge.[35] This can account for the number of non-synonymous terms in circulation that cannot confidently be matched by subjects to firm folk identifications of plants and animals, especially in populations with access to books and dictionaries.

The Consequences of Knowledge Transfer

Where individual traits are transferred as small bundles of knowledge, they are generally accommodated within the preexisting classificatory and ontological schemes of the receiving population; for example, a tomato from Mexico will become a "pomme d'amour" in sixteenth century France, or a potato from the Andes becomes an "ardappel" in Holland. In other cases, a small material

31 OPIE/OPIE, 1959, p. 2.
32 IBID., pp. 5f.
33 IBID., pp. 7f.
34 CAVALLI-SFORZA/FELDMAN, 1981.
35 ATRAN/MEDIN, 2008, p. 47.

change (such as the introduction of a new landrace or species) can have major consequences for the wider frameworks people use for organizing knowledge and practice. Thus, the introduction of high-yielding quick-maturing rice varieties into Java in the 1970s not only had knock-on effects for the irrigation system and agricultural calendar (because now two or even three harvests could be fitted into the same period), but also impinged on the symbolic system. It did this through the necessity to plant homogenously and remove normally co-planted glutinous varieties, which were important for rituals, including first harvest festivals. Similarly, the voluntary introduction of the fast-growing nitrogen fixing tree *Paraserianthes falcataria* among the culturally conservative Baduy people of upland West Java significantly improved rice production, but because the tree also dramatically reduced the time land took to recover (from twenty to eight years) also significantly influenced their symbolic calendar and cycle of agricultural activities over the longer term.[36]

Knowledge moves around and between social systems linguistically and non-linguistically: linguistically by telling, hearing, reading and writing, and non-linguistically by watching and engaging in activity (including performance). But watching and experience do not always provide a good guide to linguistically encoded knowledge, and vice versa. Given that we know that knowledge transfer is imperfect, recursive, and involves an element of rediscovery, it is not surprising that we find that new knowledge and concepts arise during the process of borrowing: changes occur inadvertently or deliberately through selection and adaptation. Even where people deliberately borrow knowledge with the intention of engineering certain changes, there is much scope for unforeseen consequences: socio-cultural output is rarely reproduced in a precisely identical form. This reinforces the argument about recipes and contexts, that it is not just "information" that is transmitted, but rather expressions of relations.

If we examine the way in which people acquire knowledge and skills, the process is much more interactive and complex than suggested by the passive ideas of "copying", or "transmission", which suggests that this stuff called "culture" is "flowing" between generations and through time.[37] Recipients are not simply "vessels to be filled".[38] The mind, like all organic learning systems, is not a fixed generic device. If we consider how individuals actually acquire

36 ISKANDER/ELLEN, 2001.
37 STRAUSS/QUINN, 1997.
38 REYNOLDS, 1981.

knowledge in particular activities, such as minaret-building,[39] woodworking,[40] metalworking,[41] gardening,[42] or basketmaking,[43] the process resembles rather the development of linguistic competence, in which representations and actions are generated, retained and communicated. We become experts not by quietly absorbing knowledge, but by actively selecting it.

Cultural transmission is, therefore, not essentially the copying of abstract models or representations, but is at least in part, as Bourdieu[44] insists, the "imitation of actions", or, we might add, emulation or stimulus enhancement. We have seen that Ingold[45] offers us a forceful critique of Sperber's[46] position that knowledge is essentially "mental content" in the brain waiting to be expressed, and transmission the process through which representations are discharged. Ingold[47] prefers the notion of perceptual engagement through performance by "a whole organism-person in an environment", rather than of a mind inside a body. All learning involves an element of self-discovery – is "situated"[48] – the retrieval of knowledge entailing "the partial reenactment" of the very situation(s) that led to its encoding,[49] and for this reason every "transmission event" is likely to modify the unit that is transmitted.

The Columbian Exchange, Folk Classification and Botanical Ontologies

Most of what Nuaulu know about the biological constituents of their environment has co-evolved over the long-term and is reproduced in each generation through a combination of self-discovery and transfer from those who already have it. New knowledge sometimes arises through new observations and the making of new connections, and lessons learned by some farmers may be

39 MARCHAND, 2001.
40 KALETA, 2008
41 KELLER/KELLER, 1996.
42 PLATTEN, 2013.
43 ELLEN, 2009.
44 BOURDIEU, 1990.
45 INGOLD, 2001, p. 138, note 13.
46 SPERBER, 1996.
47 INGOLD, 2001, pp. 135 and 142.
48 LAVE/WENGER, 1991.
49 BARSALOU et al., 2003, p. 43.

passed on to others. How new biological knowledge circulates within a society depends very much on its division of labour and structure of social relations. Thus, Boster[50] found that amongst the Amazonian Jivaro, new knowledge about cassava landraces and their properties passes largely between female cultivators. But where we draw the line between the endogenous and exogenous transfer of knowledge is fuzzy. Often biological knowledge passes between in-laws who may be from other villages or language groups. In the case of the Nuaulu, new germplasm has been brought in by migrant incomers, such as the Butonese or introduced through government initiatives, and new skills (e.g., grafting) learned from NGOs.

One way in which we might focus on changes in the Nuaulu system of plant knowledge is to look at a period of time the start of which is defined by an event with major historical consequences for plant movement. For the Nuaulu, such an event was undoubtedly contact between Europe and the Americas from 1492 onwards which resulted in the redistribution to the rest of the world, including eastern Indonesia, of a large number of plant species previously found only in the Americas. The total number of species released in what Alfred Crosby[51] calls "the Columbian exchange" has been estimated at many thousands, of which in the region of 48 species (mainly of the major starch-producing cultigens) have had a subsequent global impact on ecological and social history. For obvious reasons, most of the New World species diffusing through the Old World after 1492 were potentially major food crops, which competed with existing indigenous starch crops and grains.

Of all 1000+ records in my Nuaulu Ethnobotanical Database, 64 refer to plants that were restricted to the Americas before 1492. The status of *Ipomaea batatas* (the sweet potato) is disputed, but it certainly did not arrive in eastern Indonesia much earlier than the sixteenth century. Of course, plants of New World origin did not immediately enter the Nuaulu folk-classificatory orbit, although some did arrive surprisingly early and others surprisingly late. Thus, Rumphius, in his *Herbarium Amboinense*, writing in the last two decades of the seventeenth century on the nearby island of Ambon,[52] already lists 28 of the species. From Rumphius's descriptions, it is clear that use of chilli, tomato, cashew, peanut, cucurbits, and tomato was well established in Ambon by the time he had arrived. However, six cultigens now important had either not yet

50 BOSTER, 1986.
51 CROSBY, 1972.
52 RUMPHIUS, 1741-1750.

arrived in Ambon, or where not salient among Ambonese, at the time Rumphius was conducting his investigations. These include *Hevea* rubber, Andean potato, chocolate, and avocado.

We can select some groups of species in order to examine how they have been incorporated as part of the Nuaulu ethnobiological system. First of all, there are lexical clues that suggest how new species are incorporated within existing classificatory frameworks, like those I mentioned above for Europe – tomato and potato. Thus, soursop, *Annona muricata* becomes the binomial ***tunene warata***, where ***tunene*** is an existing unmarked term for durian, and ***warata*** means "Dutch" or "foreigner". Adjectival qualifiers of apparently specific derivation may become generic ways of indicating alterity, e.g. ***warata*** [Dutch], ***cina*** [China]. Secondly, species may be incorporated using loan-words from an intermediary language, in this case usually Ambonese Malay (AM). This may work in various ways, for example where a uninomial is adopted from another language as a lexically unaltered term, e.g. ***yakoni*** ← AM jagung [maize] or ***kasipii*** ← AM "kasbi" [cassava]. Fifty-seven percent of Nuaulu plants of New World origin have names which indicate that they are not native, though because their introduction spanned a period of nearly 400 years they have not left a clear linguistic and classificatory footprint. Time and cultural route of introduction have varied between individual cases, which has influenced the way each has been incorporated.

We can also appreciate how new species and knowledge are introduced by examining a particular category of plants with a high degree of family resemblance. For example, starchy roots and tubers are important mainly because of their role in food security. Prior to the arrival of New World species, Nuaulu depended on two main genera: yam (four species) and taro. These map onto folk terms in an interesting way (Table 1). There is no single term for yams. Two uninomials (***kawasine*** and ***akae)*** are subdivided into two named categories where their partial covert similarities are reflected in the overlapping application of unmarked ***akae*** and marked ***kawasine putie*** [white ***kawasine***] to the same species, while a binomial of ***akae*** is also applied to a kind of *Dioscorea pentaphylla*, otherwise known as ***loloeno***. By comparison, ***siahue*** is divided into eight varietals, and ***hueni*** into ten varietals. Taro is divided into eight varietals. These numbers are less than we find among many New Guinea peoples, who were introduced to American species much later, and we might well assume that there was considerable erosion of Nuaulu varietals following the arrival of New World roots. The introduced New World

	Nuaulu	No. segregates per generic term	Scientic name	Ambonese Malay
Old World				
1	***kawasine masikune***		*Dioscorea hispida*	ubi racong
2	***kawasine putie***		*Dioscorea hispida*	ubi racong
3	***akae***		*Dioscorea hispida*	ubi racong
4	***akae hunuhunue***		*Dioscorea pentaphylla*	ubi pasir
5	***loloeno***		*Dioscorea pentaphylla*	betah, akar umbi
6	***siahue***	8	*Dioscorea esculenta*	kumbili
7	***hueni***	10	*Dioscorea alata*	kumbili
8	***sikeue***	10	*Colocasia esculenta*	keladi
New World				
9	***kasipii***	10	*Manihot esculenta*	kasbi, ubi kayu
10	***kasitena***	4	*Ipomoea batatas*	batatas, ubi kastella
11	***yohoru***	2	*Xanthosoma sagittifolium*	keladi yohor

Table 1: Local terms for starchy tubers and roots in Nuaulu and Ambonese Malay

starchy tubers were cassava, sweet potato, and *Xanthosoma*, each labelled with terms that unambiguously map on to a single polymorphic species and that clearly indicate something of their external origins: ***kasipii*** (← kasbi ← casabe or casábi – Hispaniola and Cuba), ***kasitena*** (← kasitela ← Castiliano), and ***yohoru*** (← Johore – the Malay Sultanate) respectively. Of these, cassava now represents the tuberous crop with the highest level of productivity in gardens,

and all the introduced species tend to be more productive than indigenous crops.

These examples demonstrate how marking behaviour works with respect to introduced species and some of the lexical evidence shows us something of the pattern of introduction of cultigens of New World origin. We can also see that the evidence of some southeast Asian languages, particularly the various dialects of Malay that served as vehicles for the introduction of most of these new species, provides us with classic examples of the principle of "category extension". Examples include absorption of *Xanthosoma* into the Ambonese Malay category "keladi", previously exclusive to taro, and cassava into "ubi". This, however, is not necessarily reflected in Nuaulu, though not because the Nuaulu regard them as economically unimportant (as some have in fact now eclipsed Old World species in their economic and dietary significance), while most Nuaulu are now bilingual in Ambonese Malay. Such resistance to what we might expect to be the flow of linguistic influence can better be explained by the fact that, since the Nuaulu are still predominantly animist, and conduct planting and harvest rituals that focus exclusively on pre-Columbian yams and taro, classificatory practice may have something to do with the ritually privileged status of these species.

Additionally, the criteria for grouping Nuaulu tuberous crops into more inclusive named categories are limited and exclusively morphological. For the Old World starchy tubers, we only have the curious linkage of ***kawasine*** and ***akae*** (and possibly its association with monotypical ***loloeno***), which appears to relate to the common characteristics of special toxicity and an ambiguous status as wild and cultivated plants. By contrast, both ***siahue*** and ***hueni*** are long-established polymorphic cultigens with large numbers of varietals, and with low levels of toxicity. In New World *Manihot esculenta*, where it is so important to distinguish the toxicity of particular varietals, there is no overarching grouping into sweet and bitter. This, I suggest, is because toxicity is not always a reliable diagnostic feature in the species, and that it is far better to encode this feature in adjectival qualifiers.

In a multilingual environment, the ability of most people in a speech community to have access to classifiers in their non-birth languages means that they can group ethnobiological data in ways that may not be reflected in the patterns of linguistic encoding of their birth language. In other words, this knowledge and the lexical practices through which it is expressed become part of the classificatory system of the Nuaulu, even before those practices are

formally absorbed into the language. Thus, while the Nuaulu have no overarching term for yams, the fact that Ambonese Malay "kumbili" refers to all varietals of the two most widely cultivated types is relevant, similarly the use of "keladi" to group both taro and *Xanthosoma*, and indeed other aroids of both Old World and New World origin.

These plant movements have consequences for symbolic knowledge. The earliest of the surviving historic starch field crops are taro and yams, and these are the foci of planting and harvesting rituals in which ancestral spirits are invoked. However, rituals are not performed involving New World crops such as cassava and *Xanthosoma*. So, as these crops became more important, the rituals as a whole become reduced. Despite all these changes, the overarching classificatory system through which Nuaulu plant knowledge is organized – their biological ontology – remains fundamentally unaltered. This only happens with conversion to Christianity or Islam, which strips out key elements of the cultural narrative (myth, ritual) that makes sense of the relationship between different species and how they are used. The other change is formal school education, the introduction of writing, and an alternative classificatory and ontological framework for understanding the relationship between biological species found in scientific biology and the modern synthesis of biological knowledge. In this new understanding, knowledge derives from the perspective of understanding plants as a global (rather than local) phenomenon, that links plants not through their uses or position in a local ecology and cosmology, but as products of evolution.

Conclusion

Quite how we might best theorize notions of "finding", "inheriting", and "borrowing" when investigating the construction and transfer of knowledge of the natural world, and develop appropriate methodologies to do so, clearly poses many unresolved issues. However, we can highlight a number of persistent and emerging themes.

(1) The first relates to the notion of "radical simplification". By looking at cultural domains where it is relatively easy to find components that might constitute units of transmission, we can identify processes that underlie transmission in more complexly constituted domains. In complex domains

measurement is more problematic, and their very complexity may lead us to question the universalist claims of the methodology underlying Darwinian-inspired cultural evolution approaches.

(2) The second relates to levels of analysis. The virtues of ethnographic or context-rich historical approaches are not invalidated by cultural evolutionary approaches, while there is no reason to think that in analysing any data-set or system of ideas we cannot detect some processes that might be described as "descent with modification", or variation, drift, and selection of the kind advocated in those approaches we call evolutionary. Indeed, one is likely to inform the other. The methods for studying the micro and the macro are not easily interchangeable; experimental, observational, and qualitative studies involving "thick description", must complement quantitative studies of large data-sets with robust measurability over the longer term.

(3) The third relates to directionality in the movement of ideas. The rules underlying spatial movement (horizontal transmission) and temporal movement (vertical transmission) are basically the same, and often overlap.

(4) The fourth is to emphasize that form of transmission and how we can best analyse it may vary between cultural and social domains. In particular, the units we use to measure the transfer of ideas must be appropriate to the scale and substantive differences in the kind of data being examined, and the kinds of questions posed. While there may be no theoretical difficulty in measuring continuous distributions as such, measuring cultural variation and the movement of medicinal herb recipes or basketry designs is likely to be rather different than measuring, say, modes of religiosity.

(5) Finally, in making sense of knowledge transmission we need to understand that process and structure are recursive, and that the movement of ideas is not a mechanical process of simple "replication". Reproduction and change arise in systemic contexts, but those same processes give rise to the contexts in which successive processes occur. In the background, therefore, must be some kind of meta-model that combines agency and context. This applies to micro-level processes of innovation and interpersonal interaction, macro-level long-term cultural continuity and

change, as well as to the patterns of spatial and social diffusion that they instigate.[53]

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