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Symbols, Stimulus Equivalence and the Origins of Language

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ABSTRACT: Recent interest in the origins of language, within the strongly cognitive field of Evolutionary Psychology, has predominantly focused upon the origins of syntax (cf. Hurford, Knight and Studdert-Kennedy, 1998). However, Ullin Place's (2000a) theory of the gestural origins of language also addresses the more fundamental issue of the antecedents of symbols, and does so from a behaviourist perspective, stressing the importance of the peculiarly human ability to form stimulus equivalence classes. The rejection by many developmental psychologists of a behaviourist account of language acquisition has led to a modular and distinctly nativist psychology of language (cf. Pinker, 1994, 1997; Pinker and Bloom, 1990). Little has been said about the role or nature of learning mechanisms in the evolution of language. Although Place does not provide any defence of a behaviourist linguistic ontogeny this is no reason to rule out his phylogenetic speculations. We aim to outline Place's evolutionarily parsimonious view of symbol origins and their relation to stimulus equivalence. We applaud Ullin Place for bringing symbols into focus within the broader discipline of language origins and suggest that he has raised an interesting set of questions to be discussed in future work.

Keywords: symbols, stimulus equivalence, learning

The main aim of this paper is to analyse the contribution of Ullin T. Place to the study of symbols and particularly to their evolutionary origins. Place was both a philosopher and a psychologist, but in both fields he was committed to a form of behaviourism that made him somewhat unusual in comparison with many of his colleagues (though by no means all). The reason for this is that most psychologists have regarded behaviourist approaches to psycholinguistics (and psychology more generally) as inappropriate since Chomsky's (1959) infamous review of Skinner's (1957) *Verbal Behaviour*. Chomsky's nativism has dominated psycholinguistics and led to a general view that the cognitive architecture underpinning language is organised along modular lines. This position has infiltrated much of modern philosophy of mind and the commitment to modularity has spilled into other cognitive domains outside language.

Regardless of one's opinions about the "Chomskyan Revolution" it is certainly true that psycholinguistics has proceeded with some reasonable success under the cognitive paradigm. But, it is also the case that over the last

fifteen years classical cognitive approaches have been met with criticism from a new breed of associative learning theorist - the Connectionists. Their work is now beginning to throw up interesting challenges to mainstream models (e.g. Elman, 1993; Elman et al, 1996; Hurford, 1989; Oliphant, 1996, 1997, 1998).

The Connectionist challenge is felt most keenly in work on language development. However, it is worth clarifying that this does not in any way represent a direct defence of Skinner's position on language acquisition. To our knowledge there have been no satisfactory ripostes from behaviourists to the arguments about fast mapping and the poverty of the stimulus¹ - phenomena that Skinner significantly failed to deal with (Chomsky, 1959). None the less, the Connectionist work does suggest a role for a form of associative learning. Although we side with Chomsky with regard to the latter criticisms we do not feel that this means we are left only with classical cognitivism as a way forward.

An International conference on the evolution of language was held in Edinburgh in 1996 (then London in 1998, Paris in 2000). This conference did not mark the beginning of interest in language origins - much discussion has been had on this topic at least since Condillac in the 18th century. What the Edinburgh conference did indicate, however, was an increased multidisciplinary interest not only in the evolution of language but in the evolution of human behaviour and psychology more generally. Since the late 1980s Evolutionary Psychology (EP) had started to be discussed seriously as a paradigmatic focus for much of the behavioural sciences. Language immediately became a "hot-topic" as it is potentially one of the defining characteristics of modern humans.

The work of Leda Cosmides, John Tooby and their colleagues (1989; Barkow et al, 1992) has had a strong impact on EP. They have developed both explanatory and predictive projects for EP (Grantham and Nichols, 1999) attached to a coherent theoretical structure. They argue that much of our complex psychological make-up is the product of natural selection. For a trait to be selected it needs to provide a solution to a contingent adaptive problem, which needs to be fairly long term and stable. Cosmides and Tooby (1992) suggest that the Pleistocene epoch was a stable period for contingent adaptive problems in our hominid past, and they dub this our Environment of Evolutionary Adaptedness (EEA; following Bowlby). During the EEA various discretely organised cognitive mechanisms were selected that solved these putative problems. For example, Cosmides (1989) has demonstrated that people perform much better on the Wason Selection Task when the task is about seeking out violations of social contracts than in its original abstract form. Cosmides argues this is because finding cheats within a social system would have been a contingent ancestral problem and the species has evolved a specific module to deal with this. The fact that people find it hard to transfer their reasoning ability to the abstract task with the same underlying logic is indicative of a cognitive specialism. This approach led to what Samuels (1998)

¹ Fast mapping refers to the infant ability to rapidly acquire new names for new things; the poverty of the stimulus argument is the argument that infants are not exposed to negative evidence of linguistic rules, which would be essential to make valid hypotheses and learn language from "scratch". This is a result of Gold's Theorem.

calls a Massively Modular cognitive organisation whereby there were specific computations and stored representations for specific problems, which is not unlike a Chomskyan architecture as Samuels points out. In other words natural selection led to a "one problem - one mechanism" organisation, according to this view.

There is not space to discuss the various commitments implicit in this approach (see Hardcastle, 1999 for an excellent overview of the many debates). For now the key point to note is that EP is strongly cognitive. The order of cognition that EP is committed to is of a classical persuasion, each module consisting of some form of serial computation device acting upon stored representations (see Samuels, 1998 for a discussion). This cognitive position appears to be prevalent in much of the recent work in EP (cf. Barkow et al 1992; Buss, 2000; Pinker, 1997). However, in the area of language origins the perspective seems to be a little more catholic and this is what has become apparent from the first conference in Edinburgh up to the most recent in Paris. It is the case that some language origins speculations have fallen within the Cosmides camp, notably Pinker (1994) and Pinker and Bloom (1990), but there is not a consensus opinion. Most interestingly, given the subject of this paper, there has been room for discussion of the general role of associative learning - something that Place has taken up in his work.

SYMBOLS AND STIMULUS EQUIVALENCE

Despite the plural approach within language origin research much of the area has been dominated by a concern to model full, syntactic natural language. This has led to a Chomskyan emphasis at least in terms of describing the (present) end product of long evolution. But, there are some researchers who are interested in other aspects of language such as its social function (e.g. Dunbar, 1993, 1996; Knight, 1998), the origin of pragmatics (Desalles, 1998) and the origin of symbols (e.g. Balkenius et al, 2000; Deacon, 1997; T. E. Dickins, 2000a, b). It is into this latter group that Place's work falls.

The rest of this paper will critically discuss Place's definition of a symbol and his model of language evolution. We shall end with an appraisal of how far we think Place's work has taken us toward a better understanding of the origins of language as well as toward an acceptable use of behaviourist ideas within "psycholinguistics".

WHAT ARE SYMBOLS?

Place (1995/6) has made the point that symbols are a sub-category of sign. Signs, according to Place, have meaning by virtue of their orienting a creature's behaviour toward some actual or potential environmental feature. This meaning is acquired through discrimination learning. Symbols are distinctive in that their meaning is shared by a social group - the verbal community that uses them. Symbols are not reliant upon each individual having directly experienced the features that they symbolise. Symbols are attached to their referents by arbitrary social convention and maintained by linguistic and error correction practices prevalent in the social group. Specifically, symbols are artificial and acquire their status due to their role in

human social life. The final difference between signs and symbols is that signs are related to their referents asymmetrically, such that spots can be the (natural) sign of measles but measles cannot be considered a sign of spots - signs are indicative of something (Dretske, 1986). However, symbols are attached to their referents symmetrically. This means that on the presentation of the word <cake>, for instance, a person can pick “cake” from a mixed array of stimuli, and on the presentation of a cake they can equally pick the word <cake> from an array of words, or generate it themselves.

This view of symbols is not peculiar to Place. Recently Marc Hauser (1996; Table 1) used a similar taxonomy to clarify the modern ethological notion of communication - namely that communication is the transfer of information by a transmitter which has the (evolved) function of altering the behaviour of a receiver (see Krebs and Davies, 1993) in a way which benefits the signaler.

| Information Type: | Feature: | Example: |
|--------------------------|--------------------------------|----------------------------------|
| Cues | Always on | Yellow and black stripes of wasp |
| Signs/Indexicals | Indicate presence of something | Footprints, scent marking |
| Signals | Can be on or off | Alarm calls |
| Symbols | Displaced reference | Words |

Table 1: Hauser's Information Categories: Cues, signals and symbols are all used in communication systems. Signs or indexicals can be used by one organism to learn its way around the environment - this is related to communication as it is an example of behavioural change through the acquisition of information; but it lacks the dyadic (or more) interaction to be truly classed as communicative behaviour.

Deacon (1997) has also proposed a similar definition of symbols within an information hierarchy (see Table 2).

Where Place's view of symbols differs from Hauser's and Deacon's is the emphasis upon symmetry. All three theorists are concerned with displaced and arbitrary reference as "enforced" through social convention but only Place discussed the two-way relationship between symbol and referent. This is a symbol property that has received little attention in the evolutionary literature (T.E. Dickins, 2000a, b; Hurford, 1989).

| Category | Description | Example |
|----------|---|-------------------------------|
| Icon | <i>Similarity</i> - similarity between token and object | Landscape painting, portraits |
| Index | <i>Contiguity</i> - physical or temporal connection between token and object | Weathervane, alarm calls |
| Symbol | <i>Convention</i> - formal or merely agreed upon link irrespective of either sign or object | Wedding rings, words |

Table 2 – Deacon’s Taxonomy of Information Types (based on Peirce; Deacon: 1997: 70). Note that Deacon's Index encompasses both signs and signals as described in Hauser's hierarchy.

THE RELATION OF SYMBOLS TO STIMULUS EQUIVALENCE

Place's view of symbols is explicitly a position on linguistic symbols or words. Linguistic symbols, or words, in line with Armstrong et al (1995) are constituted by the relationship between the neuromuscular activity that produces a specific sound (or set of sounds) and an associated concept. As Armstrong et al (1995) point out the associated concept is also in principle explicable in terms of specific neural activity. Hence we have an association between a conceptual or semantic neural system and a motor system. This is the essence of (spoken) words. (There has to be an association between the sound of the word and the concept also, for both hearer, and speaker.)

To emphasize the one to one mapping of concept to vocal output in this manner has an obvious appeal but it does not afford us a specific position on concepts - despite the commitment to a neural substrate explanation. Ultimately all theories of concepts need a neural grounding but we could take up a Feature theory position, a Prototype theory or some form of network based model. All of these positions have well rehearsed problems of internal coherence (Margolis and Laurence, 1999), let alone of reduction to neurological terms. However, Place (1995/6) makes it clear that he is committed to an externalist position - which is unsurprising given his behaviourism - and we should therefore expect Place to emphasise the conceptual half of the symbolic equation. Place attempts this through a discussion of stimulus equivalence.

There has been a fast-growing literature on stimulus equivalence, since Sidman (Sidman, et al., 1982; Sidman and Tailby, 1982) applied to this behavioural paradigm, as operational criteria of equivalence class formation,

the 3 formal properties of a mathematical equivalence set, viz. reflexivity, symmetry, and transitivity. These are explained below.

A simple laboratory demonstration of equivalence class formation is the formation of two 3-member equivalence classes, A1-B1-C1 and A2-B2-C2. First the baseline A1-B1 and A2-B2 trained relations are established, typically by means of arbitrary matching to sample (MTS) training. The first named stimulus of a pair, say A1, is presented to the subject as a “sample”, and then B1 and B2 are presented as alternative “comparison” stimuli. By means of feedback saying whether a choice is correct or incorrect the subject learns to select B1 as the correct comparison for A1, and similarly, with intermixed trials with A2 as sample, to choose B2 as the correct comparison for A2. In such studies, any kind of stimulus may be used, and the matching connections are arbitrary in that they are applied for the purposes of the experiment only, and are not dependent upon any pre-experimental link. When a training criterion is reached, B1 and B2 now act as samples, and B1-C1 and B2-C2 relations are similarly trained. In these 2 linear ABC “training sets” the B stimuli are the nodes since they link the other 2 stimuli. It is of course possible to train multinodal linear series such as A-B-C-D-E (a 3 nodal series) or other systems of minimal interconnections between a number of stimuli.

A training set becomes an equivalence set if the 3 logical criteria are operationally demonstrated by means of tests, without any formal feedback or reinforcement. These are identity (= reflexivity), symmetry, and transitivity. Identity is usually taken for granted. With A1 as sample, and A1 and A2 as comparisons, the subject should select A1 (and similarly match each stimulus to itself). Symmetry refers to the inverse of a trained relation, for example if B2 is presented as sample, with A1 and A2 as comparisons, A2 should be selected. Transitivity is where, if A2 is presented as sample, with C1 and C2 as comparisons, C2 is selected. A combination of symmetry and transitivity, such as selecting A1 as comparison if C1 is the sample, is sometimes called the equivalence relation, since it combines two criteria in one test, the third (identity) being assumed.

Within the considerable body of research on stimulus equivalence (Fields and Nevin, 1993; Hayes, Gifford and Ruckstuhl, 1996; Sidman, 1994), several different theoretical positions have been defended (Clayton and Hayes, 1999).

In his review of over a decade of his published experiments Sidman, (1994) has continued to see stimulus equivalence as a basic behavioural phenomenon, in the same way as reinforcement itself. Recently Sidman (2000) has spelled out even more radically the idea that all of the “bag” of elements that make up a conditional stimulus discrimination – the discriminative stimuli, the responses, and the reinforcers – form one entire equivalence class even if this can only sometimes be demonstrated formally, as above, in the human laboratory.

In the human laboratory there seem to be two factors determining the success or otherwise of equivalence class formation. One may be the (cognitive) capacity of the human subject to access from memory the history of primary and secondary connections between stimuli. Some of these stimuli will be present on the screen, as samples and comparisons, and others will be absent, as in the case of nodal stimuli in tests of transitive relations. The other factor would seem to be the discovery and application of a rule to determine

the basis upon which a previously untrained selection might be made. Logically, equivalence is only one such rule. Steven Hayes and his colleagues point out that there may be many such “relational frames”, such as the relation of greater than, less than. These are postulated as operants, and behavioural analysis proceeds by investigating the reinforcement history of such operants. For some behavioural analysts this is all that is necessary. “It would be a very bad thing if the development of behavioural theories leads to traditional hypothesis-testing research. The goal is not to test theories. The goal is to predict and control behaviour with precision and scope.” (Hayes, 1986)

Despite the capacity of most vertebrate species to acquire the basic trained relations, (with a few possible exceptions e.g. Schusterman and Kastak, 1993) only human subjects (Dugdale and Lowe, 1990; Hayes, 1992) display the spontaneous emergence of novel relations formally satisfying the above criteria of equivalence. Furthermore, people too young to have speech, or those deficient in the capacity for speech, also seem incapable of forming equivalence classes (Augustson and Dougher, 1992; Barnes, McCullagh, and Keenan, 1990; Devany, Hayes, and Nelson, 1986). If there were a causal link between equivalence and language, it may be that the capacity for equivalence was a preadaptation (or exaption – Gould and Lewontin, 1979) enabling the subsequent evolution of language. These observations accord also with an alternative view (Dugdale and Lowe, 1990; Horne and Lowe, 1996), that equivalence is a by-product of a child’s first experiences of indicating objects and speaking and hearing their names, and that stimulus naming plays a key role in equivalence class formation. This Horne and Lowe (1996) put forward as an hypothesis susceptible in principle to falsification. Some efforts to test this hypothesis are described below.

Fields and his colleagues have led the way (e.g. Fields, Adams, Verhave, and Newman, 1990; Fields and Nevin, 1993; Fields and Verhave, 1987; Fields, Verhave, and Fath, 1984) in stressing the properties of nodal links which reveal a resemblance between equivalence classes and the notion of associative networks in the cognitive psychology of memory. While symmetric relations (non-nodal) seem to arise ‘for free’, in that responses on unreinforced symmetry tests are just as accurate and just as fast as on tests of the trained relations (Bentall, Dickins, and Fox, 1993; Bentall, Jones, and Dickins, 1999; Spencer and Chase, 1996), in initial tests of transitivity and equivalence these authors found that both the probability and the speed of a correct response is a lawful diminishing function of the number of nodes separating sample and comparison. Successful subjects show a progressive increase in the probability of a correct response and its speed on repeated testing, eventually making multinodal transitivity “jumps” as surely and quickly as non-nodal trained relations and symmetric relations. “Behaviourally silent” concomitants of nodal distance may subsequently still be able to be demonstrated however (Fields, Landon-Jimenez, Buffington, and Adams, 1995).

Experimental studies of this kind offer a platform to investigate the relation between successful equivalence class formation and the nameability of stimuli (Bentall, Dickins, and Fox, 1993), pronounceability of names (Mandell and Sheen, 1994), or the effects of rhyming between names (Randell and Remington, 1999) or of training relations between names which conflict with those between the stimuli themselves (Dickins, Bentall, and Smith, 1993;

Smith, Dickins, and Bentall, 1996). A distinction has also been made, by means of functional magnetic resonance imaging, between patterns of brain activation involved in word generation and in those associated with equivalence test performance on the MTS paradigm (Dickins et al., 2001). The overall picture so far is that while the use of names, and the making of connections between them, may help or may even be sufficient to mediate the formation of equivalence relations, there is no definitive evidence that names are necessary for this to happen. Further exploration of the neural concomitants of the phenomena of equivalence, compared with those of suitable comparison tasks, offers the possibility of dissecting out the role of phonological, semantic, and purely associative processes in equivalence class formation.

Place's (1995/6) initial reflections on stimulus equivalence were not optimistic:

I confess that until comparatively recently I had deep misgivings (about the idea that the formation of stimulus equivalence classes is related to the process in which symbols acquire their meaning, D&D). This was because the relation between a symbol and what that symbol symbolises is not an equivalence relation. Take, for example, a proper name such as the name *Margaret Thatcher*. If we apply the standard tests of equivalence, reflexivity, symmetry and transitivity, we find that this relation fails all of them. The name *Margaret Thatcher* does not stand for itself. (Not reflexive, D&D.) The person Margaret Thatcher does not stand for the name *Margaret Thatcher* in the way that the name stands for its bearer. (Not symmetrical, D&D.) From the fact that *Margaret Thatcher* is the married name of Margaret Roberts and *Margaret Roberts* is the name of Arthur Roberts' wife, it does not follow that *Margaret Thatcher* is the name of Arthur Roberts' wife. (Not transitive, D&D.)

Despite this reference to the non-equivalent nature of some specific socially embedded symbols and their referents Place does see a role for stimulus equivalence. *Margaret Thatcher* does not form an equivalence class with the person whose name that is, but it does form one with "the naturally occurring non-symbolic signs of the presence of its bearer such as her visual appearance and the sound of her voice".

This explanation of the use of a name gets us no further from a basic discriminative stimulus paradigm based on natural signs and indicators and suggests nothing special about the use of a name. However, Place points out that the key difference is that the name itself is not a natural sign but rather an arbitrary symbol that acts to coordinate the other signs of the presence of the person named Margaret Thatcher. Place sees symbols as crucial in the formation of stimulus equivalence classes as he states most clearly - "we have indisputable evidence for such equivalence class formation only in the case of human subjects who have attained a certain level of linguistic competence".

From Place's account it is possible that symbolic symmetry emerges through the transitive relation between symbol and referent. This transitivity is mediated by a middle "term" that is in fact a natural sign of the referent. According to this theory natural signs would have to have a symmetrical relationship with the object, event or state of affairs that they indicate however, it is not entirely clear that natural signs such as smoke are symmetrically linked

to their referent, such as fire. Smoke will act as an indexical in this case, and may alert an animal to potential danger but it seems unlikely that the presence of fire will be used to indicate smoke². However, Place is really arguing that the onset of symbolic behaviour enabled the formation of stimulus equivalence classes, which in turn fix symbolic meaning, so in some way symbols manage to force a symmetry between natural signs and their index. How this might have happened is of great interest and Place discusses this briefly in his work on language origins (see below).

The conclusion that Place draws from this discussion of stimulus equivalence is that symbols are involved in equivalence classes and they derive their meaning from equivalence classes that involve natural signs that indicate the presence of the object, event or state of affairs that that symbol is "designed" to refer to. He clarifies this as the "Fields Principle" (after a useful discussion Place had with Lanny Fields):

A symbol is a sign which designates its object, not by virtue of a naturally occurring association between sign and *significatum*, but by virtue of its membership of a Sidman stimulus equivalence class among whose other members is at least one sign which does derive its semantic function from normally occurring association and transfers that function to other members of the class. (1995/6)

So it is that Place argues for an externalist and extensional viewpoint of fixing the meaning of symbols/words.

For Place, then, language is primarily a communication system. The role of "isolated" symbols is to direct or orient a receiver's (listener's) behaviour to the appropriate referent. This is unsurprising given that Place feels a symbol's meaning is fixed by its relation to a natural sign of the referent. In this manner symbols are purely discriminative stimuli. Place's view of sentences is best summed up in the following:

The phenomenon of novel sentence construction arises from the fact that, whereas the units of which sentences are composed derive their behaviour orienting function by generalisation from or repeated association with the natural signs of the presence or impending presence of the kind of action or object they stand for, sentences, provided they are constructed in accordance with the syntactic conventions accepted within the verbal community, have the ability to orient the behaviour of the listener towards the potential or actual presence beyond her current stimulus environment of a contingency the like of which she need never have experienced in her own case. (Place 2000)

In short, Place is arguing that symbols merely point to actual things. Their sound and shape may be arbitrarily related to the referent, but when they are combined in a sentence a further level of abstraction can be added.

² Except perhaps in a sophisticated "scientific" species such as ours where the dangers of smoke are more fully understood.

INTERIM SUMMARY

Place has defined linguistic symbols as a socially agreed form of information that have the distinct features of arbitrary, displaced and symmetrical reference. He has further argued that a symbol's relation to a stimulus equivalence class that contains (an) appropriate natural sign(s) of the referent fixes the meaning of the linguistic symbol. In suggesting this he is arguing for an externalist model of informational semantics. Such models have numerous problems not least how a linguistic symbol such as "science" is to have its meaning fixed when there are no real natural signs of science³. Place's view does not account for this order of problem largely because he has focused upon a particular view of language development (similar to that endorsed by Horne and Lowe, 1996) that suggests:

The propensity of the child that is developing language to form such stimulus equivalence classes is seen as a result of having repeatedly learned both, as speaker, to produce the symbol or name in the presence of a natural sign of the thing it 'stands for' and, as listener, to pick out the natural sign when presented with the symbol or name. (Place, 2000a)

This focus has led to a concern with the non-abstract, or concrete, terms of early language acquisition. It is worth noting that there is not a consensus about this form of word learning. Recent cognitive models of word acquisition do not undermine the role of learning but suggest that a child triangulates word acquisition as a result of an innate whole object bias, the ability to infer the object of an adults speaker's attention from gaze or pointing and a desire to attach vocalisations to previously unnamed objects (Bloom and Markson, 1998; Markson and Bloom, 1997; and see Karmiloff-Smith, 1992 for a discussion of similar work). In this model the child learns very rapidly and without the two-way learning procedure of symbol-to-referent and referent-to-symbol that Place is suggesting. Indeed, Bloom has made the comment that infants often misallocate names to objects if the adult is speaking and looking at the wrong thing. This indicates a propensity to attach names that is more sensitive than traditional behaviourist training schedules would suggest. Finally, this model does not make the claim that this process of fixing an external referent in some way fixes the meaning of the symbol. It should not be taken to imply that this "cognitive" model is more semantically satisfying.

³ It is worth noting that Place's account of symbolic reference does not deal with many of the classic problems of reference. It would be a little harsh to pull him up on this especially as he is in the business of generating a psychologically plausible account of symbolic behaviour, not a theory of content. Furthermore, very few psycholinguists really deal with the problem of reference and semantic content and his position should be seen against this backdrop. It is also fair to say that Place was very well acquainted with the relevant linguistic and philosophical literature in this area. Indeed, Place had written much on the Picture Theory of Sentential Meaning as well as upon dispositional and relational theories of meaning. This work must be held over for subsequent discussion.

Place might object at this point. Maybe the sensitivity of learning has been underestimated in Place's model but what Bloom and Markson have shown is that infants still potentially attach vocalisations to natural signs of the symbolised thing and that this is potentially open to the stimulus equivalence account that has been put forward. This is possibly true but the missing feature of the "cognitive" work is that there is no training - a crucial aspect of stimulus equivalence class formation is that such a class only emerges as a result of training and testing, as Place (1995/6) makes clear.

THE EVOLUTION OF LANGUAGE

Problems of ontogeny aside, Place (2000a, b) has also developed an interesting model of evolutionary language origins in part based upon his argument about the relation of symbols to stimulus equivalence class formation. It could be that the emergence of symbols and stimulus equivalence was an important event in our linguistic evolution. The relation of these two "abilities" might have been one of a slow learning procedure to fix symbolic content in our ancestral past. Over time, such learning might have become radically constrained, or canalised (Ariew, 1996, 1999) by other cognitive systems leading to the fast acquisition of names that we see in modern infants. It is feasible that our empirical investigations into stimulus equivalence manage to isolate this ability in a way wholly unrepresentative of its relation to symbolic behaviour. Place tries to outline an important relationship at the same time as giving a more general account of language origins.

Place is not alone in hypothesising about the role of learning in symbol origins. Deacon (1997) has suggested that informational types below the level of symbol (i.e. icon and index; see Table 2) can be learnt through standard associative methods but that it is the realisation of relationships between indexicals that affords symbols. For Deacon symbol acquisition is very much about category learning and hierarchical reference. By Deacon's model, in a world consisting of a finite number of objects one can start to use discriminative indexicals to deal with them. However, this finite number is likely to be very large, although "chunkable" into categories. A better strategy is to realise that the indexicals are related to one another, by dint of their relationship to real categories. Once this is seen, relationships between indexicals can be symbolised (or indicated) and this allows a growth in referential capacity. Rather than learn new direct associations every time a new object is encountered the hominid can use the coded categorical knowledge it has to deal with the object and symbolise it. This is the process that Deacon argues occurred during the evolution of symbolic behaviour.

It is not at all clear exactly how Deacon envisages this transition to symbolising, but what is of interest is his key concern to model hierarchical structure. It may well be that the indexical relationships that Deacon sees as coordinated by a symbol system are the same order of natural sign relationships that Place sees as involved in the contentful stimulus equivalence classes that symbols depend upon.

Place's work on the origin of language could be seen as making the error that we highlighted earlier. If symbols are to fix their meaning through a stimulus equivalence class that contains a natural sign of the referent then we

still have the same issues of abstract reference to deal with. However, we would caution that we are not asking for an explanation of word learning in extant *Homo sapiens* but rather for an account of how rudimentary symbol or proto-word learning could ever have emerged. It is legitimate to expect that ancestral hominids only began naming concrete items and that the subsequent move to abstract terminology awaited later cognitive developments. The comparative evidence seen in the chimp language projects of Sue Savage-Rumbaugh (Savage-Rumbaugh et al, 1993) suggests that our ancestors at least had the ability to learn symbols for concrete objects after diverging from our common ancestor with chimps some 5 - 6 million years ago. We need an explanation of why they did so.

GESTURAL THEORIES OF LANGUAGE ORIGIN

Place laid out his theory of language origins in a target article in *Psychology* in early 2000, entitled *The Role of the Hand in the Evolution of Language*. This paper had been previously presented as a poster to the Evolution of Language conference in London in 1998. Place's theory can be very simply stated as one of gestural communication preceding verbal communication. As such Place's theory is not unusual for there are a number of modern gestural theories of language origin in circulation (cf. Armstrong, Stokoe and Wilcox, 1995; Corballis, 1991; Donald, 1998; Hewes, 1976, 1977; Noble and Davidson, 1996; Place, 2000). Such theoretical speculation has a lengthy history as Hewes (1977) makes clear in his overview of language origin theories in general. He suggests that the earliest fully formulated gestural theory of language origin was that of Condillac in 1746. Condillac hypothesised that two children isolated together would be able to invent a "language of action", by which he meant "gestures, facial expression, body movement, and inarticulate speech, which only later on would be transformed into speech" (Hewes, 1977:10).

Condillac's speculation prefigured much of the modern argument with this imaginary ontogenetic speculation, as well as the evidence it usually draws upon. This evidence shall be outlined below. Place (2000a) used all of the following four forms of evidence to ground his theory of gestural language origins.

- American and British Sign Languages (ASL and BSL respectively) – these languages are regarded as full natural languages. As with spoken languages they have symbols, syntax and even a form of phonology (Armstrong et al, 1995).
- Home-signing – this refers to the sign languages invented in some special instances by children who have had no input in terms of trained signing. Such evidence indicates a certain readiness to adopt a manual modality when the vocal one has failed – in Pinker's (1994) terms it is also indicative of an instinct to create or invent a specific language. As with ASL and BSL, home signing displays all the qualities of full, natural spoken language (cf. Hewes, 1976; Goldin-Meadow, 1993)
- The role of pointing (or deixis) in the normal acquisition of names – the argument that is made by many researchers is that this form of ostensive gesture is a "kind of guidance at a distance", functioning initially

- The supporting role of gesture during speech – it is a commonly made observation that people gesture almost continuously whilst speaking. Some of this gesturing may be deictic, and some of it may be more iconic or figurative. For example, one often observes a lecturer apparently placing parts of a larger argument in relative space to one another when addressing an audience. This is done by whole arm and hand gestures that mimic placing an object whilst speaking about one thing, then turning slightly and performing the same action in a different part of space and saying something different but related. In this way two parts of an argument can be shown as opposed, as taking up different positions. This carves out conceptual space for the audience in a similar fashion to a spider diagram. Such iconic and figurative gesturing also occurs when people speak on the telephone, or to themselves. That no audience is present to appreciate these gestures indicates a fairly instinctive drive to use gesture.

It is worth noting that none of the evidence listed above commits us to the notion of (manual) gestural languages as more primitive, or of more ancient origin than spoken languages – yet this does seem to be the tacit assumption in many theories. In part this assumption is founded upon the ontogenetic primacy of deixis as well as upon the fact that gesture often helps when spoken communication fails, thereby indicating a potentially more primitive system. This is the assumption that Place makes. Most people have had the experience of being abroad and wildly gesticulating when the phrase book fails them in a restaurant.

We shall now give a brief overview of some of the theories of gestural origins and show how Place relates to them.

Noble and Davidson (1996) have provided an account of language origins in their book *Human Evolution, Language and Mind*. In this book they argue that language is a symbolic behaviour that, once in place, enabled the onset of other symbolic behaviours such as the generation of art. Through an analysis of the archaeological record they suggest that language could not have arisen any earlier than 100,000 years ago. The most interesting proposal that they make is that the origins of symbolising might reside in deixis or pointing gestures that provide simple reference. The direct and extensive pointing that *Homo sapiens* engage in is not seen in other species, however, Noble and Davidson outline some evidence that infant pygmy chimpanzees engage in this behaviour. Also, some lab-based experiments with adult pygmy chimpanzees have managed to get them to point at objects in a referential manner (see also Leavens and Hopkins, 1998). Given this evidence Noble and Davidson suggest that ancestral hominids may well have pointed systematically at some stage prior to linguistic behaviour. Following from this idea they further suggest:

The refinement of control of the forelimbs allows for the possibility of their controlled movement in following the path of a prey or predator animal; it also allows for the possibility of making gestures that distinguish prey from predator... (L)eaving the trace of such a gesture in a persistent form creates

a meaningful object for perception. The trace of the gesture is meaningful because of the salient links among the gesture, the object that provoked it and the communicators. It is in this complex of behaviours and their products that we see the prospects for the sign itself (the trace of the gesture, hence the gesture itself) to become noticed, as against being simply the means for drawing attention to something else... Thus are symbols born. (1996: 6 - 7)

From the first part of the quotation one can see that Noble and Davidson suspect pointing may initially arise from the aiming and throwing of projectiles at prey. Such an action would become refined in terms of motor control, and may also be used in display of intention. From this we begin to get some form of gestural system of pointing that might then become liberated in the manner in which the authors suggest.

As with many other theorists Noble and Davidson postulate that the kind of call system we see in vervet monkeys (Cheney and Seyfarth, 1985, 1988) may also mark the beginnings of a vocal symbol system that possibly operated in tandem with the gestural one. This is a specific proposal about possible cognitive mechanisms and one that they base on a Peircean taxonomy of signs, indexicals and symbols. Their assumption is that the evolution of symbols had to follow a Peircean path from vervet-like signals through to words. None the less, Noble and Davidson only offer this as a "chain of carefully constrained speculation" (p.6) and state that they have no idea how this might have happened prehistorically.

Corballis (1991) discusses the role of pointing in more detail, thus filling out the cautious speculation of Noble and Davidson. In line with Greenfield (1991), Corballis suggests that language was initially gestural, perhaps beginning with pointing and demonstrations of tool making. Critically Corballis sees the need to communicate complex ideas as a result of increased social complexity. Such gestures would take the form of imperative, indicative or propositional "utterances" rather than affective communication. Corballis argues that this is to be contrasted with early vocalisations that were undoubtedly emotional expressions – such as the warning signals we see in vervets now. None the less, Corballis recognises that at some point hominid communication adopted the vocal channel and he hypothesises that vocalisations may have begun to accompany gestures and then eventually gestures became superficial.

Gestural communication as it is practised now during speech is not limited to deixis alone. As was indicated above in the lecturing example there is an element of mimicry of actions, a more descriptive aspect to gesturing. That this still accompanies modern day language use is of interest and its utility can be readily appreciated when we attempt to define a term such as "spiral" to someone⁴. One cannot help but produce a spiral-like gesture that is worth a thousand adjectives at least.

Armstrong, Stokoe and Wilcox (1995) have presented a gestural origin theory of their own. What is of most interest is their working definition of gesture, which they borrow from Studdert-Kennedy:

⁴ This is a common example in the literature.

a functional unit, an equivalence class of co-ordinated movements that achieve some end. (p. 46)

Armstrong et al go on to argue that a symbolic gesture has bipolar status. One pole of the symbolic gesture is the conceptual structure that gives meaning to the symbol. The other pole is the substantive content of the symbol, by which we mean the idiosyncratic shape of the signed symbol that allows it to be shared. It is these two poles that afford communication – upon perceiving a substantive gesture one can “switch on” the appropriate concept, and vice versa such that a concept can be communicated by you with an appropriate substantive gesture. This is the property of symmetry that we have already discussed.

It is worth noting that this definition of gestures is broad. Not only does it account for manual communication but it also describes vocal communication. The neuromuscular control of tongue, diaphragm etc. is coupled with conceptual structure in vocal symbolisation in much the same way as neuromuscular control of the hands is. As such, Armstrong et al have provided a functional task description of symbolic communication that is modality neutral.

Rizzolatti and Arbib (1998) have written a paper, *Language within our grasp*, that makes a neurological argument for the relationship between gesture and language that meshes well with the definition of Armstrong et al. They have noted that in monkeys specific neurones, termed mirror neurones, are fired both when the monkey manipulates an object and when it observes a human experimenter doing the same thing. These neurones are situated in the rostral area of the ventral premotor cortex. Rizzolatti and Arbib cite scanning experiments with humans that suggest a similar functional system that includes Broca’s area – an area specifically involved in language production.

The specific proposal that Rizzolatti and Arbib make is that this “observation/execution matching” system “provides a necessary bridge from ‘doing’ to ‘communicating’, as the link between actor and observer becomes a link between the sender and the receiver of each message” (1998:188). They go on to cite Liberman:

In all communication, sender and receiver must be bound by a common understanding about what counts; what counts for the sender must count for the receiver, else communication does not occur. Moreover the processes of production and perception must somehow be linked; their representation must, at some point, be the same. (Liberman cited in Rizzolatti and Arbib, 1998:188)

Rizzolatti and Arbib point out that although this quotation from Liberman is about explicit, intentional communication it equally applies to the ability to understand various actions – such as when one individual is attacking another, and possibly may aid in mimicking and understanding tool use and production as mentioned above. This system, then, could potentially provide the link between action and gesture that Noble and Davidson have argued for. Watching and understanding an action performed by a conspecific would be possible, and watching a refined version of the action might enable the

direction of attention. The fact that such a system in humans involves Broca's area is a tantalising hint at the phylogenetic underpinnings of language⁵.

PLACE'S GESTURAL THEORY

The preceding section outlined some key gestural theories and the assumptions upon which they are based. As we noted Place used many of these same assumptions to ground his theory. It is now time to briefly outline his proposed transition from gesture to language.

Place suggests the following hypothetical transitions:

1. Using the mirror neurone argument of Rizzolatti and Arbib, Place argues that the first stage in language origins will have been one of iconic miming (cf. Donald, 1998)⁶. This will have possibly arisen in the context of tool use where imitation of another will have led to miming in order to direct the action of another. Mirror neurone systems might have co-ordinated this. There is a slightly pedagogical element to this stage.

2. A language of gesture will have arisen next. By this Place meant a system of gestural communication using sentence-like formulations. This is not dissimilar to Corballis's speculations about imperative, indicative and propositional gestural communication that was outlined above. Place sees this as emerging from a system of complex deictic communication consisting of pointing at objects, agents and "final destinations". This would have gradually developed into a more stylised form of communication. Place makes reference to Noble's and Davidson's projectile scenario as a possible initial forum for this activity. Place notes that the trouble with this system is that to some extent it is initially dependent upon things that are "indexically present" - no future or past tense communication is to be had however refined the deixis.

3. Place sees the solution to the limitation of indexical communication as the addition of vocal gestures. Place argues that early vocalisations (which were dependent upon key physiological changes that Place only briefly mentions) would have been imitations of animal calls. There is little support for this specific vocalisation hypothesis but it is undoubtedly the case that vocalisations would allow for the displaced reference that is typical of language and removes us from the constraints of purely indexical communication⁷. But one must be cautious of this type of argument, as it is really only a restatement of our initial functional definitions of language and specifically symbolic communication. Also, we know that most (but not all) human languages are vocal (Locke, 1998) which requires any theory of gestural origin to at some point suggest the

⁵ Armstrong et al cite work by David Perrett that has also found specific cells for specific gestures in the superior temporal sulcus of Macaque monkeys. They draw similar conclusions to Rizzolatti and Arbib.

⁶ Iconic is used here in the same way as in Deacon's (1997) taxonomy of information (see Table 2). Thus a gesture is iconic if it is similar to the object or action that it represents - again the example of describing a spiral with a motion of the hand is appropriate here.

⁷ Note that thus far we are not discussing symbolic communication - despite the potential for displacement. Symmetry and arbitrariness have to be in place too.

transition from pure gestural to predominantly vocal communication. This transition, if indeed it did occur at all, would have to be well motivated - i.e. it requires a specific functional and selective hypothesis. As such this is possibly the weakest link in Place's argument as he is merely asserting a transition at what is a point of limitation for gestural communication theories - not an actual ecological point in any phylogenetic scenario.

4. Place hypothesises that the ability to count beyond ten (i.e. beyond the limit of numerical iconicity imposed by the digits of the hands) might indicate the first transition to symbolic behaviour. The argument is not clearly explicated but we think that Place had in mind the notion of symbolic place markers for each set of ten objects counted.

5. Arbitrary symbols - or names - were the next development. At this point Place lays claim to an unspecified mutation that would be necessary to explain the spontaneous ability evident in infants (at around 18 months) to rapidly acquire names. As Place admits some chimps can be laboriously trained to learn visual symbols and associate them with vocalisations and objects, but infant humans do not receive this training. As discussed in the introduction this is something that Chomsky criticised Skinner for overlooking in his theory. Place invokes stimulus equivalence at this point and argues that his putative mutation afforded the ability to form stimulus equivalence classes in modern humans. Once this ability was instantiated then the attachment of arbitrary vocal symbols to objects, events and states of affairs would be very easy. We shall come back to this point below.

Stages 6 and 7 see the onset of sentential speech and full syntax. These aspects are not the core focus of this paper, so we shall save discussion of them for a later date. Instead we should like to make a few points about the symbol argument of stage 5.

From Place's (1995/6) argument about the role of stimulus equivalence class formation in symbolic behaviour we have a model for the fixing of content or meaning of a symbol. As a symbol has to be arbitrarily and symmetrically related to its referent, and it has to mean something, a symbol cannot be a symbol without an attendant stimulus equivalence class (containing at least one natural sign of the presence of its referent). As part of such a class the symbol is symmetrically related to its referent, and the nature of this relation is arbitrary by dint of social convention attaching an unrelated sound to the referent. If we put to one side the issues of abstract symbols and other problems of reference, this all seems quite neat and tidy. However, it is not at all clear how this would explain the "naming explosion" or fast mapping which Place claims it does in his fifth stage.

Place's claim is not too strong - he argues that there is a concurrent development of the ability to form stimulus equivalence classes and the ability to rapidly learn words. This he contrasts with language trained chimps that can deliver telegraphic proto-language to a limited degree, but cannot form stimulus equivalence classes. To some extent this is an argument of least resistance - here is an ability that Place has neatly tied to symbols and that is missing in our symbolically challenged cousin species. Surely this is the key ingredient that explains our linguistic success? However, there are numerous potential candidates that could have been suggested as the critical feature or set

of features. For instance, the increase in cortical tissue in anatomically modern humans and therefore an increase association cortex; or specific social pressures affecting the order of straightforwardly learnt signalling systems (T.E. Dickins, 2000a, b); or the onset of more general meta-representational cognitive abilities (Suddendorf, 1999); or the rise of shared attention (Baron-Cohen, 1995, 1999; Brinck, 2000) etc. Whatever model we pursue, what is clear is that as stimulus equivalence class formation is dependent upon a reasonably lengthy training schedule and, as full equivalence only emerges through testing, this is unlikely to be the mechanism that explains fast mapping. The only way that stimulus equivalence class formation could be involved is if we learn that the ability to form such classes is actually mediated by a form of algorithm. If this is so then it is a moot point whether we have learnt something about a separate but related system to symbols that allows the formation of stimulus equivalence classes, or whether we have learnt something about how we symbolise.

CONCLUSION

This last argument does not undermine a role for simple learning in symbol origins or acquisition, it merely casts doubt upon a role for stimulus equivalence. Recently Hurford (1989) and Oliphant (1996, 1997) have shown that simple learning can be modelled in populations on connectionist architectures and lead to the emergence of symmetrical symbols - what Hurford refers to as a Saussurean Sign. Where Hurford (1989) speculated about an inner representation, albeit a learnt one, co-ordinating transmission and receiving behaviour to afford symmetry, Oliphant (1997) has shown how a modified Hebbian learning procedure can lead very neatly to a population that communicates efficiently and symbolically, learning from each other by observation, but not pure imitation.

We do not have the space to discuss this work in any detail but the key point is that this order of modelling has not relied on a classical computational architecture of implicit rules. If we were to look again at Place's argument of least resistance, and possibly Deacon's categorical speculations we could argue that simple associative learning is enough to get to symbolic behaviour. This may be through lengthy learning trials (as we see in chimps) but as the ability to do this became more marked in individual ancestors (perhaps through some order of Baldwinian selection) this facility might look more and more like stimulus equivalence class formation.

This last remark is loose and requires conceptual and empirical work to make certain of our species specific equivalence abilities and the age at which we can form equivalence classes, but it is a speculation that could not have been had without Ullin Place's thoughtful contribution.

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RUNNING HEAD

Symbols and Stimulus Equivalence