Immune cognition and culture: implications for the AIDS vaccine

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June, 2001

We examine the implications of IR Cohen's 'cognitive principle' address of the immune system [1-3] for the HIV vaccine program. This approach takes on a special importance in the context of recent work by Nisbett et al. [4] showing clearly that central nervous system (CNS) cognition is fundamentally different for populations having different cultural systems, and in the context of a growing body of evolutionary anthropology which suggests that such effects are inevitable, since culture is as much a part of human biology 'as the enamel on our teeth'.

The current vision of human biology among evolutionary anthropologists is summarized by Durham [5] as follows:

> "...[G]enes and culture constitute two distinct but interacting systems of inheritance within human populations... [and] information of both kinds has influence, actual or potential, over ... behaviors [which] creates a real and unambiguous symmetry between genes and phenotypes on the one hand, and culture and phenotypes on the other...
>
> [G]enes and culture are best represented as two parallel lines or 'tracks' of hereditary influence on phenotypes..."

With regard to the melding of genes and culture, over hominid evolution, genes came to encode for increasing hypersociality, learning, and language

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skills, so the complex cultural structures which better aid in buffering the local environment became widespread in successful populations [6].

Every successful human population seems to have a core of tool usage, sophisticated language, oral tradition, mythology and music, focused on relatively small family/extended family groupings of various forms. More complex social structures are build on the periphery of this basic genetic/cultural object [7].

At the level of the individual human, the genetic-cultural object appears to be mediated by what evolutionary psychologists postulate are cognitive modules within the human mind [8]. Each module was shaped by natural selection in response to specific environmental and social conundrums Pleistocene hunter-gatherers faced. One set of such domain-specific cognitive adaptations addresses problems of social interchange [9]. The human species' very identity may rest, in part, on its unique evolved capacities for social mediation and cultural transmission, hence Robert Boyd's [7] remark that culture is as much a part of human biology as the enamel on our teeth.

Indeed, a brain-and-culture condensation has been adopted as a kind of new orthodoxy in recent studies of human cognition. For example Nisbett et al. [4] review an extensive literature on empirical studies of basic cognitive differences between individuals raised in what they call 'East Asian' and 'Western' cultural heritages. They view Western-based pattern cognition as 'analytic' and East-Asian as 'holistic.' Nisbett et al. [4] find that

1. Social organization directs attention to some aspects of the perceptual field at the expense of others.

2. What is attended to influences metaphysics.

3. Metaphysics guides tacit epistemology, that is, beliefs about the nature of the world and causality.

4. Epistemology dictates the development and application of some cognitive processes at the expense of others.

5. Social organization can directly affect the plausibility of metaphysical assumptions, such as whether causality should be regarded as residing in the field vs. in the object.

6. Social organization and social practices can directly influence the development and use of cognitive processes such as dialectical vs. logical ones.

Nisbett et al. [4] conclude that tools of thought embody a culture's intellectual history, that tools have theories build into them, and that users accept these theories, albeit unknowingly, when they use these tools.

We may assume, then, the existence of gene-culture and brain-culture

condensations.

Recently Atlan and IR Cohen [3] have proposed an information-theoretic adaptation of IR Cohen's [1, 2] 'cognitive principle' model of immune function and process, a paradigm incorporating pattern recognition behaviors analogous to those of the central nervous system.

We paraphrase Atlan and Cohen's [3] description of immune system cognitive pattern recognition-and-response behavior as follows:

The meaning of an antigen can be reduced to the type of response the antigen generates. That is, the meaning of an antigen is functionally defined by the response of the immune system. The meaning of an antigen to the system is discernible in the type of immune response produced, not merely whether or not the antigen is perceived by the receptor repertoire. Because the meaning is defined by the type of response there is indeed a response repertoire and not only a receptor repertoire.

To account for immune interpretation IR Cohen [1] has proposed a cognitive paradigm for the immune system. The immune system can respond to a given antigen in various ways, it has 'options.' Thus the particular response we observe is the outcome of internal processes of weighing and integrating information about the antigen.

In contrast to Burnet's view of the immune response as a simple reflex, it is seen to exercise cognition by the interpolation of a level of information processing between the antigen stimulus and the immune response. A cognitive immune system organizes the information borne by the antigen stimulus within a given context and creates a format suitable for internal processing; the antigen and its context are transcribed internally into the 'chemical language' of the immune system.

IR Cohen's cognitive paradigm suggests a language metaphor to describe immune communication by a string of chemical signals. This metaphor is apt because the human and immune languages can be seen to manifest several similarities such as syntax and abstraction. Syntax, for example, enhances both linguistic and immune meaning.

Although individual words and even letters can have their own meanings, an unconnected subject or an unconnected predicate will tend to mean less than does the sentence generated by their connection.

The immune system, in Atlan and Cohen's view, creates a 'language' by linking two ontogenetically different classes of molecules in a syntactical fashion. One class of molecules are the T and B cell receptors for antigens. These molecules are not inherited, but are somatically generated in each

individual. The other class of molecules responsible for internal information processing is encoded in the individual's germline.

Meaning, the chosen type of immune response, is the outcome of the concrete connection between the antigen subject and the germline predicate signals.

The transcription of the antigens into processed peptides embedded in a context of germline ancillary signals constitutes the functional 'language' of the immune system. Despite the logic of clonal selection, the immune system does not respond to antigens as they are, but to abstractions of antigens-in-context.

It is possible to give Atlan and Cohen's language metaphor of meaning-from-response a precise information-theoretic characterization, and to place that characterization within a context of recent developments which propose the 'coevolutionary' mutual entrainment – in a large sense – of different information sources to create larger metalanguages containing the original as subdialects [10-17]. This work also permits treating gene-culture and brain-culture condensations using a similar, unified, conceptual framework of information source 'coevolutionary condensation'. Cohen's immune cognition model suggests, then, the possibility that human culture and the human immune system may be jointly convoluted: That is, there would appear to be, in the sense of the gene-culture and brain-culture condensations of the previous section, an immune-culture condensation as well.

Malaria, tuberculosis and HIV share the distinction of having no effective available vaccines or vaccine strategies. The evolutionary anthropologists' vision of the world, as we have interpreted it, sees language, culture, gene pool, and individual CNS and immune cognition as intrinsically melded and synergistic. We propose, then, that where the smallpox vaccine model fails, culture and immune cognition may become a joint entity in determining the kind of vaccine strategy which may be effective, 'confounded' by the distinct population genetics associated with linguistic and cultural isolation.

Africa, as the human homeland, contains the greatest known linguistic, cultural, and indeed genetic, diversity. This suggests the probable need for severe local refining and monitoring of any vaccine strategy in Africa, and implies that traditional 'case-control' studies of vaccine strategies may be profoundly affected by linguistic and cultural differences, as convoluted with the associated genetic divergence.

In sum, population differences of immune function heretofore attributed to genetic factors alone may, rather, represent differences in immune cog-

nition driven by profound cultural differences. This would, in our view, particularly affect development of vaccine strategies for culturally diverse populations where the smallpox model fails.

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