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An Information Processing View of Fringe Consciousness

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In posing the sense of 'Rightness' as a quality-of-processing measure, Mangan runs the risk of a homuncular argument, since some process needs to observe Rightness, as well as the sensory qualia. Interacting Cognitive Subsystems (ICS) is an information processing account of cognitive activity that is concordant with Mangan's arguments, but which avoids the need for any supervisory system or central executive. The approach models thought as the flow of information between nine different levels of mental representation, and includes a distinction between an unselective diffuse awareness of all active levels of representation, and a selective focal awareness of a single topic of processing. A distinction is introduced between two non-sensory representations: propositional and implicational meaning. While the propositional representations can be easily verbalised, the sensory and implicational representations can only be verbalised via propositional representations. All representations are accessible, although implications and sensory representations are harder to express verbally. As a principled model, ICS can be mapped into anatomical and neural models, supporting argumentation about physical pathways in the brain and functional pathways in the mind.

1. Introduction

In his paper on the non-sensory fringe of consciousness, Mangan set himself three aims: to establish that non-sensory experiences are a basic part of conscious contents; to identify the cognitive functions that these experiences support; and to argue that their operations are shaped by the limited capacity of consciousness. His argument is that non-sensory experiences support a sense of Rightness that indicates a concordance between conscious contents and nonconscious context, which is where the real work of cognitive processing is happening, as a sort of consciousness parity check: when conscious thoughts feel Right, then they are in tune with processing. In proposing this role for Rightness, though, he risks the circularity of a homuncular argument, for if the sense of Rightness is to be sensed or evaluated or felt, some other process must be assessing it. Some form of central executive is implied which notes any sense of unRightness and takes compensating action to alter the course of processing.

Mangan's aims are timely, for non-sensory experiences are a neglected but clearly essential component of thought. The areas of the cortex that deal with sensory input and motor output are conveniently ordered and hence locatable by neuroimaging, but the 'higher order' properties of thought that are by far the more distinctive features of our minds seem to be more diffuse. They risk marginalisation as funding directs resources towards the localisation of tractable sensory experiences. Mangan argues that non-sensory experiences form a fringe to consciousness that resists introspection, and which is of wide scope but low resolution, and hence difficult to articulate, or reason about. While I agree with his emphasis on non-sensory experiences, I personally feel that it doesn't take much introspection to realise that behind the 'inner voice' with which we rehearse our verbal arguments, and behind the 'inner eye' with which we sketch out visuospatial images, lie trains of thought which race ahead of and around the more linear, quasi-sensory images, although they seem to be harder to elucidate than imagery. In accepting Mangan's general argument that Rightness reflects a coherence in cognitive activity, I argue that there is an information processing perspective that may help to delineate the different natures of sensory, peripheral-sensory and non-sensory experiences. It may help to answer the issue of how the Rightness is sensed, avoiding the circularity problem, and explain why certain aspects of non-sensory awareness are difficult to put into words, while still being very accessible and clear.

2. Two Routes to Meaning

The approach is Barnard's Interacting Cognitive Subsystems (ICS). This is a representational theory of mind in which processing is data driven, but where the origin of data can be internal to the mind as well as external. It relates to Mangan's aims in that it includes a differentiation between parallel, diffuse and serial, focal awareness, based in different modes of information processing. The content of both types of awareness can include any of nine different levels of mental representation, only three of which are sensory. In particular, there is a distinction between the *propositional* and *implicational* representations of meaning, which arose from Barnard's early, psycholinguistic research (Barnard, 1985). He was seeking an account of the tendency people had to fill in the gaps in narratives in particular, sensible ways. When shown the sentences 'Alan dropped the vase; Hilary fetched the broom' people would on a later test answer the question 'Who broke the vase?' with 'Alan', even though this was not stated, and in fact that it had not been stated that any vases were actually broken. This implication had been drawn from the propositions that had been heard. No such implications would have been drawn from the sentences 'Alan dropped the broom; Hilary fetched the vase' even though they contain exactly the same terms, albeit differently ordered.

Implications, Barnard reasoned, were a different sort of knowledge from propositions, although they could be used to derive new propositions. They represented higher order patterns of knowledge about situations and contexts. Both levels of representation needed to be included to understand linguistic inference. Mangan's kite-flying paragraph, in which the sentences all make propositional sense and yet without the context make no implicational sense, is a good example of the need for schematic knowledge to support inferential bridging between propositions. Creating the correct implicational schema (whether by being given the proposition 'kite' or inferring it oneself) seems to correspond to the moment at which Mangan's Rightness is sensed. In what follows, I will argue that Barnard's implicational representations may provide a processing home for the sense of Rightness. To understand the nature of non-sensory awareness, it is first necessary to explain a little more of the ICS account of cognition.

To understand spoken speech, Barnard added a sensory *acoustic* level of representation, and an abstract perceptual *morphonolexical* level to represent sound structures such as phonemes. To allow the model to speak, he added an effector level of *articulatory* representation to produce motor output, derived from the morphonolexical level. To let it read and write, he added a parallel set of *visual*, *object* and *limb* levels of representation. Finally, to let it feel, he added a ninth level, of *body state* representations. Each of these levels of representation is operated upon by a cognitive subsystem, which contains a long-term memory, and a set of transformation processes that output different levels of representation. The overall architecture is shown in Figure 1. What makes ICS especially different to conventional stage models of cognition is the way that information flows between these levels of processing, and the self-regulating nature of this flow, avoiding the need for a central executive. While the conventional analytic routes exist from sensory, through structural to propositional and implicational levels, sensory representations can also be transformed directly into the implicational level, and hence qualitative aspects of sensation can directly influence the identification of their propositional content.

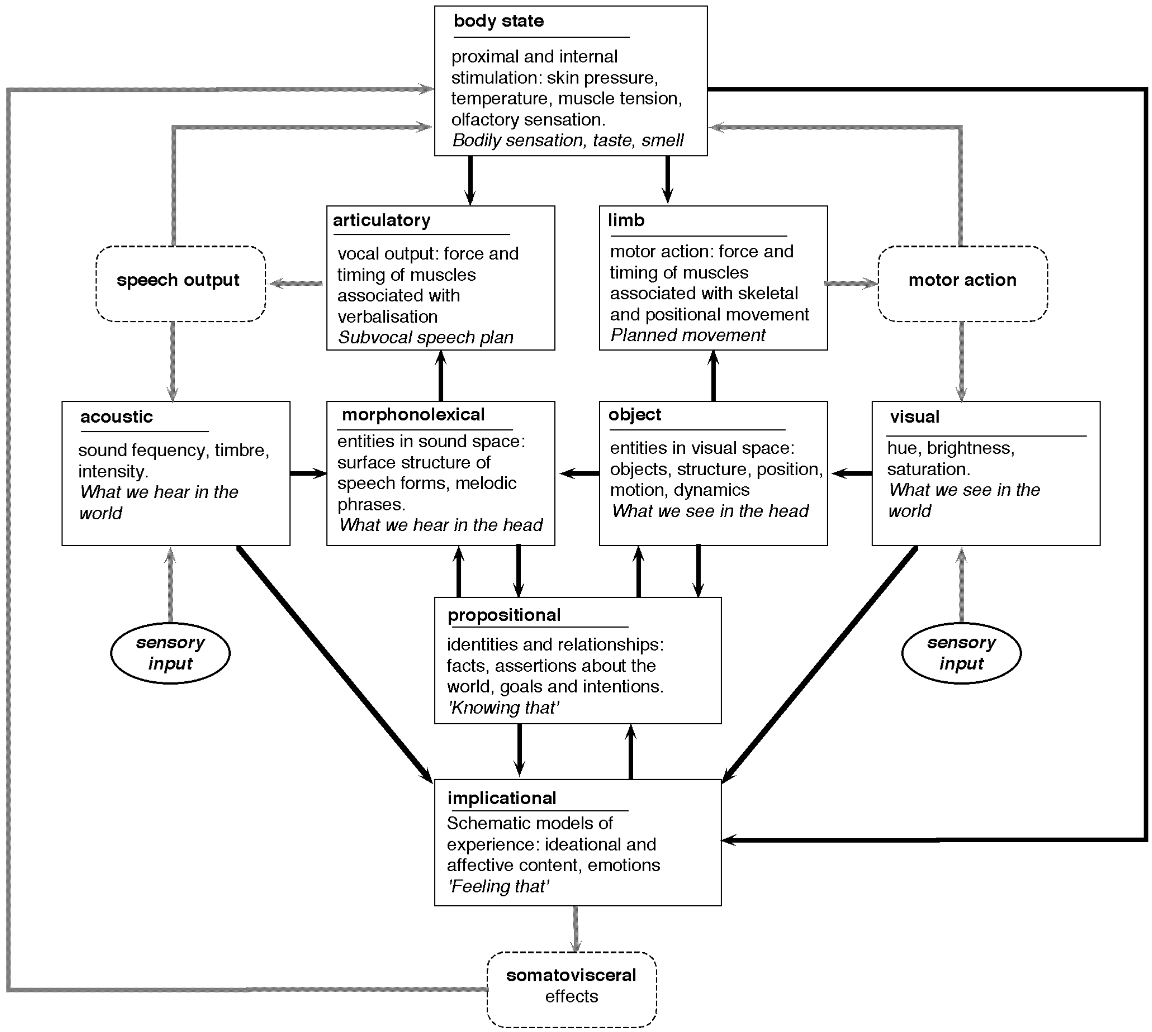

Figure 1: The nine levels of representation in ICS. Black arrows indicate transformation processes by which one representation can be used to derive another. Grey arrows and dashed boxes indicate non-cognitive aspects of the architecture.

The idea of two routes to meaning is not unique in psychology. Zajonc (1980) proposed parallel routes for affective 'preferenda' and rational 'discriminanda': the attributes of sensory patterns that respectively allowed one to say whether or not one liked something, or to discriminate and identify it. In decision making, Petty & Cacioppo's (1984) Elaboration Likelihood Model posits superficial quick and dirty 'peripheral' processing when one is in a good mood (and hence has no motivation to challenge the details of one's situation) but detailed and analytical 'central' processing when one is in a bad mood (and hence has some motivation to change one's situation). What is unique about the two routes in ICS is their appearance within a unified model of cognitive activity that seeks to account for all other patterns of processing. The model has outgrown its psycholinguistic roots. Teasdale and Barnard (1993) argue that in affective disorders such as depression and anxiety, the Implicational feeling-schemata need to be addressed, rather than Propositional factual knowledge about one's situation. The way that these two interrelating levels of meaning can carry out central executive tasks, such as generating and monitoring random number sequences, has recently been explored (Barnard, Scott & May, 2001; Scott, Barnard & May, 2001). The rather touchy-feely nature of the implicational level might also be important in understanding the nature of hunches in decision-making.

3. Two Types of Awareness

The ICS architecture is described in Teasdale & Barnard (1993), and only the aspects relevant to the awareness and accessability of conscious contents will be dealt with here. The first point to note is that the nine levels of representation mean that any chain of thought results in the simultaneous presence in the mind of several different levels of mental representation about the same thing: sensory (acoustic, visual and body state), structural (morphonolexical and object), meaningful (propositional and implicational), and effector (articulatory and limb).

A sense of diffuse awareness is associated with a process that copies each of these representations to long-term memory. Diffuse awareness is thus distributed across the whole architecture, with nine distinct qualitative aspects, one corresponding to each level of representation. This is the awareness that we have for aspects of the world that we are not currently attending to, but still nonetheless 'feel' are still there, and to which we could direct our attention if we wished. As I write this paragraph, I am diffusely aware of the sounds around me, objects in the periphery of me vision; the hardness of my seat, the temperature of the room. I am diffusely aware of the keystrokes I make, the words I am writing, and the ideas that the words express. I can focally attend to any of these modalities in turn, but when I am not attending to them, they do not cease to be accessible to me. This, I think, is what Mangan means by 'peripheral', but while the sensory levels generate 'peripheral-sensory' awareness, and the structural levels generate awareness of one's inner voice and visuospatial imagery, which one might construe as sensory (incorrectly), propositional and implicational awarenesses are clearly non-sensory. Where James writes of the 'penumbra' or 'fringe', this diffuse, non-focal awareness, distributed over many levels of representation, may be what he was identifying.

Directing our attention to some aspect of the world means bringing it into focal awareness, and this is a consequence of a particular mode of activity involving a tight coupling between processing and memory. In ICS, representations in long-term memory that match those currently being received (those in diffuse awareness) are automatically revived, becoming potentially available for transformation processes to use in place of the live representation. This allows processes to operate upon the 'best match' from memory for an incoming representation rather than to operate upon the live representation itself, which may be impoverished or ambiguous. The focus of processing is the information that is currently and recently being written to memory; that is, the source of information is an extended 'immediate present' encompassing the very recent past. This is called buffered processing, in an analogy with the way that a computer software process can write information to one end of a memory buffer while another process reads it from the other end. Because there is inevitably a very close match between the content of live representation and the revived representations in the 'buffer', the otherwise diffuse sense of awareness of this level of representation is amplified into focal awareness. Focal awareness is essentially a louder, more detailed form of diffuse awareness, with any signal contained in the representation amplified above the noise - the signal being identified by similarity with memory records.

An advantage of adopting an information processing architecture is that the principles and constraints in the model support inference about cognition and behaviour. One consequence that follows from the ICS account is that at any moment, only one level of representation can support buffered processing, and hence give rise to focal awareness. The argument is this: each level of representation has a characteristic rate of change of information, and information revived from memory will reproduce that characteristic rate of change. While transformation processes can cope with other rates of change in the live representation, buffered processing requires a synchronisation between the live representations and memory activation, and hence requires this particular rate of change in the flow of information in the overall configuration of processing over all levels of representation. If another representation were also buffered, then the rate of change in its transformed output would be locked into its own characteristic rate, and so not support buffered processing elsewhere. A representation can remain in buffered processing until its own input ceases to support the required rate of change in memory activation - perhaps because a representation that it is derived from upon also needs buffered processing. In effect, the location of buffered processing oscillates rapidly between subsystems, according to the demands of the data flow. The phenomenological consequence is of focal awareness flickering between levels of representation.

To summarise, ICS distinguishes between a continuous diffuse awareness of all representations that are being generated within the architecture, which are at several different qualitative levels, and a single, detailed focal awareness of one aspect of processing, which can oscillate between levels from moment to moment. There is a further distinction within focal awareness between the 'subject' of the representation that is the current topic of processing, and its 'predicate' structure within the same representation. This allows ICS to switch attention within as well as between representational levels. These other elements of the representation, as well as the constituent units of the subject and the superordinate chunk that the subject and its predicate belong to, form a sort of primary 'fringe' within focal awareness. They could all potentially become the next subject of processing, following an attentional transition within the representation. In the figure-ground and ambiguous figure examples that Mangan cites, the predicate consists of the aspects of a structural representation that are not being transformed into propositions. They are still part of the active structural representation, and so are in focal awareness, but their propositional interpretation is not. When the perception organisation flips to another aspect of the structure, some part of the predicate becomes the focus of processing and is used to derive propositions; the previous focus falls into the predicate.

4. Nine Flavours of Accessibility

The different qualitative natures of the nine levels of representation within ICS lead to a fractionation of the phenomenology of awareness. Buffering at a sensory level gives a rich awareness of the quality of the sensory world; at a structural level gives an awareness of the abstract perceptual content of sensation or imagery; at the propositional level gives awareness of the semantics and relationships between entities in the stream of processing; and at an implicational level gives the holistic impressions of the meaningfulness of the stream of processing. Arguably this is where ICS would place Mangan's sense of Rightness: in the random number generation studies cited earlier, it was argued that the implicational representation was acting as a monitor of consistency between planned behavioural output (i.e., the numbers being generated) and the task goals that the volunteers had inferred from the instructions they had been given. This suggests a role for implications in decision making under uncertainty: when a decision cannot be made unambiguously on the basis of propositional information, alternative possible actions can be 'considered', i.e., imagined by mental construction of a plan for their execution, and the one that generates the most complete implicational sense of Rightness is chosen. Hunches about decisions, in other words, are derived from matches between actions and an individual's implicational conception of the task (the context of the decision). The distinction between the representations that are required for generation of internal speech and overt spoken behaviour also allows us to address the issue of 'accessibility' of awareness. This is often conflated with reportability in a verbal form, in that we can have phenomenological awareness of some aspect of the world, for example the subtle variations in flavour of an expensive wine, but because we are unable to put it reliably and comfortably into words, we do not have 'access' to this experience. Similarly, Mangan argues that non-sensory fringe is of very broad scope, because it summarises all nonconscious cognitive activity, and hence of low resolution, given capacity limitations.

The ICS processing view is that the entirety of active representations are in diffuse awareness (and hence in the fringe), but that we are able to bring them in to focal awareness. Our difficulty in putting these focal experiences into words is a consequence of the absence of a direct processing route between them and the propositional level that controls verbalisation. In wine tasting, the gustatory and olfactory experience must be mediated by a transformation from the body state into an implicational representation, losing sensory detail and becoming highly schematic. These schemata may be of various forms of fruitiness or fermentation, leading to propositional accounts of gooseberries and blackcurrants, fungi and dung-heaps. The development of a wine expert's ability to produce highly differentiated and elaborate verbal taste descriptions corresponds to a strategy of buffering the implicational schema aroused by the wine, and the development of mappings from these schemas to propositions; the novice buffers the sensory representations and is able to report little more than whether they like it or not.

Auditory and visual sensations can also be verbalised only following an implicational transformation, allowing descriptions of their qualitative aspects, and hence supporting such apparently cross modal expressions such as a 'loud shirt' (where a sound based quality is attributed to a visual sensation) or a 'dark note' (where a visual quality is attributed to a sound or flavour). Hunches themselves are difficult to express because they are implications, not propositions. Implications are just as likely to become the focus of awareness as propositions, and are just as accessible, but only propositions can be directly mapped onto words. Implications and sensations can only be expressed via propositions, but while they may not be directly articulable, this does not mean that they are inarticulate. To this extent I disagree with Mangan when he writes that non-sensory experience is of low resolution; it is just that the detail that is resolved is not sensory, and so does not easily correspond to metaphors of pixels.

Mangan's examples of semantic satiation (losing meaning when a word is repeated over and over again) and the tip-of-the-tongue (TOT) phenomenon also illustrate the propositional control of speech; in these cases showing an unusual decoupling between propositional meaning and morphonolexical sound structures. When the same word is repeated exhaustively, the motor output can eventually be controlled by the articulatory representation alone, leaving no need for the meaning to be represented propositionally. The speech continues with no mental representation of its semantics. The opposite is happening in TOT: a failure in the mapping between propositional and morphonolexical levels leaves the semantic meaning intact (what the speaker wants to express) and its sound structure form absent (what they actually have to say). Brown and McNeill (1966) found that while the generation of the exact sound structure might have failed, if forced to guess at attributes of the sound structure, such as the number of syllables, or its initial letter, they will be more accurate than chance, suggesting that at least some of the morphonolexical representation is being generated, if not enough to support the derivation of the appropriate articulatory level. These two examples can be explained by the ICS architecture without needing to invoke hidden levels of cognitive monitoring.

5. Conclusion

This rapid summary of ICS and its link to awareness has not attempted to fully detail the operation of the model, but I hope that it shows that there is a principled information processing account that does support reasoning about the relationship between those aspects of our phenomenology that are internal in origin, based on ideation, and those that are external in origin, based on sensation. By distinguishing between different levels of representation and different modes of processing ICS can help to clarify the nature of experiences that are, by their nature, difficult to put into propositions and verbal sound-structures. As a principled model, ICS can also be mapped onto anatomical and neural models, supporting argumentation about physical pathways in the brain and functional pathways in the mind. Large amounts of neural metabolism associated with the memory activation supporting sensory signal detection, and in distributing motor actions to muscular assemblies, should not be allowed to blind us to the faint light of reason.

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