Main conclusions:

1. Self-touch is the primary means of establishing the self-model that, according to my web site, provides the basis of the self-referential processes that produce consciousness.

2. A crucial, but generally unrecognised, step towards the development of a consciously accessible world model is the shift of motivation from sensory satisfaction to success in achieving predicted action outcomes.

Introduction

Four early stages in the development of consciousness are identified. It is assumed that consciousness is produced by a specific type of information processing structure that operates in certain living organisms. The web site argues that this structure involves self-reference. Hence it should be possible to describe the development of human consciousness in relation to the development of the self-referential processing structure, and how this is reflected in behaviour.

It is necessary to avoid the assumption that consciousness ‘switches on’ at some specific age. Like any other biological function, conscious experience develops gradually. It also evolved gradually, so that babies’ early conscious experience is expected to be more like animal consciousness than adult human consciousness.

Self-referential processes depend upon establishing a self-model that is not itself part of the content of consciousness, but is involved in producing conscious predictions of the outcomes of possible actions. The self-model co-ordinates emotion, internal state (feelings and motivation), sensory information (including proprioception) and memory.

Given that conscious processing is set up through interaction with the environment, it is expected that there will be a simple relationship between behavioural development and the development of self-referential processing.

Each stage defines a step in self-model construction. The stages merge: they don’t have precise beginnings and endings.

Stage 1: Use of touch to distinguish ‘self’ from ‘other’

Even before birth babies use touch to explore themselves and their environment. The double sensory input provided by self-touch enables them to distinguish themselves from their environment (Samuels 1986, Rochat 2003).

Kinaesthetic information also enables them to distinguish between active touch sensations produced by their own movements and passive touch sensations not coupled with movements. As consciousness is not necessary for this process it is assumed to be pre-conscious.

Skill development

Within a few days of birth, babies show an interest in touching themselves. In particular, they explore their hands and mouths in considerable detail. These explorations are carefully carried out, and accompany the development of a range of skills relating to hand, finger, mouth and tongue movements.

By the age of one month, repetitions of self-touching activity provide the first signs of self-model construction. This begins using touch well before there is any contribution from the development of visual co-ordination, which develops too late for it to be used in making either the self-other distinction or the initial steps in self-model construction (Lewis and Brookes-Gunn 1979, Bahrick and Watson 1985, Neisser 1993, Bermúdez 1998).

Stage 2: 1-4 months: Constructing the physical self-model

Piaget (1952) observed what he called primary circular reactions: repeated actions involving self-touch that begin at about one-month. The author’s observations (reported in Page 4a of the web site) suggest that this behaviour is better described as a systematic exploration by a baby of his own body.

The self-referential structure of the primary circular reactions has the form:

If I carry out action B then outcome C will be produced.
Repetitions and slight modifications of self-touching support the development of manipulative skills and the construction of a model of the self as a physical object.

Exploring the environment
Systematic hand-mouth and hand-hand self-exploration develops around 2 months and serves to coordinate the role of hands and mouth as tools in exploring the environment by touch. The surfaces of materials and objects are carefully felt. Small objects are put into the mouth. The systematic nature of the exploration suggests that it is becoming voluntary.

At this age babies are normally kept in simple, easily recognisable environments, so that exploratory activity can provide them with information about what can be expected to happen next. This type of prediction does not involve any action on their part.

Stage 3: 4 months onwards Piaget’s secondary circular reactions mark the onset of dynamic and systematic interactions with the environment.

Piaget (1952) observed that, from about four months old, babies perform secondary circular reactions: repeating actions that involve external objects. Young babies demonstrate this behaviour if they are given access to an appropriate mechanism. Typically, the baby is enabled make a foot movement that actuates a mobile or makes a noise. Repetitions demonstrate the ability to predict action outcomes (or rewards) in a highly structured environment.

The self-referential structure of the secondary circular reactions may be expressed as:

If, in my current situation (A), I carry out action B, outcome C will be produced.

For this to be an effective procedure it is necessary that situation A be recognised, that B is part of the baby’s repertoire of possible actions and that C be regarded as a reward. The essential step forward is that external objects are now involved in the self-referential loop.

Books on developmental psychology (e.g. Shaffer 1996) suggest that babies are motivated to perform secondary circular reactions because of their ‘pleasurable’ or ‘interesting’ outcomes. While this may initially be true, it does not explain why they are alert to almost any circumstance that allows them to repeat the same outcome.

Stage 4: 6 months onwards - motivation by success
It appears that, around this age, babies become motivated by success: they seek to demonstrate, both to themselves and interested adults, their ability to produce specific effects on their physical and/or social environment. This provides them with the first indication that they have the ability to effect their physical and social environment.

This stage is also significant in that it allows the outcomes of actions to be expressed as changing the initial situation (A) to a final situation (C). Simple reasoning processes (observed from about 9 months) can now develop, comparable to those used by other great apes in using tools to achieve objectives.

Forming an external world-model
Conceptualising the outcomes of actions as changes in situation supports the development of chaining - linking successive actions together to produce an overall (predicted) change in the environment.

One consequence of ‘motivation by success’ is the formation of an external world model, in which situations that provide possibilities for effective action are sought. This model necessarily incorporates self-referential aspects that will eventually be eliminated in the (ideally) objective model of the world employed by adults.

An important consequence ‘motivation by success’ is that babies become active explorers of their environment. This becomes very apparent when they learn to walk.

Later stages
Rochat (2001) and Tomasello (1999) have identified a ‘revolution’ that takes place at around 9 months. They associate this with infants recognising that other human beings are intentional (I would say self-referential) agents. This opens the way for infants to observe and desire the skills of other agents. At the same time they are able to understand that their carers have the intention to teach.
The 9-month revolution is an important motivator of language learning - which involves the development of a wide range of skills. At first, infants regard word production as just another method of achieving a desired outcome. It then becomes an effective means of communication between infants and their carers.

As word meanings relate to a shared, or objective, model of the world, language shifts the conceptual basis of infants’ world models. This has two aspects. First their original conceptualisation of the world has to be adjusted to the constraints of language. Secondly, the (self-referential) feelings that they have come to associate with objects are not communicable. This, I suggest, is the origin of 'infant amnesia'.

This poster summarised material on Pages 4 and 4a of my 'Structure of Consciousness' web site: www.con-structure.org.uk, where the above references will be found.