Theory Building in Developmental Psychology
P.L.C. van Geert (editor)

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Developmental Contingency Modelling

A framework for discussing the processes of change and the consequence of deficiency

John Morton

This paper introduces a notation for discussing development. A Developmental Contingency Model (DCM) focusses on the representations and processes that are necessary for a particular piece of behaviour to emerge. The idea is to trace the contingencies (mostly internal) for the presence of such representations back in the developmental history of the child until we reach something that seems unlearnable. In this way we build up a list of likely candidates for innate "primitive" functions or structures. Absence of the behaviour that provided the starting point for the analysis could then be due to absence of one of the primitives.
A DCM analysis is provided of some recent work on the nature of autism. The methodology is further illustrated by considering what a child must possess in order to exhibit the "stranger reaction". The properties of the framework are discussed.

Change can arise for a number of reasons and in a number of ways. It is often helpful to draw sharp divisions between different types of change even though all individual examples of change are mixed in their origins. Thus we find it useful to contrast the innate and acquired components of knowledge, even though every act of acquisition has an innate aspect, howsoever small, and every piece of knowledge that is postulated as innate will require some learning to take place if the innate structures are to exert an influence on behaviour.

Change can also be examined at different magnifications in terms of the time scale, the domain size and the level of generality. At one extreme we can look at the microdevelopment of a particular skill in individuals. At the other extreme we

can try to set up a framework within which all change can be located and, so, contrasted. Neither of these approaches will answer all the questions we might wish to put. Clearly there is no one approach that could answer all such questions. Any particular notational device that one uses in theorising will be best suited to a particular type of question.

The specific question to be addressed here concerns contingencies in development. We commonly ask what mental elements (processes, structures, etc.) are necessary before a particular piece of behaviour will develop. Less commonly, we ask about the conditions under which the elements themselves will develop. What is missing completely is a diagrammatic representation of such questions. For people who operate as scientists in a purely verbal mode, the latter stage may seem unnecessary or even confusing. For visualisers, like the author, it is a prerequisite for constructive thought. It is the only way I can keep the complexities in simultaneous view.

The impetus for talking about and depicting developmental contingencies came from attempts to analyse the preconditions for autism. Inevitably it proved to be more general.

A STORY ABOUT AUTISM.

One day in November, 1982, Alan Leslie was talking to our in-house seminar about pretend play. The special thing about pretend play is that it cannot involve normal use of normal representations (i.e. knowledge of objects and their properties). When a 15 month old infant pretends that a banana is a telephone, the memory of that episode has to be kept separate from (or very clearly distinguished from) the representations relating to normal use of bananas and normal use of telephones. Otherwise, the properties of the banana would get mixed up with the properties of telephones and the baby could end up trying to eat the telephone, which could be confusing.

Overall, the properties of pretend play resemble the properties of mental state terms like "believe". Thus, the

following two sentences are similar in a number of repects:

1. Bill believes there is a king of France.
2. I pretend that banana is a telephone.

While asserting these two statements we can simultaneously assert:

3. There is no king of France.
4. That object is really a banana.

where "that banana" in 2 and "that object" in 4 have the same referent. The predicates in sentences 1 and 2 are protected from reality. Thus, whether or not sentence 1 is true is unaffected by the truth of sentence 3. Equally, given that we first say "I pretend", we can go on to complete the sentence with anything at all without actually coming into conflict with what we believe. On the other hand, bits of knowledge like sentence 3, facts about the Queen of England, the taste of butterscotch or the way to Burnham Market can be directly confronted by perceptual experience or by factual knowledge gained by other means. They can, that is, be falsified. Such bits of knowledge are stored in the brain in what Leslie (1986) calls first order representations.

As we have seen, the predicates of sentences 1 and 2 cannot be falsified. Now, these sentences could be descriptions of the beliefs of an individual, and what is true for the sentences is also true for the mental events that would be described by those sentences. That is to say, when we are actually pretending, we have to protect the contents of our pretence from reality. Otherwise they might be falsified and that would be the end of the pretend. Equally, we do not confuse as a matter of course what we know of other people's beliefs with what we "know" to be the case. It follows, then, that if we want to represent in our brains the belief structures of another person, we cannot use first order representations. If we did, they would be susceptible to normal confirmation procedures. We have, then, to use another form of representation that is not susceptible to confrontation perceptually or by other means. In Leslie's terminology this would be a second order representation. For such representations to be created we need some process over

and above that used for first order representations. Leslie has termed this device an "expression raiser". Its exact form is not of any concern for the current argument. What we do want to be able to do is to refer to its function of being able to create representations, or parts of representations, that are protected from the normal verification processes.

In the course of the discussion of Alan Leslie's ideas, Uta Frith remarked that autistic children were supposed not to pretend play (Sigman & Ungerer, 1981; Wing & Gould, 1979). Now, we know that one of the defining characteristics of autism is an abnormal view of other people (Frith, 1982; Kanner, 1943; Rutter, 1983). It is as if the autistic child misses something rather fundamental about humanity (Hermelin & O'Connor, 1985; Hobson, 1983, in press). Suppose, then, (the discussion continued), the problem is that autistic children lack an expression raiser and so cannot form second order representations. This would, by definition, explain their inability to pretend play. What consequences would it have for the way they view other minds? The clearest prediction was that they would be unable to attribute to anyone else a belief that was different from their own beliefs. So, they would be unable to represent the fact that Bill believed there was a King of France was bald, given that they actually knew there was no King of France.

The proposal, then, is that autistic children are unable to form second order representations. The prediction that follows, concerning the attribution of beliefs, was later tested by means of a little puppet show (derived from Wimmer & Perner, 1983) acted out in front of autistic children, normal children and children with Down's syndrome. In the story, one doll, Sally, has a marble and puts it in a basket. She then leaves. Another doll, Ann, takes the marble out of the basket and hides it in a box. Sally then comes back. At this point the child is asked, "Where will Sally look for the marble?" Normal children, aged 4, and Down's children with mental age of 6 had no trouble with the task. On the other hand, 16 out of 20 autistic children, with average mental age of about 9, were unable to do that task, responding as if Sally had the

same knowledge as themselves (Baron-Cohen et al, 1985).

WHO NEEDS A MODEL?

The theoretical task was to represent all the relevant claims in an interesting way; in a way, that is, that would help us to relate the underlying facts to other facts, in an unexpected way. The claims of interest are as follows:

c1. Pretend play requires second order representations

c2. MENTALISING - i.e. Understanding the mental states of others -
requires second order representations

c3. The creation of second order representations requires an expression raiser that acts upon first order representations

c4. Autistic children lack an expression raiser

c5. Autistic children cannot pretend play as a consequence of c1 and c4,

c6. As a consequence of c2 and c4, autistic children cannot mentalise.

Of these claims, c5 is an empirical observation, c1, 2 & 3 are theoretical claims, c4 is an interpretation of c5 in the light of c1-3, and c6 is an empirical prediction from the others. Note there are a number of optional views, in particular that there are different expression raisers for representations referred to in c1 and c2. That would be a different interpretation of c3.

The main point that we wished to express in the model is that of the contingent relationship between the existence of an expression raiser and the ability to understand the mental states of others. More specifically, we want to express our hypothesis that the absence of pretend play in the autistic infant is caused by the absence of an expression raiser and we also want to express the consequent prediction that autistic children would not be able to mentalise. This was the reason for performing the Sally/Ann experiment described above. The point that we wished to make in addition was that of a

developmental relationship. An expression raiser would have to have been present for mentalising to develop. At this instant it is irrelevant whether expression raising is learned or innate, though we cannot imagine how it might be learned. In either case it would have to exist before any pretend playing or mentalising could take place.

Autism, by the account given above, is a developmental disorder caused by the lack of an expression raiser. Since it is likely that such a statement still strikes the reader as peculiar, let me remind you that it was this hypothesis that led to the triumphant Sally/Ann experiment. However, we know that there are a lot of other things the matter with autistic people (Frith, 1982; Hermelin & O'Connor, 1970; Prior, 1979; Rutter, 1983), and many of these need to be accounted for in the model. What we need to be able to explore is whether the lack of an expression raiser would lead to such symptoms. As an example we could take a defining characteristic of autistic children, that their language development is retarded. How could this possibly be accounted for by the absence of an expression raiser? One possibility is that the key deficit is in speech production. Consider that a large proportion of early utterences on the part of children have to do with communicating to another mind reflections on the contents of their mind. Early naming, for example, seems to have this property. A child without second order representations and, so, without a concept of mind, would have far less to say than a normal child.

The form of the model also encourages us to identify the prerequisites for an expression raiser and see if the absence of one of those could lead to the other symptoms associated with autism. We must, of course, also allow for the possibility of more than one kind of autism (Coleman, 1976; Fein et al, 1985; Waterhouse et al, in press) and that autistic people, particularly subnormal ones, have other processing problems that interact with the lack of an expression raiser. We must also allow for the possibility of a redefinition which would exclude some people who would, at the moment, be classified as autistics.

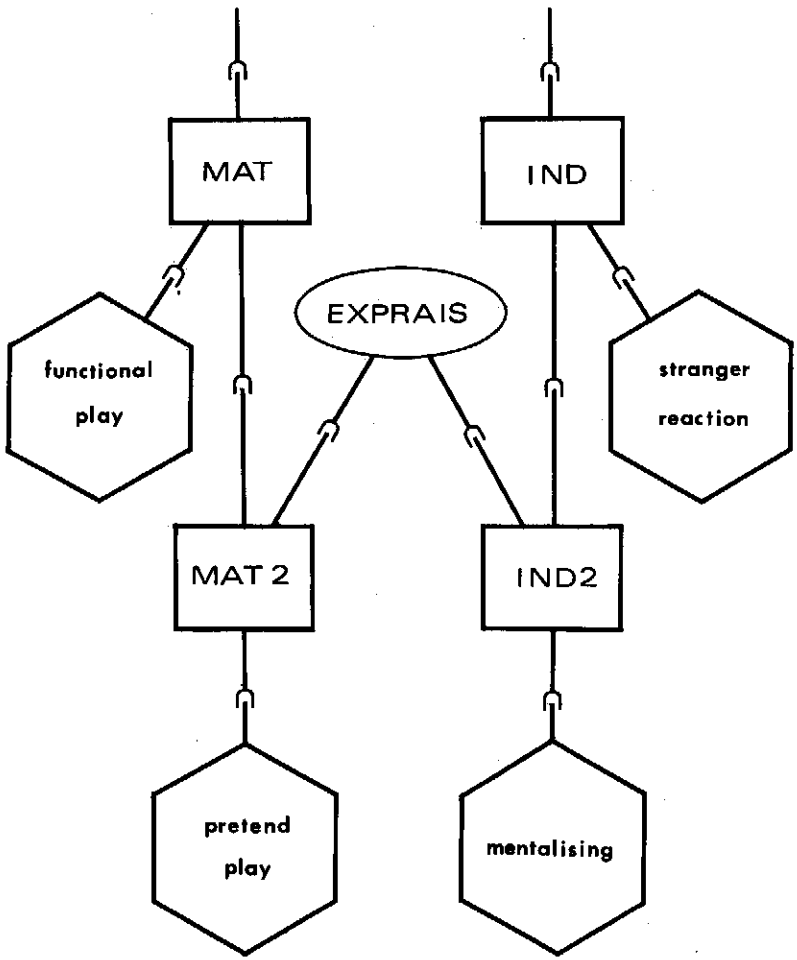
In this article we will not approach the goals just outlined very closely. However, the first step along the road is shown in Figure 1. This is a developmental contingency model and not a flow chart or an information processing model. The symbol on the lines in Figure 1 is to be read as "(normally) requires the (pre-) existence of". Thus, pairs of connected elements are related developmentally. Each such pair of elements in the figure effectively represents a hypothesis about developmental contingencies. We have choice of which elements to represent and in their relationship.

The particular form of Figure 1 was driven as follows. We (and Uta Frith in particular) wanted to separate pretend playing from mentalising. We did so by dividing representations into two kinds, one to do with things and one to do with people. Provisionally, I will call these representations Material and Individual, or MAT and IND. IND constitutes those representations that have to do with individual people. MAT is made up of all other representations. Note that this is a content division. I am not postulating the existence of two different memory stores and it would be a grave error to imagine that Figure 1 represents two or, indeed, any memory stores. In Figure 1 IND is to be understood as the ability to create representations with respect to individual people rather than as those representations. If we did produce an information processing model or an information flow diagram, we would then want to depict IND (and MAT) representations. However, Figure 1 is not, repeat not, an information processing model and it is illegitimate to read anything into the notation that has not been put there explicitly.

I will, in fact, in the text, from time to time, refer to MAT and IND as representations. When I do so I will be refering to their functions in some as yet unspecified (except Leslie, unpublished) processing model[1].

MAT and IND are first order representations. The equivalent second order representations are created by the action of the expression raiser on first order representations.

figure 1



1. A D.C.M. (Developmental Contingency Model) relating to autism. There are three kinds of elements used: representations (rectangles), behaviour (hexagons) and processes (ellipse). The relation between linked pairs of elements is that of contingency or implication. Thus, the development of pretend play is contingent on the development of a MAT2 representation which, in turn requires EXPRAIS (see the text for further explanation).

We call the resulting second order representations MAT2 and IND2. Again, it would be a grave error to imagine that we propose to divide our knowledge into four stores, two for first and two for second order representations. A single knowledge fragment, or "thinks", could include all four kinds of representation:

> Daddy is on his brown chair (which I am pretending is my space machine) and he believes I'm human.

In this fragment, the four kinds of representation are as follows:

> MAT: The chair is brown
> MAT2: the chair is a space machine (alien)
> IND: Daddy is-on-the chair
> IND2: Daddy believes I'm human

We maintain the separation between these four classes of knowledge because we believe that some people cannot create some of them and because they do not appear to develop at the same time. In Figure 1, the relationship between MAT and MAT2 should be understood as: the development of the ability to form MAT2 representations is contingent on having previously developed the ability to form MAT representations.

In Figure 1, we find the six claims made above, in a more specific form. Thus pretend play is linked to MAT2 representations and mentalising (the ability to attribute mental states) is linked to IND2 representations. The contrast is made on the one hand with ordinary play, which only requires first order MAT representations, and on the other hand with the stranger reaction which only requires first order IND representations (this will be discussed at length in the next section). If someone cannot mentalise, as with the majority of the autistic children in the Sally/Ann experiment, it is because they cannot form IND2 representations. The diagram makes it obvious that such an inability could arise for two reasons. In the first place, if the expression raiser (EXPRAIS) was missing there could be no IND2. This was our original supposition for autism. The resulting inability to mentalise would be accompanied by a lack of pretend play.

The second possibility, that we have not yet considered,

is that there could be someone with no IND representations. Such a deficit would also lead to a lack of IND2 representations. A person with this deficit would fail the Sally/Ann experiment but would be able to pretend play, so long, that is, as the expression raiser existed. This person would have other problems associated with the absence of IND representations and we would want to be able to spell these out. In such a case, the figure would also encourage us to think in terms of the prerequisites for the establishment of IND and to consider which of them might be missing in someone who lacked IND.

At this point, however, we will leave the topic of autism for a while in order to explore the properties of the methodology depicted in Figure 1. We will call the method of theorising Developmental Contingency Modelling.

DEVELOPMENTAL CONTINGENCY MODELS - THE PROPERTIES OF THE FORMALISM.

There are always hidden presuppositions or biases when one begins to theorise. Some are surprising, some are not; some have consequences, others are incidental.

The first presupposition in the DCM shown in Figure 1 is that the causes of major deficits are traceable to the absence, actual or operational, of some biological givens. Thus, the theoretical method itself would encourage one to think in terms of a biological cause for autism rather than, say, a social cause (e.g. "refrigerator mothers"). It is not that the need for a particular kind of social interaction as a prerequisite cannot be represented in a DCM, it is just that there is a bias against it.

The second presupposition is that such biological givens will be buried deep with respect to behaviour. Each one will be implicated in a wide range of activities and the absence of any one would have far-ranging consequences.

A third presupposition is that no special environmental conditions are required for the normal fruition of the givens.

That is not to say that there is no learning, simply that the learning is effort-free. The child learns about language, objects, family, causality, number and so on in an effort-free way because what is happening in the course of such learning is that the givens are being used. There is almost a teleological element about this. The processing machinery and the innate structures are constructed in the way they are in order that the goals shall always be reached. This is the achievement of evolution. The child has no choice in the matter; its "learning" is under the control of its processes. A child can choose not to speak but it cannot choose not to learn its native language. The biological givens which subsume language learning make sure of that. However, effort-free learning has its natural borders. If you get a group of children to use LOGO there are no biological guarantees of anything. Hence the need for some externally imposed structure rather than relying entirely on the hazards of discovery in the classroom.

The DCM framework is one in which the focus is on the prerequisites for the emergence of a particular process or structure. Such properties of the infant brain form "elements" in a DCM model. Note that while our direct evidence for the existence of such an element will be behavioural, our primary focus will be on the elements and not on the behaviour. There are two main reasons for this.

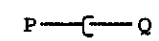
Firstly, an element may be present without being visible in behaviour. Thus, if one takes a profoundly deaf infant who is not signed to, we would want to say that the innate component of the language learning apparatus was present but not able to exert any significant influence on behaviour.

The second reason for focussing on the underlying elements rather than behaviour is that a particular piece of behaviour could be mediated by a variety of means. For example, autistic children may learn to have exchanges of utterances with adults. However, in the majority of cases, such exchanges would not, on close analysis, be confusable with the conversations that normal children have. Normally, conversations are driven by IND2 representations (among other

things) and are intrinsically "reinforcing" for normal children. The autistic child would have to learn that they were appropriate modes of behaviour. Even if they did happen to match a normal conversation in form and content, they would never have other than a utilitarian function.

In the preceding paragraphs I indicated why the focus of the DCM method is on the elements of the child's cognitive apparatus rather than on behaviour. We should now look at elements more closely. To start with, we can make the point that elements are either primitive or not. By "primitive" I mean innate and irreducible. Trivially, it must be the case either that a particular element E can only emerge given that an element D has already emerged (to some level of specification) or that E is a primitive. The development of non-primitives depends upon the prior functioning of particular primitives plus exposure to specific kinds of stimuli. Primitives require at most a minimal environment. Note that primitives need not be present from birth but could arise in the course of maturation.

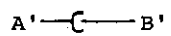
In practice there will be a variety of patterns of contingencies. Thus, one can imagine a skill whose emergence is a function of a late maturing structure but which also depends upon the prior existence of other processes or knowledge. We would want to be able to represent all such contingencies. The general form of the contingency model is that of elements connected in a directed graph. The elements can be of a variety of kinds - processes, structures, knowledge, perceptual or other experiences, or biological elements. The symbols on the connecting lines have temporal/causal implications. Roughly speaking, a dyad of the form



can be read weakly as "P emerges before Q". Where theoretical statements are being made, a stronger reading of the dyad would be required such as "P is a precondition for Q" and the strongest reading would be "P causes Q". In the case that P is a set of elements, the dyad might be interpreted as "some of P

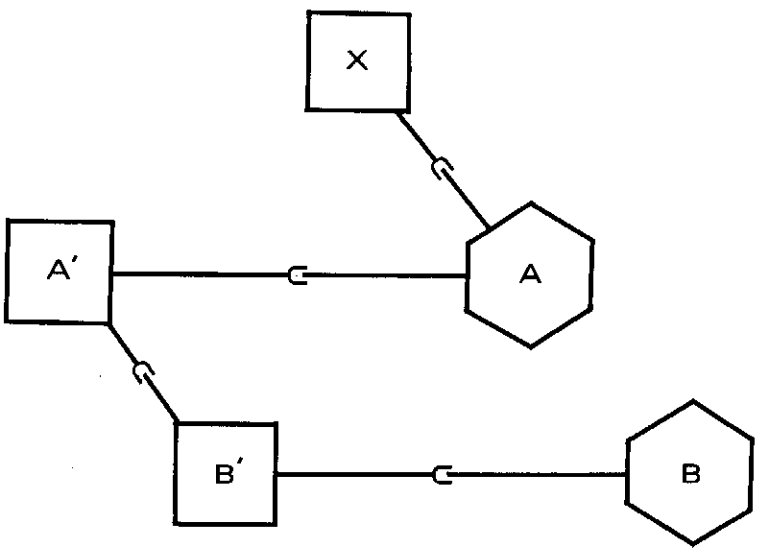
(which ones to be specified) are a precondition for Q" or "the elements in P will influence the way in which Q emerges". Which one of these interpretations is to be applied to a particular dyad will have to be understood from the context. This is a very useful property for a framework. Note that the default implication is that P is necessary for Q. There may be cases in which P is sufficient for Q but this would have to be spelled out.

The elements that can enter into a DCM have certain restrictions as to where they are allowed to occur. The most obvious ones are that a specified behaviour will rarely (if ever) be found as a precondition, equivalent to P in the diagram, that is. Thus, we will not want to say in our theories that the emergence of any particular behaviour A is a precondition for the emergence of some other behaviour B. Nor would we wish to specify in a DCM that a particular behaviour A is to be found developmentally before or after any other behaviour B. Statements of this kind will, rather, represent an important source of data that enter into the formation of a model fragment. The resulting DCM statement could take one of two forms. The first would be "a theoretical element A' is a precondition for the emergence of behaviour B", where A' is an element also underlying behaviour A. An alternative claim might be that "A' is a precondition for B'" where A' and B' are the processes, etc. underlying behaviours A and B respectively. Note that if one found a child where B was found before A, such a discovery would constitute a challenge to claims concerning the order of emergence of the behaviours, but would not by itself consitute a challenge to a theoretical claim of the form:



The defence would be that the emergence of A required another process or structure, X, to be present and it was this that was delayed. The full model would, in this case, look like Figure 2. In this DCM fragment we can see that the absence of X would hold up or prevent the emergence of behaviour A but would not affect B.

figure 2



2. Behaviours A and B are contingent on representations A' and B' respectively. B' is contingent on A' and A normally appears before B in development. If X were delayed then B could occur before A.

(While we are here we might as well remind ourselves that the presence of a behaviour B in an individual child does not necessarily require that we infer the presence of the normal underlying representation, B', in that child. There may be other data indicating the absence of B'. In such cases, the general principle of compensatory mechanisms allows us to postulate that this child performs B by different means than normal. The example of the way in which autistic children might come to carry on conversations, referred to above, is

one such case.)

The other element type we can think of as restricted is the biological type. Thus, we would not normally expect to find a biological element being dependent on the emergence of either a behaviour or a process, etc. A statement of the form "One cannot pass puberty until the twelve times table has been learned" would have a distinctly peculiar ring to it.

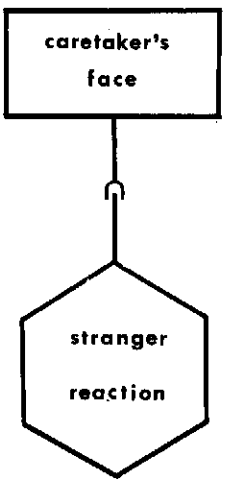
A DCM ANALYSIS OF THE STRANGER REACTION.

Having outlined some properties of a DCM we can explore the notation further. Let us take a standard piece of behaviour and look at the DCM that results. Most children, at 7 or 8 months, will, under the appropriate conditions show a fear or distress reaction to a stranger, a reaction not found prior to that age. To the caretaker, C, there will be a different response. There are many possible patterns of behaviour depending on circumstances, including the finding that the fear reaction is stronger if the caretaker is present but about four feet away than when she is absent (Bowlby, 1969; Morgan & Ricciuti, 1969). A complete discussion of the stranger reaction would include considerations of smell and touch, movement and affect. For the moment let us consider simply the situation of a child left on its own briefly and compare the reactions when either the caretaker returns or a stranger enters.

The question to be asked is what inferences can be drawn from the behaviour with respect to the representations and processes possessed by the child at that time. The first thing we can do is simplify the observation for the moment by removing from consideration the nature of the infant's response. We can bring this back later. Secondly, we will assume that the differential reactions can be found simply to faces and that the faces do not need to be attached to bodies or voices, etc. If the data turn out to be otherwise, then the inferences will have to be changed accordingly. On this basis, then, we have evidence of discrimination, from memory, of C's

face from other faces. This means that there must be a representation of C's face at some level of detail. In the DCM we turn such an inference into the claim that a prerequisite for the stranger reaction is a representation of C's face. We would diagram this, trivially, as in Figure 3. We can immediately go further.

figure 3



3. A DCM fragment representing the fact that the stranger reaction is contingent on the baby having a representation of its caretaker's face.

Since there is also a particular response to C, this response must be accessible from the representation of the face. The response is, however, only elicited under the appropriate circumstances (C having been away and currently at a distance, for example). The response cannot be directly connected to the representation of the face. Rather, (and obviously, if one were not attempting to proceed painful step at a time), the face must be connected to some individual, affect-laden, specification of C. It is natural, here, (well, for me,

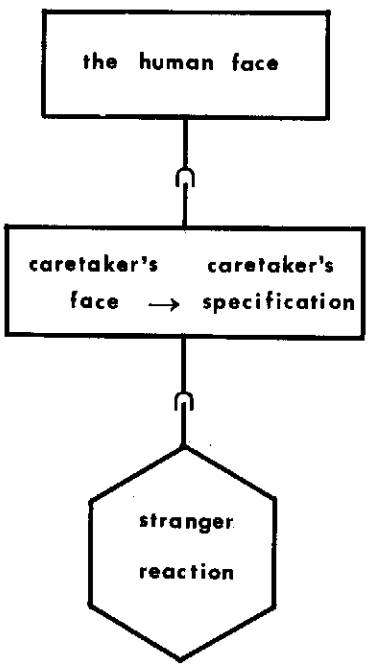
anyway!) to think in terms of a Headed Record, where one part of a memory serves as the means of access to another part (c.f. Morton et al, 1985). In this case there would be a representation of C's face in the Heading and the specification of C in the Record. Questions about the content of this Record and how it may come to be set up will be left, as will those questions relating to the nature of the infant's reaction and how this reaction follows from the content of the Record. We merely note at the moment that such questions can be posed in the context of the current framework. For the moment we are pursuing other hares.

To recap, the infant establishes a differential response to C's face with respect to other human faces. I assume that the stranger reaction would not be elicited by the face of a previously unknown stuffed animal. If this is the case, then we can advance the DCM to include a generalised representation of the human face. This is shown in Figure 4.

In effect, in this figure, we now have the hypothesis that there cannot be a representation of C's face unless there is a generalised representation of the human face. Note that this is not implied by the data we have assumed. It would be perfectly possible for a representation of C's face to be set up without there being a generalised representation of the human face but that the Stranger Reaction be dependent upon the existence of both. This would be indicated by the DCM in Figure 5. Figures 4 and 5 constitute competing theories.

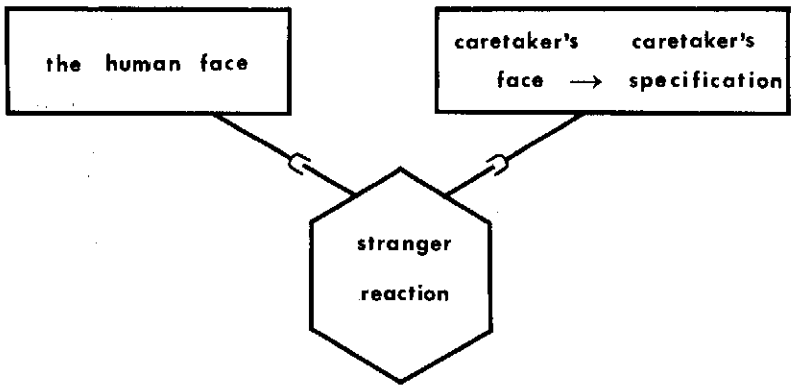
We should note here that a number of obvious things have been left out. For example, as I have already indicated, the specification of C that is found in the Record has presumably been set up previously and is also accessible by smell, and so on. There will have been a lot of experience of C by the infant in order to make such a specification possible. This experience will have been of a special kind, including feeding and other pleasurable activities. I also want to postulate that there is another element that is required.

figure 4



4. A DCM fragment representing the hypothesis that the infant must have a generalised representation of the Human Face before the crucial representation of the caretaker can be set up.

figure 5

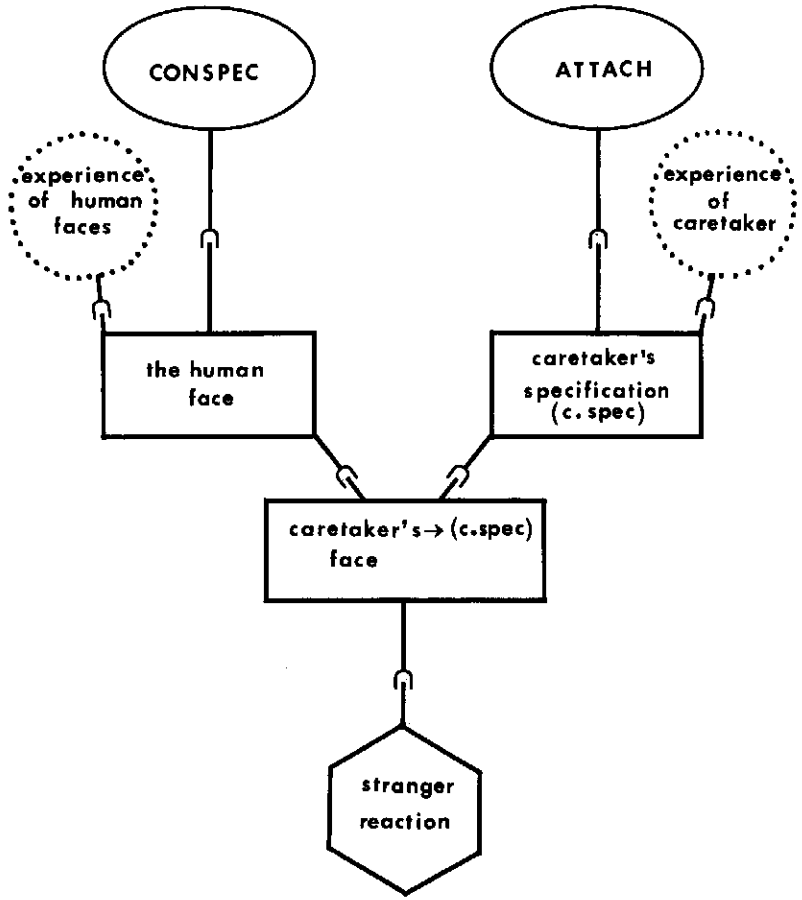


5. The DCM representation of an alternative hypothesis to that in Figure 4. In this case the proposal is that the crucial representation of the caretaker can be set up independently of that for the Human Face.

This element I will call ATTACH. It corresponds to the factors in other kinds of theories that lead to "attachment" or "bonding".

The assumption I am making at this point is that the interaction between C and the infant, while necessary, is insufficient by itself to give rise to the observed phenomena. For example, it seems to be the case that some autistic children who have had exactly the same exposure as normal children will nonetheless fail to respond in the same way, will fail to set up the special relationship with C and will not show a differential Stranger Reaction at the usual age. This shows that the "experience" is insufficient, and that some other factor is required. In Figure 6, then, ATTACH is shown as a prerequisite for the formation of a specification

figure 6



6. An expansion of the theory in Figure 4. This introduces a fourth type of element, interaction with the environment, which is indicated by the dotted circle.

of the caretaker.

This representation will be unique by virtue of the participation of ATTACH. In the model in Figure 6, there is no reason why the infant should not simultaneously set up representations containing specifications of other people.

These would not, by definition, involve ATTACH and, from the model, would be an insufficient precondition for the stranger reaction to occur. The model, then, expresses the hypothesis that the Stranger Reaction is only made once the infant has set up a specification of an individual, C, with the participation of ATTACH. Note that while it is possible that ATTACH is learned, I assume that it is a biological given, a primitive.

One of the elements of Figure 4 is the generalised representation of the human face. I assume that this is in large part learned and that a human infant who had not seen any human faces would not show a unique reaction if presented with one for the first time at the age of, say, twelve months. It is natural, in the context of a DCM, to ask whether there are any other prerequisites for learning about the human face. Certainly, it would make biological sense if human (or, in general, mammalian) young were predisposed to learn the nature of the faces of the species into which they have been born. This seems to be the case for chicks (Bolhuis et al, 1985; Johnson et al, 1985; Johnson & Horn, in press). The fact that chicks are precocial might be crucial, but we can speculate that mammals also have special ways of learning about faces. We may hypothesise that the innate contribution to this consists of a rough specification of what kind of thing a face is together with some size and distance constraints. Such a specification, possibly together with some specialised learning processes, could constitute a universal mammalian package. Be that as it may, I will term the relevant element CONSPEC and will assume that it is a primitive. This constitutes a further (falsifiable) hypothesis.

The DCM in Figure 6 summarises the discussion in this section. Some, but not all, of the prerequisites for the Stranger Reaction have been spelled out and some ancillary hypotheses have been postulated. In the course of doing this we have seen the way in which a DCM is structured and have used four kinds of elements: behaviour, experience, representations and primitives. In addition we have been able to see the need for specification of certain kinds of

processes. A number of things have still been left out, notably any account as to why fear should be expressed to a stranger and why there are individual differences in the reaction. Such considerations would involve extending the formalism and will have to await another occasion.

SOME PLAYBACK.

Developmental Contingency Modelling is an attempt to tighten and enrich our normal scientific practice. Basically, I have taken a hypothesis concerning autism that was formulated on the basis of a theory by Alan Leslie concerning the relation between pretend play and mental state terms (Leslie, in press). On this theory, both pretend play and mental state terms require the use of an "expression raiser". From the observation that autistic children are incapable of pretend play, the hypothesis was formulated that such children lack an expression raiser. If this were the case, it would follow that autistic children would also be incapable of mentalising - i.e. attributing beliefs to others. This prediction was upheld with the Sally/Ann experiment (Baron-Cohen et al., 1985).

A diagramatic representation of the above reasoning has led us in certain directions. We have been led to differentiate between two kinds of representations, one, MAT, to do with things, and the other, IND, to do with individual people. Use of an expression raiser allowed the formulation of second order representations. The hypothesis concerning autism was that autistic people, lacking an expression raiser, also lacked the ability to form second order representations. The Sally/Ann experiment was designed to test for a lack of IND2 representations. The DCM made it clear that a lack of IND2 representations could also arise in the absence of IND representations. Some possible preconditions for the formation of IND representations have been proposed following a DCM analysis of the stranger reaction. In particular, I have suggested the involvement of a primitive termed ATTACH. We

have noted the feature of DCM's that they encourage the theorist to focus on the biological givens. The implications of some of these ideas for autism have been sketched by Frith (1985).

The representations that concern things, MAT, are fundamental for any degree of learning. The equivalent second order representations, MAT2, are implicated in pretend play. One can also note that a well developed MAT2 ability is essential for the creation of DCM's. Their refinement, however, will require hypothesis testing, and this resides at the MAT level only.

NOTES

1. I have dwelt on the difference between a DCM and an information processing model at length and anticipate doing so at greater length in future. This is a consequence of the need readers have to impose their own view of the notation.

DEBTS

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