# LEARNING HOW TO LEARN : THE DEVELOPMENT OF MEMORY IN 3-6 YEAR-OLDS

Stephen Whittaker

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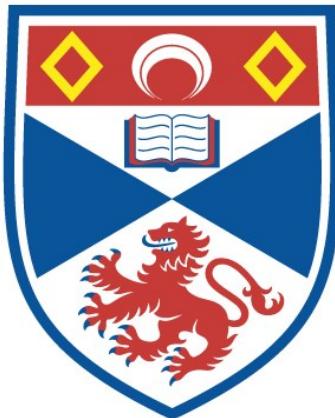
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Dissertation submitted for the

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PREFACE

This dissertation is the result of my own work and includes nothing which is the outcome of work done in collaboration.

ACKNOWLEDGEMENTS

ABSTRACT

The aim of the present study was to investigate the
development of children's ability to make use of external
sources of information when they are studying or remembering
different types of information. More specifically, the
research was directed at two recurring problems for
theories of memory development: the production deficit;
and the problem of change.

The production deficit describes children's failure to
spontaneously use a strategy which is 'in' their behaviourial
repertoire. Use of the strategy can be induced with
minimal training. The study contains a set of experiments
which suggest a number of reasons why children may fail
to use available strategies.

Another major problem with theories of memory development
lies in explaining changes in strategy use. Three
experiments address the issue, and suggest two mechanisms
which produce such changes. The experiments indicate
that feedback may provide one means by which routines
already in the cognitive system are generalised to serve
memory goals. Monitoring of one's own performance may
also produce such changes. These mechanisms are incorpor-
ated into a model of how early strategies might develop.

Other theories of memory development have stressed young

children's lack of knowledge about their own memory
processes. This has been invoked to explain both the
production deficit and developmental change. Apart from
the demonstrations that monitoring may influence strategy
generalisation, the study found little evidence that
knowledge about memory is related to either of these
phenomena. Current theories of the development of knowl-
edge about memory are reviewed, and it is suggested that
there are major problems with explanations of memory
which appeal to such knowledge. One weakness of such
theories is that they fail to explain the origins of
this knowledge. The present study provides an account of
the early development of knowledge about memory.

The results of the experiments are also considered in
the light of recent speculations about developmental
theories and also memory processes in adults. It is
suggested that the mechanisms of change demonstrated in
this study may well apply to other areas of development.
It is also argued that recent theories may have misrepre-
sented the nature of adult memory processes.

CONTENTS

INTRODUCTION   COGNITIVE THEORIES AND MEMORY DEVELOPMENT

0.1   The issues

This chapter provides the background both for the review
of literature in Chapters 1, 2 and 3 and the experiments
conducted in Chapters 4, 5 and 6. It begins by discussing
what attributes an adequate developmental theory should
possess and then focusses on particular issues which
have been controversial in recent developmental psychology.
These issues are also discussed in the light of theories
of memory development. Thereafter, the concern is with
psychological accounts of memory and the importance of
the environment in everyday remembering.

0.2   Criteria for a developmental theory

Despite the enormous amount of research effort which has
been dedicated to the study of particular theories of
development, there has been little speculation about what
criteria theories of development in general have to
satisfy. There are of course, some exceptions to this,
(e.g. Atkinson, 1982; Brainerd, 1978a; Flavell, 1972;
Flavell and Wohlwill, 1970; Wohlwill, 1973). Simon (1962)
characterises the construction of developmental theories
in the following way:

> We select certain instants in the course of .....
> dynamic change, take 'snapshots' of the system at

> these instants, and use these snapshots as descriptions of the system at a particular stage of development. (p. 130).

Though this account will explain some aspects of behaviour at different points in development, it is not truly developmental because it fails to provide a mechanism which will explain the transformation of the system from one 'instant' to the next. The account is misleading in a second respect; there are many different approaches to a given psychological field (e.g in the field of language we have theories of pragmatics, syntax and semantics), and it is clear that no single theory will account for all the phenomena within one of these fields. A developmental theory should therefore have a limited domain of application within its field.

Atkinson (1982) offers a detailed set of five criteria for judging the adequacy of theories of language development. Following Newell (1962), he proposes that a developmental account requires the construction of a series of explanations of behaviour at different points in development. He labels each of these explanations as a theory $(T, \ldots T_i \ldots T_n)$ which applies at a given point of development $(t_1 \ldots t_i \ldots t_n)$ in a domain D.

Atkinson's first two conditions concern the relationship of the developmental theories to general psychological accounts. He argues that each development theory $(T_1 \ldots T_i \ldots T_n)$ should constitute an adequate psychological explanation and that all the theories $(T_1 \ldots T_i \ldots T_n)$

should be constructed in accordance with a particular
general theory. While the first condition seems acceptable,
the second may be problematic because there are acceptable
developmental accounts which appeal to different general
theories. Atkinson is aware of this possibility "if the
T_i (1<i<n) are not so constructed, then additional argument
may restore the explanatory status of T." (p. 26), but in
adding this qualification, the original condition has
been weakened.

Atkinson borrows from Flavell's (1972) analysis of develop-
mental sequences in the construction of his next two
conditions. It is important to note that Flavell's
analysis was intended to operate at the level of individual
cognitive 'items', and not at the level of theory constru-
ction discussed by Atkinson. His third condition is that
if theories admit of additive complexity, then they are
explanatory only if T_{i+1} is additively more complex than
T_i. The latter part of the statement seems to capture an
important intuition we have about development: that the
organism becomes more complex (see Harris, 1957 and Brown,
1973, for these arguments). As Atkinson and Flavell note,
however, it is possible that some sorts of developments may
lead to the simplification of the theories explaining
behaviour. One such mechanism by which this may be achieved
is generalisation, by which a single cognitive item takes
over the functions which had been served by a number of
different items, thus simplifying the theory we offer to
explain behaviour. Atkinson recognises this by introducing

an alternative third condition, that if the theory operates
within a domain of constraints, then T_{i+1} should be less
complex than T_1. This explains the qualification in the
first version of the third condition, that the theories
must "admit of additive complexity". However, there are
sequences in theories which admit of additive complexity
which may not result in more complex theories. Flavell
(1972) notes that the substitution of one item for
another may have this result.

Atkinson's two final conditions concern the explanation of
of theoretical sequences. The fourth condition states that
a developmental theory has explanatory status only if the
sequence of theories $(T_1,...,T_n)$ admits of a teleological,
a reductive or an environmental explanation. A teleolo-
gical sequence occurs when an early theory is included
in a later one. To give an example at the level of
individual cognitive items: the ability to name objects
quickly is a prerequisite for verbal rehearsal, and it
would be impossible to imagine an account in which rehearsal
emerged before this ability. A reductive sequence involves
appeal to some other level of explanation in attempting to
account for the sequence. To give another example: it has
been argued (e.g. Denney and Ziobrowski, 1972) that
children change from clustering items in recall according
to functional criteria, to recall according to taxonomic
criteria. Denney (1972) argues this is due to a change in
underlying cognitive structures, and a corresponding shift
from the classification of objects according to functional

criteria, to their taxonomic classification.[1] Other types
of reductions are possible e.g. to the level of physiology,
but the basic principle remains that certain items at one
level of our theory can be related to items at a different
level of explanation, that the sequence of the items of
the reducing theory is repeated at the level of the theory
to be reduced, and that the items emerge in the reducing
theory before they do in the theory to be reduced. The
environmental reduction argument is that items could not
emerge before time t_1, because they were simply not avail-
able in the environment before this time. One such sequence
may relate to arguments about Motherese (e.g. Snow and
Ferguson, 1977). The argument is that children base their
early utterances on the speech of caretakers, which is
carefully tailored to match the linguistic and cognitive
demands of the child. Caretakers thus exclude complex
syntax or complex concepts from their speech to children.
Thus the environment could not be said to make such infor-
mation available to the children.

The final condition concerns the proposal of the mechanism
of change discussed earlier. Atkinson states that theor-
etical adequacy is only achieved when a mechanism is prov-
ided to explain the sequence of theories described above.

It seems that overall, despite the problems with
Atkinson's second and third conditions, his account is well

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1 Other research has failed to find such a change, but
   this does not affect the argument.

motivated. While his criteria will not be explicitly
applied to the theories of memory and metamemory develop-
ment discussed in Chapters 1, 2 and 3, the arguments he
offers are important, especially concerning explanation
and the mechanism of change, and some attention will be
paid to the problems he raises.

0.3 The Piagetian legacy and recent issues in developmental psychology

Leaving aside these normative statements about develop-
mental theories, there are a number of particular issues
which have generated controversy in recent developmental
psychology. The dominant theory in this field has been·
that of Piaget, and the controversies have mainly arisen
from demonstrations that his predictions are not fulfilled.

0.3.1 Generality

The first concerns the generality of cognitive structures.
Piaget's structuralist approach led him to propose that
children's logical skills could be explained by a limited
number of highly general logico-mathematical structures.
According to Piaget, all tasks which tap the same struc-
tures should be performed with equal facility. However
a large number of experimental studies have shown this
assumption to be false. In particular, it has been shown
that subjects do not perform at the same level on tasks
which are logically isomorphic.(Donaldson, 1978;

Johnson-Laird and Wason, 1977). While these studies have
shown a lack of generalisation, and recent theories
of development (e.g Fischer, 1980; Keil, 1981) recognise
this fact, there have been no real attempts to specify
the factors which constrain generalisation.

In principle, the above studies do not demonstrate that
thought processes are necessarily context-specific, all
they show is that generalisation does not occur for the
logically isomorphic tasks which Piaget studied. It may
be that generalities can be found if a different level of
analysis is employed.

A first step towards such an analysis may be provided
by recent studies which have offered explanations for
the context-specificity of thought. Two sorts of arguments
have been made to explain young children's failure to
generalise a skill which is 'in' their cognitive reper-
toire. The first (e.g. Brainerd, 1973; Bryant, 1974),
suggests that our criteria for inferring the presence of
a skill require abilities in addition to those under study.
Simplify the task, and the skill will be manifested. The
context-specificity here is explained by the fact that the
'simple' and 'complex' tasks may be logically isomorphic,
but they place different information-processing demands
upon the children. Other writers, (e.g. Bruner, 1966;
Donaldson, 1978) suggest that children have problems
in accessing the appropriate cognitive skill in certain
tasks. Both suggest however that within certain domains,

cognitive skills will generalise.

The problem of context-specificity is not limited to
the study of purely cognitive skills, however, for as
Chapter 1 will illustrate a major feature of young chil-
dren's memory behaviour in certain task situations,
is that they fail to use strategies which are clearly 'in'
their behavioural repertoire. A major aim of Chapter 4
is to examine what underlies preschool children's failure
to employ a memory strategy in various situations.

0.3.2   Competence in preschoolers

Another problems for Piagetian theory was the finding
that the cognitive structures which were supposed to
emerge late in development could sometimes be found in
very young children. Piaget's theory can explain away the
late emergence of cognitive structures in terms of "environ-
mental factors", but early emergence clearly cannot be
incorporated into the theory.

Aside from the implications for Piagetian theory, the
research into preschoolers' capabilities is important   in
the consideration of other developmental problems, such
as change. If the demonstrations of preschool competence
are correct; we have clearly simplified the problem of
explaining change. If the thought processes of adults
and children are "similar", then the mechanism we propose
to explain change will have to be considerably less

powerful, than if adult and child thought are radically different. Of course, it still remains to be specified exactly what is meant by arguing for the 'similarity' or 'difference' of thought processes through development, and this is a major problem with recent accounts (e.g. Keil, 1981) which adopt this position.

Whatever we might find out about memory skills in preschoolers therefore has implications for such theories, but there is also some internal debate within the memory development literature about the extent of the preschooler's memory skills. Early studies (e.g. Appel, Cooper, McCarrell, Sims-Knight, Yussen and Flavell; Yendovitskaya, 1971) suggested that young children were incapable of using deliberate cognitive strategies in order to remember. This led to a further set of studies (Wellman, Ritter and Flavell, 1975; Yussen, 1974) which indicated that this was false. These in turn generated other studies which showed that apparently intentional strategy use may have a stimulus-response type characteristics (e.g. Gordon and Flavell, 1977; Ritter, 1978).

One aim of the experiments conducted in Chapters 4, 5 and 6 is to assess exactly the nature of strategy use in very young children. In addition to resolving an empirical dispute, the memory capabilities of preschoolers will clearly influence the nature of the developmental change we have to explain.

0.3.3 Change

A final issue concerns the mechanism proposed to account
for change. Piaget explains this process in terms of a
homostatic mechanism of assimilation and accommodation.
Fodor (1972) points out one major problem with this
explanation. According to Piaget, development takes the
form of long periods of 'preparation' in which minor changes
in structures occur. These are followed by 'achievement
phases' in which structures undergo radical and general
change. Fodor argues that one mechanism cannot explain
these two radically different types of change. We might
wish to argue, as Flavell and Wohlwill (1969) have done,
that Piaget's preparation-achievement description is
incorrect, and that all development consists of steady
quantitative type change. If there is only one type of
change, then Fodor's argument does not apply. There is,
however, a much more serious problem with Piaget's account:
it is circular, because the processes of assimilation and
accommodation proposed to explain change, cannot be
inferred independently of the changes they are proposed
to explain.

Other developmental research has not suggested much to
replace such an account. There have been a set of more
piecemeal attempts to investigate possible mechanisms
in particular the role of conflict in inducing change
(e.g. Bower, 1974; Bryant, 1974; Doise, Mugny and
Perret-Clermont, 1975; Russell, 1982) but these could not

be said to represent a coherent alternative. Evidence from training studies could be utilised in the search for change-inducing mechanisms, but for the most part such studies have concentrated on demonstrating that a behaviour which is not spontaneously manifested may be induced with suitable training. A further problem with training studies are that they show sufficient but not necessary conditions for change.

The approaches described above also tend to assume a single change-inducing mechanism. There are two pieces of evidence suggesting this may not be entirely justified. Firstly, the earlier discussion of context-specificity might lead one to propose that a single mechanism cannot explain change in a widely fragmented system. If thought is context-specific, then the mechanisms which lead it to change may be also context-specific. Secondly, cross-cultural research (e.g. Greenfield, 1969) has indicated that there may be separate routes to the same cognitive acquisition, which would again imply the need for multiple mechanisms.

In contrast to cognitive theories, the problem of explaining change has been considered in some detail by theories of memory development. In particular, Flavell (1971) and Brown (1978) have argued that changes in cognitive strategy use are the result of children's increased knowledge of their own memory processes. The adequacy of this explanation is subjected to theoretical analysis.in

Chapters 2 and 3, and to experimental test in Chapters 4, 5 and 6. A further reason for conducting these studies is that there has been little investigation of preschool children's knowledge of their own memory processes, and none of it has been attempted to establish how this knowledge influences memory.

0.4 Memory

0.4.1 Defining memory

It is important that any developmental account of something must include an analysis of what that thing is. One problem with undertaking such an analysis lies in the diversity of the phenomena which are describable by the term memory. A core meaning to the term would seem to involve the reproduction of autobiographical events, but it is clear that such a definition is too restrictive, because it is possible to remember things one has not experienced (e.g. the date of Queen Victoria's coronation), and there are certain things which are not event-like which are remembered (e.g. the colour of a friend's eyes or how to drive a car).

In addition to the different types of information which can be remembered, we must provide some account of how such information is initially acquired and also appropriately accessed. We must also explain the phenomenon of being unable to access information once known, i.e.

forgetting. Now given the diversity of types of inform-
ation to be remembered, it is likely that there will be
different explanations for the processes involved in
acquisition and access of these different types. Thus,
remembering the plot of a book or story may occur as
a byproduct of comprehension and interest, whereas remem-
bering facts for examinations may require detailed inten-
tional strategies such as imposing organisation on the
materials or note-taking. Accessing information will
clearly depend not only on the type of information, but
also on the requirements of the situation. Thus, for
example, remembering in the absence of environmental support
may be considerably different from remembering when the
environment provides support such as diaries, reference
books or other people as external information sources.
A related point is that the criteria we use in applying
the term memory, may vary with the type of material and
situation. Thus, verbatim recall is unnecessary.if we
are to attribute someone with remembering an incident or
story, whereas absolute accuracy of reproduction is
necessary if we are to claim to have remembered a telephone
number.

0.4.2 Domains and theories

As we noted earlier for the case of language development
there are a number of different approaches to the same
field within psychology. This is also reflected in the
different focusses of theories of memory. Thus, early

approaches to memory investigated only the processes
involved in learning and forgetting of arbitrary stim-
uli, whereas later ones proposed that the organism trans-
forms the information it receives, and the focus became
the internal organisational structure of the organism
which enabled such transformations. More recently there
has been some stress on how memory is used in other cog-
nitive tasks (e.g. Baddeley and Hitch, 1974).

The present thesis will be constrained to the study of
constructive and reconstructive processes in memory,
i.e. children's preparation for retrieval, and retrieval,
when external sources of information such as cues are
present. Such processes were chosen for study because
they reflect the types of processes involved in everyday
remembering and also those required in schools. In
particular, I shall be interested in the use of intentional
strategies in memory, because knowing when something
has to be done in order to remember is again important
in education.

One problem is choosing such a domain is that there is no
obvious theory of adult memory to account for these pheno-
mena. An obvious strategy in constructing developmental
theories is to take the adult account and to investigate
how it relates to developmentally prior phenomena.
Although Reitman (1970), Norman (1973) and Collins, Warnock
Aiello and Miller (1975) do have some useful suggestions
about these memory processes, the major attempts to

deal with this problem have been developmental, and it
is these which are reviewed in Chapters 1-3.

CHAPTER 1 FLAVELL'S THEORY OF MEMORY DEVELOPMENT

1.1 Historical background and mediational theories

It has often been suggested that a qualitative change
takes place in the nature of thought processes sometime
between infancy and school-age, and this has sometimes
been attributed to the increased role of language in
controlling thought. (e.g. Vygotsky, 1962; Luria, 1961;
Kendler and Kendler, 1961; 1962). These theories claim
that the infant is largely stimulus-bound and incapable
of reflection⁻ but that the development of language and
the symbolic function enable the older child to generate
mediators between stimuli and responses, allowing him to
exercise increasing control over his own behaviour.
Although there are differences of detail among the theories,
two reasons are generally given to explain the younger
child's failure to mediate. The early theories (e.g. Kuenne,
1946; Kendler, Kendler and Wells, 1960; Reese, 1962) sugg-
ested some form of mediation deficit, i.e. the child
generated a verbal response but for some unspecified rea-
son it failed to mediate performance. The second reason,
was advanced by Kendler (1964) and Maccoby (1964), who
drew attention to the fact that children may notmediate
because they fail to produce a mediator. These were com-
bined in Kendler's (1964) model where the development of
discrimination learning is represented as a three stage
process. In the first stage, the child does not generate

the mediator spontaneously, nor does it improve perfor-
mance when generated: this Kendler attributes to some
unspecified 'structural deficit'. As children mature,
the mediator does begin to influence performance, but
they do not generate the mediator spontaneously. In
the final stage, the mediator is generated in all appro-
priate situations and it does improve performance.

It is worth noting several problems with these theories.
There is a failure to make explicit the processes by
which mediation facilitates recall, and the related problem
of explaining the mediation deficit (why a potential med-
iator sometimes fails to mediate) is not dealt with. In
addition, no reason is given for the change from mediation
to production deficit:- why should a word suddenly begin
to mediate performance? Finally, there is the problem of
why children fail to utilise a mediator which is 'in'
their behavioural repertoire, and which does improve perf-
ormance. These problems are not unique to the above
theories of discrimination learning; they also appear in
the mediational theories of memory, which were derived from
such theories.

1.2 The early experiments

In the late 1960's Flavell began a series of experiments on
memory development utilising notions derived from the
framework of mediational theories. Although he originally
operates with concepts similar to the classical mediational

theorists, Flavell's experiments led him to suggest that the discriminative learning model of Kendler must be changed in important ways if it is to account for memory development. In the following account we see how theoretical concepts like mediation are extended to a range of non-verbal behaviours, and terms like production deficit are shown to have less precise meaning than was originally foreseen.

In 1966, Flavell, Beach and Chinsky conducted an experiment to investigate the role of verbal mediation in a simple task of memory for an array of objects. Children were shown a set of objects, which were named, and then the experimenter indicated a subset of the objects. The child had to remember this subset during a delay period. during which the objects were removed from view and point to the correct subset on a recall instruction. , In contrast to the earlier discrimination learning experiments (Kuenne, 1946; Kendler et al,1960) observation of mediation was carried out directly; one of the experimenters simply lip-read the instances of verbalisation. Rehearsal increased with age; about 10% of 5-year-old children were observed to name the objects, compared with 100% of 10-year-olds.

As recall data were not available in this experiment, it was impossible to directly test the relationship between verbalisation and recall. Flavell's next experiment investigated this issue, in the form of four different

hypotheses:

1. Does rehearsal increase performance? Spontaneous producers of the rehearsal strategy should outperform non-rehearsers. If they do not, this is evidence of a mediation deficit.

2. Can non-rehearsers be induced to rehearse? If they can, this indicates a production deficit.

3. Is induced rehearsal as effective a mediator as spontaneous strategy use?

4. Do children who are trained to rehearse maintain this strategy when they are not explicitly requested to use it?

The experimental task was the same as in the Flavell et al (1966) study: children were first classified as spontaneous producers if they rehearsed on 9 out of 10 pre-trials, or non-producers if they failed to rehearse on more than one pre-trial. Children who did not fall into either of these groups were dropped from the experiment. The producers were further sub-divided into a group who were given instructions on how to rehearse, and a group who were not given training. All non-producers were instructed in the rehearsal strategy, and all the three groups were given a retest on the original task, with both training groups being given instructions to rehearse before the retest began. Following this, more trials were administered, before which the experimenter explained to the children that they could say the names if they wished but it was no longer required of them to do so.

The results of the study gave clear answers to each of the questions. Children who spontaneously rehearse remember more items than non-rehearsers, and the rehearsal strategy can be trained in children who do not spontaneously produce it; these children now rehearsed on 75% of the trials. When trained producers use the strategy their recall is improved to the level of spontaneous producers. All this indicates that rehearsal does mediate recall, and that failure to rehearse is the only reason why non-producers do not perform well.

In theoretical terms we have clear evidence for a production deficit; the non-producers can be easily induced to produce a behaviour which mediates recall. Whenever rehearsal is used, recall increases, so there is nothing to indicate a mediation deficit. In answer to the final question, it was found that children who rehearsed only under instructions, quickly abandoned this strategy when they were no longer directly requested to use it. Ten of the 17 non-producers failed to use the strategy when given the choice whether to do so.[2]

Flavell had therefore demonstrated a clear relationship between mediation by simple verbal rehearsal and recall. He had found strong evidence for a production deficit, but little to indicate problems of mediation.

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2   But see the later discussion of the effect of instructions and priming on strategy selection.

In his next study (Moely, Olson, Holmes, and Flavell, 1969),
Flavell attempted to investigate whether his results
generalised to mediators of a more complex cognitive form
than simple verbal rehearsal. It has often been demon-
strated in the adult literature (G. Mandler, 1967) that
sorting conceptually   related items during study will
considerably improve recall of lists of items. The
question of interest was whether and when this would medi-
ate performance in the young child. The study differed
from early mediational research in another way: Flavell
suggested that the change from production deficiency
to spontaneous production may not occur as a sudden qual-
itative shift, as the mediation theories imply by the
dichotomy they propose between elicited production under
conditions of explicit instruction, and spontaneous prod-
uction where no cues are given. Flavell argued that every
situation includes some clues to the strategy required
and that strategies first emerge when they are explicitly
requested and gradually generalise to situations which
provide weaker clues for strategy selection. To test
this, Moely et al introduced an intermediate instruction
condition in which the children were given a hint as to
the strategy they should employ.

In the experiment, the children (aged from 5 to 11 years)
were shown a set of pictures, which could be categorized
into sets of animals, furniture, vehicles and articles
of clothing. They were told they should study the pic-
tures, so that later they could say them back to the

experimenter. It was suggested to the children in the
control group that they could move the pictures or do
anything they liked to help them remember. A second
group (Naming) received more explicit cues for strategy
selection - the experimenter named all the categories
(e.g. "Things to ride in") and then pointed out each
category member. In the explicit cue condition (Teaching)
the children were told to sort the items manually, then
label them, and then count the number of items in each
category.

Strategy use was again directly observed by filming
the subject's activity through a one way mirror. Following
the test trials, the subjects were asked to sort the items.
This is important, because it must be established
whether failure to sort was due to an inability to cate-
gorise, or whether this is another example of a perfor-
mance deficit, i.e. the subjects can category-sort but
they just do not do so in order to remember.

The results of the sorting task indicated that even the
youngest children were capable of some category-sorting,
although the absolute level of performance increased with
age. The interesting comparison, however, is between
children's sorting behaviour under instructions to
remember, with that under instructions to sort, that is
how good are children at employing their sorting skills
as a strategy to mediate recall? Moely et al compared
sorting performance under the two sets of instructions

within subjects to control for differences in absolute

sorting ability. They found that the ratio of clustering
produced
category sorting/under instructions to remember, to

category sorting made under instructions to sort,

increased from 0.07 in 5-year-olds to 0.60 in children

aged ten, indicating that the older children were much

more likely to employ their sorting skills to mediate

memory. These results indicate that young children

have a production deficit as regards this particular med-

iator, but even the oldest group failed to make maximum

use of their categorisation skills. Moely et al's

observations suggest one reason for this may be the use

of other strategies such as rehearsal or self-testing

(looking away from the pictures and trying to reproduce

them from memory).

Another difference between the age-groups was in the

explicitness of the instructions required to elicit

clustering as a memory strategy. While only the 10-year-

olds sorted spontaneously, to remember, both this group

and the 8-year-olds showed sorting behaviour in the Naming

condition. For the 5-year-olds and 6-year-olds only

the strong prompts of the Teaching condition induced

appreciable clustering.These results are important

because they suggest that mediational strategies do not

enter the child's repertoire, and immediately generalise d

to all situations. Younger children may need highly

explicit prompts to engage in a mediational strategy,

which older children will produce under mild prompting.

In neither case could the strategy be said to be fully
productive however.

In addition to these differences in production 'threshold'
the data suggest that even when a strategy is elicited,
it may be executed more or less efficiently. For example,
the youngest group in the Teaching condition showed
evidence of category sorting, but often only applied
this to a few of the list items. So, the ability to
execute a given strategy like the ability to evoke it
is not an all-or-none phenomenon, as the older mediational
theories would seem to suggest. The Moely et al study
showed that many different behaviours in addition to
speech may serve to mediate memory. This was supported
by Corsini, Pick and Flavell (1969), who demonstrated
that the modified mediational framework could be applied
to a task which involved specifically non-verbal cueing.
Children were required to remember a pattern and provided
with materials which made it possible to construct a
replica of this pattern. The replica could then be used
to remember the pattern. Again there was no evidence
of a mediational deficit; children who correctly cons-
tructed recall cues recalled equally well, independent
of age (as in the other studies, there was strong evidence
for the production deficit). The Moely et al finding that
production threshold for a given strategy decreased
with age was also replicated.

The final experiment in this series, conducted by Daehler,

Horowitz, Wynns and Flavell (1969), attempted to look
at the effect of different recall demands on strategy
selection. Subjects were shown the same stimulus array,
a set of coloured lights flashing in sequence, but were
variously required to remember the colours which flashed,
the order they flashed, or both. Daehler et al predicted
that a verbal rehearsal strategy would mediate recall
of the colours, whereas gestural rehearsal (pointing)
would improve recall for the sequence. It was also
expected that older subjects would be better able to select
the appropriate strategy for each task.

The results for the colour-naming and colour-and-sequence
tests essentially replicated Keeney et al (1966). Most
subjects at some time used verbal rehearsal, this incre-
ased with age, and was positively correlated with perfor-
mance.

In contrast, the sequence and gestural rehearsal data
were completely at variance with this. The incidence of
rehearsal was equal in both older and younger children,
in addition it was unrelated to memory performance. Overt,
gestural rehearsal does not seem to mediate recall of
position sequences.

There were also some interesting asymmetries in strategy
transfer for the two strategies. Half the subjects had
received colour-only and then sequence-only tests with
the other half being tested in the opposite order. Few

subjects who received colour-only trials first and used
verbal rehearsal on these trials, then used it as a
strategy to remember sequence. In contrast, gestural
rehearsal seemed to generalise from early sequence trials
to later trials for colour. This result is important
because it shows that strategy selection is not only
influenced by the instructions before a given trial, but
depends on what has previously occurred in the experiment -
certain strategies may be 'primed' by what has happened
earlier.

1.3 The mediational model

On the basis of these experiments Flavell produced an
mediational account of memory development. Before attemp-
ting a detailed explication of the model, I shall make
a few preliminary remarks about the nature of the develop-
mental theory he was proposing.

Firstly, the basic emphasis was on the similarity of
memory processes throughout development and the same mech-
anism, mediation, was proposed to explain memory. This
is in contrast with the then predominant Piagetian account
of the development of cognitive processes which stresses
qualitative differences between the processes in operation
at different stages of development.

In addition to proposing the basic mechanism of mediation,
Flavell argues that development is the result of changes

in the mediational strategies available to the young
child, in the number of strategies available, and in the
child's increasing efficiency in using an appropriate
mediational strategy, often as a result of having a
larger mediational repertoire to choose from.

The model also provides a description of various mediators,
a set of theoretical concepts for analysing changes in
mediational activity within and among tasks (e.g. product-
ion and mediation deficits, production threshold), a
descriptive account of various developmental sequences
which obtain among mediators, and some speculations about
what might explain these developmental sequences.

1.3.1 Memory is mediation

Flavell argues that memory occurs as a result of media-
tional strategies. When subjects are induced to, or spont-
aneously employ, a behaviour such as rehearsal, category
clustering or cue construction, these mediational activi-
ties result in increased recall. Evidence for this is
provided by the finding that spontaneous strategy producers
recall more than those who do not produce, but the argument
is made much more powerfully by the demonstration that
when non-producers are induced to employ a strategy they
improve their recall.

Flavell's account of the mediation process is much richer
than that of his predecessors; the notion of mediator is

extended from a simple verbal response interposed between
stimulus and response(as in Kendler and Kendler's (1962)
S-(s)-R account of mediation) to encompass a whole variety
of cognitive activities from rehearsal to self-testing or
constructing images. He does not only focus on the diff-
erences among strategies, he points to the variations in
what seems to be essentially 'the same' strategy. For
example, the young child's 'rehearsal' activity may stretch
only as far as the simple naming of objects which are
physically present, while the older child might rehearse
in the absence of the objects, re-order them to construct
links amongst items and self-test to see whether the
items are well-encoded. Although it is not explicitly
stated, the account suggests that the sophisticated memor-
iser may resort to the use of more than one strategy in
a given task.

Flavell regards all these activities as the result of
deliberate problem-solving activity by the child:

> a memory task can be profitably regarded as a
> type of problem-solving situation in which efforts
> at mnemonic mediation constitute the means or
> problem-solving strategy and recall the goal or
> problem solution. (1970, p.195.)

Tt is important to note that Flavell characterises such
problem-solving as a deliberate conscious activity, a
fact which will assume greater significance in our later
discussions.

There are, however, several problems with the memory as
mediated activity model, some of which are raised by

Flavell's own data. The first concerns the mediation
deficit. There are two separate issues involved here.
The first concerns the traditional mediation deficit,
and the question of why behaviours which mediate memory
in adults, do not do so in younger populations. Secondly
there is the problem of explaining why some behaviours
mediate, whereas others do not. I shall deal first with
the general problem of certain behaviours failing to
mediate. While this was much emphasised by the early
mediational theorists, it seems to play almost no role
in Flavell's account. It is of crucial significance to
the theory to establish whether such deficits do exist,
because if they do, it means that not all activity results
in improved memory. While it is possible to generate
trivial examples of activities not having memory pay-
offs (e.g. going to the pub does not help exam revision) there
is an important counter-example to the principle in the
Daehler et al experiment. Gestural rehearsal, which on prima
facie grounds appears to be adequate strategy for remem-
bering sequences, does not result in improved memory for
any age group. This suggests that for every memory
task there are a limited range of activities which will
benefit recall, and the research has identified some of these
by the study of adult processing (as in rehearsal and
category clustering) or on intuitive grounds (cue
construction). An adequate theory must specify the const-
taints on those activities which will facilitate memory
for a given task and explain why certain activities (e.g.
gestural rehearsal) show no effects on performance in those

tasks. The questions of why behaviours may not mediate
at one age level, but do so later in development is also
not tackled. In one sense Flavell is justified in ignor-
ing this problem because he found little evidence for it.

Flavell's data also show the opposite effect; memory
occurs in the apparent absence of mediation. For example,
children who show no signs of rehearsing or category
clustering nevertheless retain several items when tested.
(Keeney et al, Moely et al). How can we account for this?
Flavell's solution is to retain the 'memory is the result
of mediational activity' axiom but to suggest that some
mediation may occur in an involuntary manner.

> One must assume that some mnemonic processes -
> no less "mediational" in the literal sense - are
> not ordinarily subject to voluntary control.
> (1970, p.193).

If this is so, then the model must both specify what
processes underlie involuntary mediation, and criteria
for distinguishing it from deliberate mediation if it is
to remain more than an ad hoc means of explaining away
awkward data. Suggestions as to how involuntary mediation
might occur, are the most important way in which Flavell's
(1970) model has been modified. The notion of involuntary
mediation is discussed in the next chapter.

A second solution to the problem of "recall without strat-
egies" is to propose that the youngest groups are in fact
employing deliberate strategies but we do not know what
they are, because they are covert and because the children
are unable to describe them to us. This form of

explanation is both implausible and inadequate; implaus-
ible, because adults typically remember some items when
they are prevented from rehearsing (e.g. Baddeley and
Hitch, 1974), and yet cannot and do not report the use of
any strategy; and inadequate, because it does not specify
the processes involved in these 'unobservable' strategies.
(see later discussion of methodology).

The notion that memory occurs as a result of deliberate
problem-solving activities is further weakened by Flavell's
suggestion that under certain circumstances task materials
may 'elicit' various behaviours, which do mediate behaviour
but are not the result of intentional activity. In his
discussion of a study in which children had to set up
pictures as cues to locate various animals (Ryan, Hegion
and Flavell, 1970), Flavell appeals to this notion(1970,
P.206)

> .....another(child)might idly bring the pictures
> up next to their animal referents, on one or more
> trials(a prepotent high-probability response to
> these particular task materials for young chil-
> dren, we think, even without a recall set).

Again Flavell appeals to the notion of mediation following
on involuntary behaviour, though this account better
explains recall than in the rehearsal case, because on this
occasion the effective mediating process is specified.
There seem therefore, to be three problems with the media-
tional model proposed by Flavell. The first concerns his
failure to answer the question of which activities can
serve as mediators for different stimuli in different
situations. Secondly, he weakens the mediation principle

by allowing that memory may occur in the absence of media-
tion, without saying when this might occur, or what princ-
iples determine memory under these conditions. Finally
he suggests that mediation may not always involve the inten-
tional access of cognitive routines. This notion is
derived from his demonstration that mediations can be
generated without intention to remember (Ryan et al,
1970). The theory must therefore include some account of
the child's other activities which will allow the explan-
ation of why a certain stimulus array "elicits" particular
behaviours. All these problems have led to modifications
of the model which will be discussed in Chapter 2.

1.3.2   Changes in mediational activity

In addition to the axiom that memory occurs as a result
of mediational activity, Flavell argued that the develop-
ment of memory followed changes in the number and type
of mediators available. Older children have a broader
range of strategies from which to choose, and are therefore
more likely to possess one which is task appropriate. In
addition, they have more powerful strategies in their
repertoire, as well as being more flexible in their
control and use of strategies.

The theoretical constructs inherited from the mediational
theorists, mediation and production deficits, and spontan-
eous production suggested . neat distinctions and qualitative

stage-like shifts between them, and one of Flavell's
major contributions to this field is his emphasis on
the continuity of development in mediational skills, and
the complexity of factors involved in the selection and
use of a particular strategy.

The original conception of mediation (leaving aside the
mediational deficit which has already been discussed in
detail) represented development as the smooth execution of an
invariant behaviour, first only in those situations in which
it was elicited by the experimenter and then its sudden
generalisation to all situations where it would facili-
tate memory.

Flavell's experiments suggested that this account was
wrong on two counts. The mediational behaviour itself
undergoes changes in efficiency over the entire course
of its development, although the changes themselves may
                      periods there may be
be gradual, over long / radical changes in form. In
addition, the process of a strategy becoming productive
involves slow generalisation from those situations where
the behaviour is strongly elicited by experimenter instru-
ctions and the materials employed, to situations where
few such cues are present. Flavell's account differs
from Piaget's general cognitive model, firstly because
behaviours undergo discrete changes with development, and
also because of the lack of generality of a given mediator
across different tasks.

Flavell describes two types of changes in the form of a

given strategy. The first he calls changes in efficiency;
the young child may correctly elect to employ a certain
strategy, but fail to execute it correctly or completely.
Examples of such behaviour occur on the Moely et al task
where young children only partially category sort, or in
the Corsini et al experiment where they decide upon a cue
construction strategy, but sometimes construct the cues in
an inaccurate way.

The second type of change is more radical; in the same
task children show behaviours which are so dissimilar that
we do not regard them as variants or increases in efficiency
of the same strategy, but as different strategies. For
example, in the Moely et al experiment, young children
labelled stimulus items when the items were physically
present, a lower order verbal strategy which appeared in
a more sophisticated form in the older groups who averted
their gaze and attempted to name all the stimulus ideas
in a self-testing strategy. In the Keeney et al experiment
subjects demonstrated an intermediate form of this strategy -
they used verbal rehearsal as a simple means of retaining
ideas in memory while the stimuli were physically absent.

While it is possible to dispute that the above behaviours
are all variants of the 'same' strategy, it is obvious
that a simple production deficit a spontaneous production
model will not satisfactorily account for the data,
because it ignores changes in the mediating behaviour.

The acceptance that mediational behaviour may increase
in efficiency or exist in different forms creates a
whole series of new explanatory problems. We now have
to give an account of these changes in strategies and
allow for the possibility that a subject may use more
than one strategy in a given task, and possibly build in
some form of executive decision maker to determine which
strategy variant is accessed.

According to Flavell, the original conceptualisation of
the production deficit was wrong in a second sense; a
mediational behaviour does not suddenly change from being
highly situation-specific and elicited only under condi-
tions of explicit instruction to a decontextualised general
strategy. This view is to some extent derived from studies
which contrast training with no-instruction conditions.
The experiments of Moely et al and Corsini et al demonstrate
however that the discontinuous notion of production deficit
ought to be replaced by something like a production thres-
hold, with less and less explicit situational ones being
required to evoke a given strategy as it develops. This
suggests that a mediational behaviour should show a
pattern of slow generalisation across different situations.

This has two implications for the model; firstly it means
that the actual task context is a crucial determinant of
memory performance as to whether it elicits a particular
strategy. We must therefore attempt a detailed analysis
of tasks to determine the factors which are critical in

this process. In Flavell's experiments, control over
these eliciting factors is operationally defined; subjects
are given no instructions, a hint or explicit strategy
model to cue a desired behaviour. While it is clear that
instructions will have a powerful effect in determining
behaviour, it is not obvious how an analysis of task
might proceed in the absence of such obvious manipulations
of instructions. Flavell does suggest that recall demands
may have an effect of strategy selection, more subjects
labelled items when they were told to remember their
names, (Moely et al) than when they merely had to point
to them (Keeney et al), and a similar effect was noted
in the Daehler et al study. Other relevant variables
appear to be the presence or absence of the items: more
naming was observed in the Moely et al study when stimuli
were present, than the Keeney et al study when they were
not. Another way of conceptualising the effects of task
or stimulus variables is to investigate the child's normal
activities with such materials, for example, Ryan et al
suggest that picture-object matching is a high probability
response even when no memory goal is set, consequently
such behaviours may need little experimental inducement
to be evoked. While much of this account is plausible, it
must be noted that we lack a theory of task analysis; and
explanations of eliciting factors are either obvious
(e.g. explicit instruction is more likely to evoke strat-
e gies than implicit) or ad hoc (remembering sequences is
more likely to elicit gestural rehearsal than is remember-
ing colour names. Another problem is that the weighting of

the various factors, i.e. materials, task demands and instructions may change with age, for example, Donaldson (1978) has suggested that pre-school children pay little attention to verbal instruction on certain tasks, and worse still, the various factors probably interact with each other.

The problem of eliciting factors is further complicated by the fact that evocation of a given strategy is not independent of the child's proficiency with that strategy. For example, a child may preferentially select a strategy which he can smoothly execute, rather than one which at first sight better fits the problem, but may be difficult to actually use.

1.3.3 Predicting sequences of strategies

One task of any developmental theory is to predict the order of emergence of various behaviours (Flavell, 1972, Fischer, 1980). This is made all the more difficult in the case of memory strategies because of the constellation of processes subsumed under the general category of strategies, and also because of the effects of the various eliciting factors.

If we consider the case of a single strategy, prediction of 'the age' at which it 'emerges' is complicated by the various task and instruction factors. A strategy will emerge much earlier if it is elicited by close training or

clever manipulation of materials. In addition, different
strategies may well have had different amounts of practice,
which we have just argued may be a powerful determinant
of strategy selection. For example a behaviour like object
naming may be overlearnt and hence more elicitable than,
say, category clustering.

Leaving aside the problems of task factors and practice,
and assuming we have adequate criteria for assessing the
contribution they make to strategy selection, if we hold
these factors constant is there anything else we can say
about the sequences in which memory strategies emerge?
Flavell immediately rejects any notion of general struc-
tural change, because of the widely different sets of
skills which make up each strategy. What he attempts
to do is to explain the sequence obtained in his experi-
ments where he discovered that labelling/naming developed
before rehearsal which itself preceded category-clustering
in terms of a sort of measurement sequence, in which the
set of skills required for an early developing strategy
are included in and thus a pre-requisite for, the develop-
ment of later strategies. So for example, simple
labelling, the ability to name an object is necessary
for rehearsal, that is, naming it when it is no longer
present.

The problem with the inclusion account is that it can
only be systematically applied to closely related skill
sets. How, for example, would we be able to predict

whether tying a knot in a handkerchief emerges before
the self-testing strategy of the Moely et al study?

The theory implies that there exists some hierarchy for
explaining the order of emergence of strategies and
although some of the sequences (e.g. rehearsal develops
before category clustering because one involves temporal
ordering and sequencing without reference to meaning and
the other involves the construction of relations at a
conceptual level), do have intuitive plausibility,
a theoretical explanation is nowhere given.

In conclusion, although Flavell is correct to stress
the complexity of factors which determine the evocation
of strategies, his failure to provide a detailed account
of task factors and the strategy hierarchy means that
prediction of ages of emergence of various strategies,
and of the sequences and relations which hold between
different strategies means that the theory makes very
few specific predictions about development. Because of
this, it is extremely difficult to refute.

Explaining strategy development

In addition, Flavell provided an explanation for the
development of memory by reference to specific and general
factors. The specific factors apply to the particular
cognitive activities which underlie the use of particular
mnemonic mediators. A strategy such as rehearsal, for

example is made up of a whole set of underlying skills,
such as item-naming, sequencing, re-ordering and re-
cycl ing, and it is clear that a factor such as speed
of stimulus naming may constrain rehearsal efficiency,
if for example naming is to show, then the user may only
be able to rehearse items in sets of two.[3] Development
of such underlying skills may well make the strategy
more efficient, and hence more likely to be elicited
in a wide range of situations. A similar argument
which Flavell doesn't make, could extend across strategies;
general cognitive development should leave the subject
with a wider range of activities which can be subsumed
to a memory goal. He is therefore more likely to have a
strategy which better fits the task demands.

The general factor Flavell calls planfulness. Consistent
with his arguments that memory is a matter of generating
mediators to achieve memory goals, he suggests that
careful planning of activities to do now (encoding),
which will have pay-offs later (recall), is not part of
the general cognitive outlook of the young child. This
increased awareness of the means-ends structure of cer-
tain problems is not linked to any specific strategy,
but it may account for the fact that older children are
much less dependent on eliciting factors in selecting
strategies, than are younger children. This is the

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3 Chi (1978) has suggested that there are age differences
   in the skills which make up rehearsal. For example,
   children are slower to name a familiar stimulus (see
   Chapter 2).

introduction of the concept of 'metamemory' or knowledge about memory which was later refined and invoked as a major explanatory factor in the emergence of strategies. (Flavell, 1971). Metamemory will be discussed and evaluated in Chapters 2 and 3.

CHAPTER 2   MODIFICATIONS TO FLAVELL'S MODEL

2.1   Introduction

The modifications which have been made to Flavell's (1970)
model are not the result of it being falsified, but
follow from its failure to provide an adequate account
of several important phenomena including the development
of involuntary memory, the production deficit and memory
for meaning.   The changes also represent attempts to
integrate the field with other areas of research, in
particular, information processing in adult cognition,
Russian research and Piagetian cognitive development.   Both
research findings and explanatory notions have been
imported from all these fields.

This chapter will focus on two ways in which the model
has been modified, the first following the integration
of the notion of mediation with the literature on Levels
of Processing (henceforth refere d to as LOP) and attempts
to explain changes in mediation.   The second followed
the inadequacy of mediational theory in explaining
memory for text, recognition memory and relative recency.
This second difficulty led to the introduction of struc-
tural explanations of memory imported from theories of
information processing.   Both modifications resulted
in reconsiderations of developmental issues.   A number

of theorists speculated about changes in the child's
use of different mediational strategies (Brown, 1975;
Flavell, 1971; Meacham, 1972; Paris, 1978a; 1978b)
and Piaget and Inhelder (1973) present a case for struc-
tural change .

2.2 Changes in mediational models

2.2.1 Mediational models and levels of processing

Meacham (1972) drew attention to the similarities
between the mediational model of Flavell and the levels
of processing literature (Craik and Lockhart, 1972; Hyde
and Jenkins, 1969). The research in both areas shared
three basic assumptions: (a) memory is dependent upon
the particular cognitive operations the subject applies
to the stimulus materials; (b) operations differ in
their implications for memory and these operations may
be arranged in some sort of hierarchy; and (c) it is
not important whether such operations are the result
of intentional selection. The first of these propositions
that memory is dependent on the particular operations
the subject uses, is illustrated in a typical LOP experi-
ment in which subjects may be instructed to carry out
operations focussing on the structure of words (e.g.
cross out all the letter e's), while others are induced
to focus on the meaning of the stimulus (e.g. rate the
meaning of the words along the dimension pleasant-
unpleasant). Jenkins and his colleagues (e.g. Hyde and

Jenkins, 1969; Jenkins, 1971; Johnston and Jenkins, 1971)
have conducted a number of such studies. The generalis-
ation which emerged from this research was that the
activity in which subjects engaged substantially affected
their memory performance. In 1972, Craik and Lockhart
suggested that such activities may be ordered in a hier-
archy from the 'perceptual' to the 'semantic'. Thus, a
subject required to assess whether a word contains a
letter 'e' will remember less than the subject making
semantic decisions. Finally as the experiments of
Mandler (1967) had shown for organisation, it is the
activity itself which determines memory, it does not
matter whether such activity was selected by subject or
experimenter. Meacham pointed to the parallels between
these propositions and the suggestions of Flavell (1970).
The notion of activities having different implications
for memory performance and the concept of a strategy
hierarchy has already been discussed in Chapter 1.
The research on incidental memory also closely relates
to the performance deficit, for what Flavell's experiments
demonstrated was that experimenter-induced strategies
were as effective as spontaneous strategies in mediating
memory.

This led to a series of experiments based on the paradigms
of adult research Murphy and Brown (1975) and Geis and
Hall (1976), replicated the standard LOP result that
instructions which lead to processing of meaning ("deeper"
levels) lead to better free recall than instructions

to process more superficial features such as colour or
shape.

However there have been a number of recent criticisms
of the LOP approach and some of these have important impli-
cations for mediational models. It is important that
these criticisms are examined not only because of the
general insights they offer into mediational models
but because a number of reviews have suggested that LOP
theory be used as a framework for interpreting memory
development (Brown, 1979; Naus , Ornstein and Hoving,
1978). Firstly, there have been criticisms of the
notion of a hierarchy of levels. For example Craik
and Tulving (1975) demonstrated large differences in
recall for subjects processing to the same semantic
level. This suggests that there are differences in
processing within levels. Craik and Tulving , recognising
that the notion of "levels" had relied on intuitive
definition, attempted to find an independent measure
of depth of processing. They suggested that processing
time may well offer such a measure, but their data indi-
cated that this was not so. Subjects required to make
complex judgements about the formal features of words
took much longer to carry out such tasks than subjects
making semantic rating decisions. If time is an ade-
quate measure of processing depth than the group engaged
in the formal orienting activity should perform better.
than the group making semantic ratings. Craik and Tulving
found that this was not the case. A further problem for

the LOP approach was the finding that semantic ("deep")
processing may not always lead to better recall than
perceptual ("shallow") processing. Morris, Bransford
and Franks (1977) demonstrated that memory performance
was not determined by encoding activity alone, but by
the compatibility of encoding activity with retrieval
demands. Subjects who were required to remember percep-
tual features of the stimulus performed better when
they had engaged in the perceptual rather than the seman-
tic orienting activity. Thus depth of processing alone
does not determine performance, rather it is the
appropriateness of the encoding activity for the demands
of the retrieval task.

In addition to these problems, which are internal to the
LOP framework, there are a number of difficulties
associated with using the model in the interpretation
of developmental data. Firstly, there is the problem
of mapping the sorts of encoding strategies studied
by Flavell onto the levels described in the model.
Thus, while it is obvious that labelling involves
shallower processing than categorisation, what is the depth
of coding of a strategy such as self-test (i.e. looking
away from stimuli and attempting to name them all). This
brings us back to the previously mentioned problems
with the model: that levels of processing were defined
in an ostensive and intuitive way. The account does not
really explain the cognitive processes involved with
each type of processing, i.e. why it is that semantic

processing is more efficient than perceptual processing. A second problem with applying the framework to developmental data is that it ignores the crucial problem of the production deficit. The LOP experiments typically involve the experimenter instructing subjects to engage in various orienting activities: they do not explain the relationships between these activities and the strategies subjects normally employ. In addition, the account cannot explain the fact that children become increasingly able to select strategies appropriate to the task demands.

Given the problems associated with the framework itself and also with its application to developmental issues, it does not appear that the LOP framework in a developmental context offers any great advances on the theory put forward by Flavell. However, it does illustrate some of the problems associated with the mediational account. In particular, there is the problem of explaining why it is that mediators differ in their efficiency for inducing memory What is absent from the mediational account is any discussion of internal mechanisms, because of the focus on external activity. A model which includes such state variables may go some way towards accounting for the differential effectivieness of different mediators. In addition the findings of Morris et al (1977) imply that any such account must include some reference to the retrieval environment.

2.2.2   Explanations of mediational change

It has already been suggested (Chapter 1) that a major
problem with the mediational account is explaining how
mediation changes, and becomes increasingly effective
with age. A number of different accounts have been
offered attempting to explain this change.

Flavell's metamemory account

In 1971 Flavell published an article in which he reaffirmed
that memory is an intentional problem-solving activity,
and then attempted to apply what is known about the
development of problem solving in order to understand
the development of memory. Although acknowledging that
an increase in the mediational behaviours in the child's
repertoire may contribute to this development, he argues
that the major reason for the increased efficiency of
mediated memory is that it comes under increased inten-
tional control. This he attributes to children's increased
knowledge of when and how to remember. Thus, if young
children do not realise that they forget, they may
make no special effort to try and remember. Alternat-
ively, children may realise that they should do something
to remember, but they don't know enough about the cog-
nitive routines they have available to assess the
correct one. Flavell attributes this to a general change
in the child's cognitive abilities.

As children grow older, we know that they

> become more aware of the mental processes
> of other people (role-taking) and also more
> aware of their own mental processes (intro-
> spection). We think that they also become
> more aware of the what and the how of their
> own memory, <u>simply as a special case of their</u>
> <u>increasing introspective ability</u>. (1971, p. 277).

A more detailed exposition and analysis of the position
advanced by Flavell will be attempted in Chapter 3,
the section was included here merely to contrast the
theory with others which have been suggested.

The involuntary account

The set of suggestions discussed in this section has
been advanced piecemeal by a number of writers as a
model for the development of memory. The most detailed
discussion of this position is by Paris (1978a), but he
does not offer any empirical support for it. Apart
from this, both Brown and De Loache (1978), Meacham
(1972) and Yendovitskaya (1971) offer some speculations
which are consistent with the account offered here.
According to Yendovitskaya (1971), Meacham (1972),
Paris (1978a) and Brown and De Loache. (1978), one very
important means by which memory becomes more efficient
is by involuntary routines coming under the increased
control of deliberate memory. This is distinct from
the account offered by Flavell (1971) in two respects.
In Flavell's account it is suggested that memory strat-
egies are problem-solving routines specifically gener-
ated to meet the goal of remembering. According to
Yendovitskaya (1971) and Brown and De Loache (1978)

strategies are the modification of routines already in the cognitive repertoire. The second difference lies in the generality of the mechanism proposed to explain <u>how</u> routines come under the control of deliberate mechanism. Whereas Flavell (1971) argues that the growth of deliberate memory is the result of a <u>general</u> increase in reflectivity, they seem to suggest that reflectivity acts at the level of the specific routine itself. Meacham (1972) speculates that <u>practice</u> of the routine may lead to reflection into its structure, but no really detailed explanation is offered to account for reflectivity. A number of experiments and two major reviews (Lange, 1978, Ornstein and Corsale, 1979) offer some support for this position, although the data are suggestive rather than conclusive in many cases. If the account is to be supported, it seems that it is necessary to establish (a) that routines are originally involuntary, i.e. they are produced independently of memory goals; (b) that routines are later under the control of deliberate memory; and (c) that some knowledge of the <u>structure</u> of the routine emerges during this time. Condition (a) could be satisfied by giving the children a variety of non-memory instructions and establishing that the behaviour is produced in the absence of memory goals. Evidence that a routine is under deliberate control (condition (b)) might be supplied by the child modifying the earlier 'automatic' behaviour to meet the memory demands of the <u>particular</u> situation. Condition (c) may be satisfied by some metamemory measure.

Two major reviews of organisation in children's memory,
by Lange (1978) and Ornstein and Corsale (1979) suggest
that initially organisational factors are involuntary
and only gradually come under the control of voluntary
memory.

> ...the subject is "struck" by the organisation
> he perceives, and he encodes and stores organi-
> sation unites as a direct and automatic function
> of their perceived structure....it is reasonable
> to posit further that the recall organisation
> we sometimes see in pre-school and elementary
> school children has an exogenous basis and occurs
> through a series of involuntary actions that can
> operate at both the perceptual-encoding and
> retrieval phases of processing. (Lange, 1978,
> p. 107).

It is clear that both these reviews would argue that organ-
isational factors in the memory of older children are
under deliberate control, although neither seems to argue
strongly for 'reflection on structure' being responsible
for this change.

Lange advances two arguments to support his contention
that early clustering is involuntary. The first is
that such clustering only occurs with high-associate items
(Haynes and Kulhavy, 1976). It could be argued that
with low-associate items young children fail to detect
the categories, but as Lange points out, this failure
should be avoided when the experimenter labels items and
categories. However, even when labels are provided no
such clustering occurs.(Cole, Frankel and Sharp, 1971a,
Moely et al, 1969). In contrast, clustering does occur
when items from the same category are presented in
sequence (blocked presentation), because in this case

the experimenter is _imposing_ an organisation rather than
suggesting one to the children (Bjorklund and Ornstein,
1976).

In contrast, older children and adults appear to impose
structure on lists, regardless of item-relatedness or
item-order.   They will even do so when there are _no_
category relations between items (.Tulving , 1962).   In
addition subjects will modify the positions of the stim-
uli or their order, so that the stimuli correspond to
their own category organisation (Moely et al, 1969;
Ornstein, Naus and Liberty, 1975).

There is thus evidence which satisfies Conditions (a)
and (b) above, that routines are initially involuntary
and only later come under deliberate control. What is
the evidence for Condition (c), that this change is
due to reflecting on the structure of organisation?
Three studies have found that knowledge of the advantages
of categorised stimuli emerges around the time of the
first deliberate use of organisational strategies.(Monroe
and Lange, 1977; Moynahan, 1973; Salatas and Flavell,
1976a). However two of the studies found only weak
evidence that knowledge of category structure was predic-
tive of strategy use, and Monroe and Lange (1977) report
no relationship.

Brown and Smiley (1977) advance the argument that story
recall is initially mediated by involuntary processes

which come under intentional control and can thus be
employed as study strategies. They point out that all
subjects in the age range they tested (3 - 17-year-olds)
"extract the main theme and ignore the trivia" (Brown,
1979, p. 239). Brown and De Loache (1978) argue that
this occurred "with or without conscious intent to do
so" (p. 19), although they give no empirical evidence
in support of this statement. While it is implausible
that the youngest group were employing a deliberate
strategy of ignoring trivia, this has not been demon-
strated. Brown, Smiley, Day, Townsend and Lawton (1977a)
do demonstrate that <u>other</u> processes of text memory, initially
<u>are</u> mediated in an involuntary manner but they report no
relevant study of the extraction of central themes.

The evidence that the routine is later under intentional
control is much stronger. Brown and Smiley report two
findings which support this contention. Firstly they
found that children of 14 years or older, if given a
period of extra study time (equal to three times their
normal reading rate) would considerably improve their
recall for the important elements of the text. Recall
of less important details did not improve. Younger
children shared no such improvement. In addition,
older children were observed to make attempts to render
important information more salient, either by under-
lining it, or by taking notes during study time.
These actions do not much resemble automatic or over-
learnt activities. Condition (b) is therefore met:

there seems to be clear evidence of intentional use
of the study strategy, although there are slight
problems with satisfying Condition (a) as the crucial
experiment has not been conducted. There is also some
difficulty with Condition (c); Brown and Smiley do
report that subjects' knowledge of the <u>structure</u> of text
increases with age, but there is no obvious relation
between this knowledge and the emergence of the study
strategy.

The remaining evidence for this position is rather more
anecdotal in nature. In a study of the development
of cue use, Ryan, Hegion and Flavell (1970) observed
that not all their subjects seemed to be employing cues
in an intentional manner. Rather, it seemed that putting
pictures at the locations of identical animals, was the
result of some low-level matching behaviour. "Another
(child) might idly bring the picture up next to their
animal referents on one or more trials (a prepotent,
high-probability response to these particular task
materials for young children ... even without a recall
set)" (Flavell, 1970, p. 206).

Other studies of cues also report similar behaviours:
Ritter (1978) found that young children would search
under a marked cup even when they had observed an
animal being hidden under a different (unmarked) cup.
It is almost as though the children believe the cued
object moves with the cue. Gordon and Flavell (1977)

also suggest that early cueing has stimulus-response
characteristics. Young children had no awareness that
the usefulness of a cue might depend on the knowledge
of the searcher, or that low-associate objects may serve
as useful cues. Although these studies are consistent
with the general argument advanced here, in that appar-
ently involuntary early behaviours come to have increa-
singly deliberate characteristics, there is no attempt
to explain these changes in terms of changes in knowl-
edge about cuing. Ritter (1978) does include a number
of questions which are designed to assess the extent
of children's knowledge about cues, so it is possible
to test the hypothesis. Ritter's data would seem to
weakly support the hypothesis: knowledge about the cueing
 strategy appeared to increase during the pre-school
and early school years, and this was followed by more
systematic use of the strategy by older children.
However the expected relationship did not emerge at
the level of individual subjects. It is not possible
to conduct a similar analysis on the Gordon and Flavell
data.

In conclusion, there is a body of experimental findings
which support the contention that involuntary routines
are later used in a deliberate, intentional manner
in the service of memory. However there is little
evidence to support the argument that this is the result
of reflection on the structure of such routines. There
is more to support the account than Flavell's (1971)

arguments. The fact that knowledge of the structure
of different routines emerges at different ages depending
on the nature of the routine, suggests that a general
change in introspective ability cannot be responsible
for the increased intentionality of memory. There is,
however, one major problem with which the account leaves
unexplained, and that involves the origins of 'insight'.
The account offers no explanation as to how children
might become aware of the structure of their routines.
The problems of trying to explain the origins of knowl-
edge about memory, and the relationship of this knowledge
to the use of deliberate strategies will be discussed
in the next chapter.

Paris (1978a) suggests that reflectivity may not be the
only means by which involuntary routines enter the reper-
toire of strategies:

> Considerable practice and feedback may be
> necessary before the child understands the
> functional utility of the skill as a memory
> operation"   (p. 269)

Paris also suggests that another means by which routines
may enter the repertoire is by instruction, i.e. under
suggestion from the experimenter, an adult or a teacher.
This is important, because it suggests an important means
by which novel routines may enter the repertoire.
Unfortunately Paris' comments are largely speculative
and he offers no data to support these arguments.

If we consider first the influence of practice on the
development of intentional strategy use, there seems only

to be one relevant experiment, conducted by Butterfield
and Belmont (1977). The experimenters compared a group
who had extensive training in a particular strategy,
with a naive control group on a series of memory tasks.
They found that the trained group showed much more effi-
cient use of the strategy. In particular, unlike the
controls, they did not blindly apply the strategy to
lists they had already overlearnt. In addition, Butterfield
and Belmont found that the experimental group showed a
greater tendency to generalise the strategy to new lists.
While the results of this study are not inconsistent
with the reflectivity account it seems that the data
are more consistent with Paris' (1978a) focus on instruc-
tional settings.

The second mechanism suggested by Paris, to explain how
routines become intentional strategies is feedback.
Here we run into the problem of defining when a routine
has become such a strategy. We may determine whether
a routine already in the repertoire is initially invol-
untary, by the criteria offered above. Similarly, it
is clear that a routine directly induced by the experi-
menter is involuntary, because it has not been inten-
tionally accessed. After feedback, routines already in
the repertoire must satisfy the criteria set out above, but
what conditions must a trained behaviour meet, in order
to be accorded intentionality? This problem has been
raised by Kuhn (1974) in the context of inducing change
cognitive development and Brown (1978) when training

memory skills. They both conclude that the criterion
of generalisation is too strict because naturally
developing skills do not generalise in this way (witness
the whole debate on context-specificity , e.g. Donaldson,
1978). Brown has suggested that the criterion for
inferring that change has occurred is that the routine
follows the normal pattern of development. Though well-
intentioned, this criterion is of little use, because
we do not know the natural course of most developmental
acquisitions, and secondly the amount which a given
routine generalises during natural acquisition may
depend on its state of development (Flavell, 1970).

Given these problems in defining change in cognition,
and the unacceptability of the criterion of generali-
sation, it would seem that use of the strategy when
the experimenter no longer prompts is sufficient criterion
for inferring the behaviour is under voluntary control.

What then, is the evidence to suggest that induced
behaviours will be maintained without prompting, if
feedback is given? Kennedy and Miller (1976) demonstrated
that feedback will lead to maintenance of a rehearsal
strategy. The initial part of their experiment was a
replication of Keeney et al (1967), in that they diag-
nose 6-7-year-old children as producers or non-producers
and then trained the non-producers in the rehearsal
strategy. As in the Keeney et al study they found
that training elevated the performance of these children

to the level of spontaneous strategy users. Kennedy
and Miller then randomly assigned non-producers to two
groups and gave half the trained producers feedback
about the influence of strategy use. These children
were told that they were remembering much better and
that this must be due to the fact that they were whisp-
ering the names of the stimuli to themselves. The
spontaneous producers and the two groups of trained
producers were then given a transfer test. They were
told that they could whisper the names of the stimuli
to themselves if they wished, but they need not do so.
Both the spontaneous producers and the trained producers
who were given feedback continued to use the strategy.
The trained producers who did not receive feedback failed
to maintain the strategy. Feedback information would
therefore seem to be crucial in determining the main-
tenance of induced strategies. It is possible that a
similar mechanism could operate in natural learning
settings. Other studies have also shown that feedback
can influence strategy maintenance. (Borkowski, Levers
and Gruenenfelder, 1976; Cavanaugh and Borkowski,
1980; Moely and Jeffrey, 1974).

Although feedback seems to influence the maintenance
of evoked strategies, it does not seem to be an absol-
utely necessary condition. A number of studies report
maintenance in the absence of feedback. (Bjorklund ,
Ornstein, Naus and Stone, 1977). and the position is
further complicated by the fact that others find that

feedback is sometimes, but not always required. (Heisel
and Ritter, 1981; Ringel and Springer, 1980).

A study by Brown, Campione and Barclay (1979) suggests
a possible resolution of these anomalies. In the
initial part of the experiment they trained a group of
educable retarded children on a supraspan list. The
children were taught both a strategy for dealing with the
task, and a checking strategy to monitor the effectiveness
of the strategy use. When these children were given
a different task - the recall of prose passages - it
was found that they retained the original strategy.
Another group of children who did not receive training
in the monitoring strategy did not show transfer (Brown
and Barclay, 1976). The findings here are exactly
analagous to the Kennedy and Miller (1976) study except
that feedback information is not provided by the experi-
menter, but is detected by the children themselves, in
monitoring their performance. If children can detect
the effectiveness of the strategies they have been
induced to use, and if they realise that performance
improvements are due to the use of strategies, then
this should lead them to use the strategies in the service
of memory. In the absence of such training in monitoring,
transfer or maintenance will depend on the child's
spontaneous monitoring skills. Three studies have been
conducted which show that even 5-year-olds are accurate
at judging their performance after they have carried
out a memory task (Berch and Evans, 1973; Bisanz,
Versander and Voss, 1978; Masur ., McIntyre and Flavell,

1973). However these suggestions of early competence
in monitoring memory tasks are contradicted by findings
in other cognitive domains suggesting that children's
moment-to-moment monitoring of their performance is
poor (Flavell, Speer, Green and August, 1981; Harris,
Kruithof, Meerum-Terwogt and Visser, 1981; Markman,
1977; 1979). Possible reasons for these differences
are suggested in Chapter 3, in the review of metamemory.
However, if we assume that the ability to monitor
strategy effectiveness does increase with age, then the
data on strategy transfer may be explained.

If we consider first the Ornstein et al (1977) study, we
find that maintenance of a rehearsal strategy seems to
be a function of strategy effectiveness. The experi-
menters trained 7- and 11-year-olds to produce one of
a number of different rehearsal strategies. Children
were taught to rehearse in sets of one, two or many
items. It was found that for the 7-year-olds, only
those subjects who rehearsed many items were observed
to maintain the strategy when not directly instructed
to use it. Now, in general, the subjects using the
many item strategy were much more effective in remembering
the list, for one and two item rehearsal produces
little elevation of performance. It is possible that
the one and two item rehearsers did not monitor the
strategy because (a) their inability to monitor accurately
left them unable to detect the improvements resulting
from the use of the strategy; or (b) they could detect

the effects of the strategy but decided that the advantages of strategy use were so slight that there was little point in employing the strategy; or (c) they detected a small change in performance but attributed this to other factors likely to produce such a change, e.g. practice and not the strategy itself. Whichever of these explanations is applicable it is clear that transfer crucially depends on the detectability of the changes in performance following strategy use. This would seem to depend among other things upon the absolute size of these changes, and the ability of the child to detect them.

The other experiments in which maintenance occurs without feedback also suggest that such factors are important. Thus Bjorklund et al (1977) found strategy maintenance in 10- but not 8-year-olds. Closer analysis reveals that the strategy did not improve performance in the 8-year-olds, there is therefore no real reason why this group should maintain it. The Heisel and Ritter (1981) and Ringel and Springer (1980) studies provide evidence for explanations (b) or (c) offered above. Both studies found three different sets of conditions under which maintenance could occur: (1) when information was provided about changes in performance and the relationship of these changes to strategy use; (2) when information was provided only about the effectiveness of strategy use; and (3) when no information was provided. It was found that the amount of feedback information and

explanation necessary to induce maintneance decreased
with age, although the ages differed in the two studies
because different strategies were involved.

It seems therefore that feedback is not the only means
by which trained routines may come to serve as memory
strategies. If children are able to detect the results
of their activities this may produce maintenance when
no feedback is given. This sort of mechanism may only
operate, however, if strategy is detectable, i.e. if
its effects are large and children are able to monitor
them.

Paris' (1978a) offered a number of speculations as to how
routines may enter the memory repertoire. Although
he reviewed no evidence for these suggestions, it appears
that there is some validity in what he proposed. Both
practice at a strategy and feedback about its effective-
ness seem to influence whether strategies are maintained.
Change may also be brought about by a mechanism he
did not specify : self-monitoring may well explain
maintenance in the absence of feedback. All of the evi-
dence reviewed here concerns induced strategies, it
remains to be seen when feedback or self-monitoring influ-
ence voluntary routines in the way Paris suggests. Des-
pite this, there is rather more evidence to support Paris'
speculations than there is for the account which attri-
butes developments in deliberate memory to reflections
on the structure of involuntary actions.

The motivational account

Another set of speculations about how mediated memory
develops is offered by Russian theorists (e.g. Istomina,
1975; Leont'ev, 1975; Yendovitskaya, 1971) and endorsed by
statements from Brown (1975), Meacham (1972) and Paris
(1978a). Although allowing that practice, feedback and
instruction can and do influence memory development,
these theorists suggest that major changes in the ecology
of the young child may be the determinants of developmental
change. In particular, they suggest that the goals
which are motivating to the older child or adult are
not motivating for the pre-schooler. They argue that
deliberate memory (remembering for its own sake) is much
less motivating for the younger child. The first emerg-
ence of skills occurs in those situations in which memory
is subordinated to some other activity which is meaningful
for the child.[4]

> the development of retention and recall as
> internal, purposeful acts takes place initially
> as part of a broader, articulated and meaningful
> activity (since it is only within the context
> of such activity that the specific acts of
> remembering and recall have any meaning for a
> child). (Istomina, 1975, p.8-9).

The theory therefore suggests that memory skills (presumably
equivalent to mature adult abilities) emerge first in a
restricted set of situations, and only later generalise to

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4   These speculations parallel recent suggestions made
    by Donaldson (1978) about general cognitive development.
    She suggests that young children do not perform well
    on tasks which are "abstract" or do not make "human
    sense".

the set of situations corresponding to adult usage. The
restricted situations can be characterised by the fact
that they are "embedded in a meaningful (to the child)
activity" (Brown, 1979, p. 249), and they later occur
in other situations in which memory itself is the goal
of activity. However, if this account is to have explan-
atory value, it becomes necessary to appeal to some inde-
pendent criteria by which we can determine which context
will be "meaningful" to the young child. We require a
theory of the child's goals and activities in order to
provide this. The nearest that the account comes to
specifying what might be meaningful contexts, is to suggest
that young children perform well in "game-like" situations.
Clearly the manipulation of embedding a memory task in
a game-like setting does improve memory (Istomina, 1975),
but it seems to be motivated by an intuitive rather than
a theoretical analysis of what is "meaningful" for the
young child. Another problem lies in the claim that in
deliberate memory tasks, remembering itself is the only
goal. It is clear that any activity takes place in some
context with its attendant motivations, such as a desire
to please the experimenter or instructor. Memory is
therefore not the only goal involved. This relates to
the problem of defining meaningful contexts because a
principled analysis of context would have indicated that
deliberate memory tasks are different but not context-free
situations.

The theory also seems to contravene a commonly held

assumption of developmental theories. Memory strategies
first emerge when memory itself is subordinated to some
higher-level activity, and are only later in evidence in
the service of memory alone. Subordinating a strategy to
achieve a memory goal in order to carry out some meaning-
ful activity would appear to a more complex activity than
simply subordinating that strategy to memory. If this
is the case, then memory becomes simpler with age,
which would appear to contradict most theoretical state-
ments about development (e.g. Atkinson, 1982; R. Brown,
1973; Harris, 1957). Of course, the account could be
rescued by arguing that deliberate memory tasks are part
of some wider activity, but this would seem to contradict
the fundamental tenets of the argument.

Finally, an account such as this must specify how chil-
dren become increasingly able to apply strategies in
the absence of supportive contexts. Some theorists are
clearly aware of this problem, and Kussman (1976) and
Elkonin (1972) advance a set of "leading activities" which
children at each age level find most motivating. In
generating this description, the authors make some appeal
to the conditions and ecology of the child at each of
these ages. But such speculations in no way amount to an
explanation of why leading activities change, nor how
they are related to the everyday environment of the child.

Literacy

Another factor invoked to explain changes in mediated

memory has been formal education or literacy. (e.g. Brown,
1977; Meacham, 1972; Paris, 1978a) Cole and Scribner (1977)
review a number of experiments which indicate that non-
literate peoples behave rather as do young children
when confronted with a deliberate memory task. They
characteristically show production deficits for categor-
isation and rehearsal strategies (Scribner, 1974; Wagner,
1974). In addition, Scribner and Cole (1973) suggest that
unschooled populations do not transfer strategies.

There are two problems with this approach. Firstly, in
some of the studies it is not clear that the onset of
literacy or formal education is the only explanation
for the results obtained, because in some of the studies
the effect of schooling may be confounded by other varia-
bles such as conversion to a cash economy (Cole and Scribner,
1977) or collective farming (Luria, 1971). Additionally,
one may have found differences between the two populations
and the relationship of these differences to a particular
factor, but it is still not clear precisely how schooling
or literacy influence memory mediation. It may well be
that schooling and formal education include more of the
sorts of instruction and feedback type activities which
have been shown to influence memory. If this were the
case, (and it is an empirical question whether schooling
includes these processes) then this argument is reducible
to the mechanisms suggested earlier in the chapter.

In the initial sections of this chapter I have discussed

attempts to apply the LOP framework to mediational
models of memory and also attempts to explain how media-
tional processes develop. I concluded that there are a
number of important deficits in the LOP model when applied
to adult memory. The model is even more problematic
when applied to developmental data, in particular because
there has been no detailed analysis of encoding activities,
and consequently it is difficult to see how the results
of Flavell's (1970) experiments could be interpreted
within the model. Additionally, the model avoids the
key question of how subjects access encoding activities
which is of crucial importance in exploring production
deficits. Because of these difficulties, it was con-
cluded that the LOP framework was of little use in
developmental theorising.

I then examined a number of reformulations of Flavell's
(1970) model which attempt to explain the production
deficit, and also the question of how memory mediation
becomes more efficient. A number of alternatives were
suggested one of which (Flavell, 1971) will be assessed
in the next chapter. A number of theorists have suggested
that memory is initially involuntary in nature and only
gradually comes under the control of intentional processes.
The evidence would seem to support this view, but not
the mechanism suggested by some accounts to explain
the change. Of the studies so far conducted, none
show that knowledge of the structure of routines induces
intentional strategy use. In addition such accounts do

not explain how such knowledge originates. Evidence
for Paris' (1978a) speculations about the influence
of feedback in modifying involuntary routines into
deliberate ones was also reviewed. It was suggested that
feedback may well induce such a change, but that evidence
suggests other factors (such as self-monitoring) may
also be responsible. Soviet theories of memory develop-
ment were also reviewed and found to be problematic
in a number of ways. In addition it was argued that
cultural factors influence the development of mediated
memory, but that such factors may well be integrated
with the earlier studies on feedback, self-monitoring
and instruction.

2.3 Memory without mediation

Attempts to integrate the mediational model with the
LOP framework, and the speculations about how mediation
may change with age (Brown, 1975; Flavell, 1971;
Istomina, 1975; Meacham, 1972, Paris, 1978a) were all
modifications to the basic model, and all accepted the
principle that memory is mediated by various strategies.
A number of experimental results which emerged in the
early 70's suggested, however, that mediation may not
be a sufficient explanation of memory, i.e. certain
phenomena were detected which could not be explained
within the mediational framework. These led to a mod-
ification of the basic model by Brown (1974, 1975)
to include the structural features of information

processing models. Brown (1974, 1975) and Hagen,
Jongeward and Kail (1975) review evidence for such struc-
tural effects, and Brown (1975) provides a taxonomy
of tasks and processes in an attempt to unify structural
and mediational explanations.

2.3.1 Problems for the mediational model

One finding which suggests problems for the mediational
model has already been noted. In Flavell's (1970) review
he points out that in most studies non-producers remember
some (but often not many) items. This would suggest that
mediation is sometimes not necessary for memory. To give
an example, non-rehearsing 4- and 5-year-olds typically
manage 23% correct responses, while rehearsing 10-year-olds
obtain 45% correct (Hagen and Kingsley, 1968).

Chi (1978) reviews other data which suggest the inadequacy
of the mediational account. In all these experiments,
attempts have been made to control for strategy use in
adults and children, and yet age differences still remain.
Thus: if an adult strategy is taught to children, recall
is still generally better in adults (Butterfield, Wambold,
and Belmont; 1973); if an adult strategy is taught to
both children and adults, the initial difference in perfor-
mance between age groups is generally maintained (Huttenlocher
and Burke, 1976); and if adults are prevented from using
certain strategies, their performance remains superior
to that of children (Chi, 1977).

In the above experiments, it is clear that mediational

accounts cannot explain <u>all</u> of what is remembered. It
could be argued, however, that the account is still
adequate, because the "non-strategic" component is
relatively small, and could be written into an explan-
ation as a sort of "error term". Brown (1974) argues
that this ad hoc modification to the theory will not
suffice, because there are phenomena in which memory
performance occurs in the <u>total</u> <u>absence</u> of mediation. She
claims that recognition memory and memory for relative
recency are two such phenomena, and that strategies cannot
explain any part of what is remembered in these cases.

In addition there are a number of tasks in which memory
occurs, where it is not clear what mediational factors
may be acting, although a mediational explanation looks
possible in principle. Thus, adults recall lists of
taxonomically related items by category, without <u>any</u>
overt evidence of item sorting (Tulving and Pearlstone,
1966). Such findings can be explained by extending the
notion of mediated activity to something internal, and
claiming that the recall observed in adults is the
result of the internalisation of the externally mediated
activities observed in children (e.g. Moely et al, 1969).
What, however, are the internalised activities which
mediate the recall of text (Mandler and Johnson, 1977;
Stein and Glenn, 1979) or sequences of story-like events
(Brown and Murphy, 1975)? Again the explanation in terms
of internalised mediational processes looks possible in
principle, but it is not clear what the form of these

processes might be.

Brown's (1974; 1975) and Hagen et al's (1975) solution
to these problems was to propose that mediation was
not the only explanation of memory. They argued that
the above anomalies could be explained if we invoked
the structural factors included in information processing.
models (e.g. Atkinson and Shiffrin, 1968) and also theories
of cognitive development (e.g. Piaget and Inhelder,
1973).

2.3.2 Structural effects in memory

Two types of structural models have been invoked in
attempts to explain the various anomalies with the media-
tional model: these are the modal model (e.g. Atkinson
and Shiffrin, 1968; Waugh and Norman, 1965); and the
semantic and structural models, (e.g. Collins and
Quillian., 1972; Piaget and Inhelder, 1973; Rummelhart
and Ortony, 1977; Schank and Abelson, 1977a, 1977b).

The modal model argues that information entering the
memory system is held in three separate stores, it
being transferred from a low-level sensory store, to
an intermediate short-term store of limited capacity,
and then to a long-term, permanent store. Each store
was primarily defined in terms of three characteristics:
capacity, coding type, and the length of time the
information could be retained in the store. Information

in the sensory store was said to be a "copy" of the
sensory input (hence the terms iconic or echoic store),
and could be held in this store for short periods. The
duration of the sensory store ranged from half a second
to several seconds, depending on the particular store
studied, and the method of measurement. Its capacity
was large, but there were problems in accessing inform-
ation from the store, so the capacity could not be directly
estimated. The information from the sensory stores
was transferred to a short-term store (STS) of limited
capacity (7 $\pm$ 2 "chunks" of information according to
Miller, 1956), in which it was stored in the form of a
speech based code. The amount of time information
could be retained in STS depended on control processes
such as rehearsal, by which this information can be
refreshed. It was then transferred to a long-term store
(LTS) of large capacity in which information is held
for long periods (in the order of years) in a semantic
code.

The model came under attack by Craik and Lockhart (1972)
in their initial LOP paper. They point out that there
are problems with capacity, coding and duration in each
of the stores. For example, there are large disparities
in the estimates of duration for the sensory stores
mentioned above. Similarly there are problems with the
notion of coding in STS and LTS. In particular, semantic
effects have been found in STS, and speech based coding
in LTS, both of which are obviously contradictions of the

basic model. Craik and Lockhart also pointed to anomalies between different estimates of capacity for STS which vary, once again, with the method of measurement used. The solution that Craik and Lockhart proposed to all these problems was an attempt to explain many of the invariant structural features in terms of control processes such as rehearsal or chunking. This approach has also been advocated in the working memory theory of Baddeley and Hitch (1974).

If Craik and Lockhart are correct, then it would appear that there is little use in appealing to the modal model, because many of the features which were thought to be explicable in terms of structures now seem to be the results of processes similar to mediational activities.

This contention is supported by the recent work of Chi (1976, 1977) and Huttenlocher and Burke (1976) who have investigated developmental changes in memory span. The consensus is that the explanation for such changes lies mainly in adults' and older children's use of control processes such as rehearsal or re-ordering items. There was little evidence to suggest any changes in the underlying capacity of memory. This conclusion is important because it challenges the contention of a number of recent Neo-Piagetian theories, that changes in cognitive skills follow directly from increases in the capacity of memory (Case, 1974; Pascual- Leone , 1970). At the very least, it suggests that "capacity" is a

problematic concept.

Chi (1978) <u>does</u> report some underlying differences
between adults and children which are not readily explic-
able by control processes. In a carefully controlled
set of experiments she attempted to prevent adults from
using strategies in a face recognition test. She used
faces which were equally familiar to child and adult
groups, and prevented adults from modifying their order
of recall. Additionally, the use of face stimuli should
prevent organisational strategies, because groups of
faces do not readily form units. Despite all these pre-
cautions, Chi still reports differences between adults and
children. These differences were removed, however, by
reduction of the time the stimuli were exposed to the
adult subjects. By reducing the presentation time
for adults to half their speed at naming the stimuli,
Chi managed to equalise performance in the two groups.
Thus, there are underlying processes such as speed of
naming, encoding time, which are not themselves control
processes, but which change with age, and influence the
use of such processes. As Chi (1978) puts it:

> One could speculate... that the inaccessibility
> of the (stimulus) names prevents the children
> from actively using any mnemonic strategies
> that required name manipulation.   (p. 80)

Such changes go some way towards explaining some of the
anomalies which first led us to question the utility of
the mediational model. It may well be that they will
explain why children do not perform as well as adults

when trained to use adult strategies (Butterfield et al,
1973) or why adults are better than children when trained
on a new strategy (Huttenlocher and Burke, 1976). They
will not, however, explain all the anomalies. The results
of Chi suggest that there are limitations in the component
skills which make up control processes. They do not
explain memory in the absence of such control processes .
(e.g. Flavell, 1970) or when the use of strategies is
blocked (Chi, 1978).

In conclusion, structural models of memory such as the modal
model seen problematic in their application to adult
memory (Craik and Lockhart, 1972). Many of the properties
associated with structural features seem to be the result
of control processes such as those described in the media-
tional model. If indeed the structural model is reducible
to such processes, it will not serve to explain the anomal-
lies in the mediational model, because some these problems
are common to any mediational account. Research on the
modal model, and in particular the notion of capacity,
has, however led to the discovery that the components of
control processes (such as naming or encoding) may well
vary with age, and hence explain the differences in perfor-
mance between adults and children when strategy use is
apparently matched.

The second set of structural models which influenced
developmental theorists, were those that included some
component of meaning. Among these were the semantic

memory models (Anderson and Bower, 1973; Collins and
Quillian, 1972), schema models (Piaget and Inhelder, 1973;
Rumelhart and Ortony, 1977), and story grammars (Mandler
and Johnson, 1977; Rumelhart, 1977; Stein and Glenn, 1979;
Thorndyke, 1977). All these models are cognitive, i.e. they
make the assumption that there are certain state variables
(in most cases, these take the form of structures) to
which incoming stimuli are assimilated. This results in
some modification of the input (and in most models, a
reciprocal change in state) and then some output. The
output is not a replica of the input because of the infl-
uence of the modifying state variables, and it is possible
to make inferences about the putative cognitive struct-
ures from the process of distortion which results.These distortions
are not the result of deliberately invoked strategies,
because in most cases the effects seem to be involuntary.
If we consider that the modifications to the input often
result in reduced performance, because the criterion used
for memory is verbatim reproduction, this strongly suggests
the effects cannot be prevented.

A large number of studies have investigated semantic
effects at the level of individual words. Thus Esrov,
Hall and LaFaver (1974), and Kail (1976) demonstrated the
presence of category information in 3-5-year olds. Simila-
rly, habituation (Faulkender, Wright and Waldron, 1974),
choice reaction time (Morin, Having and Konick, 1970), and
the Stroop effect (Rosinski, Golinkoff, and Kukish, 1975)
have all been employed to demonstrate the presence of

taxonomic encoding. A review by Kail and Siegel (1976) concludes that children are much better at encoding the denotative than conotative features of stimulus words.

A series of studies on adults by Bransford and his coll-eagues (Bransford, Barclay and Franks, 1972; Bransford and Franks, 1970 ;and Bransford and Johnson, 1973) suggested that the knowledge system may influence what is remembered at higher levels than the level of individual words. These experiments suggested that under certain conditions, adult subjects did not remember individual sentences (Bransford and Franks, 1970), they also modified their memory for sentences in accord with their knowledge of spatial relationships (Bransford et al, 1972) or setting information such as a picture or story (Bransford and Johnson, 1973).

Corresponding studies have been conducted on children. Thus Paris and Carter (1973) and Paris and Mahoney(1974) have found that young children also integrate information across sentences or pictures to make spatial inferences. Harris, Mandias, Meerum- Terwogt and Tjintjelaar (1980) showed that children use the information provided by a title to disambiguate a prose passage. Paris and Upton (1976) also suggested that children may use information in their knowledge system to go beyond the information presented in the text.

There are, however, a number of problems with these
studies. The results of Paris and Carter (1973) and Paris
and Mahoney (1974) were obtained using a false recognition
paradigm, which Paris (1975) and Trabasso and Nicholas
(1980) point out may be subject to response bias.
Additionally Liben and Posnansky (1977) show that part
of the effect attributed to semantic inferences in the
Paris studies, can in fact be explained in terms of a
syntactic matching strategy. The presence of this strat-
egy demonstrated that subjects did not abstract only the
meaning of the stimuli, but did retain information about
the surface structure of text.

There are also problems with the results obtained by
Paris and Upton (1976). They asked subjects questions
which probed verbatim information and two types of
inferences which could be drawn from the passage. These
were lexical inferences and contextual inferences: the
first assessed children's knowledge of word meanings;
the second, their ability to infer the motivations of
the characters, and the consequences of their actions.
Paris and Upton found that the ability to make infer-
ences increased with age, and also that contextual infer-
ences correlated with free recall scores. From this,
Paris and Upton inferred that recall depends on the extent
to which children integrate the story with their knowl-
edge of the world. Older children are better able to
make such inferences, and hence better able to remem-
ber.

In a similar study, Omansen, Warren and Trabasso (1978)
showed, however, that inferential skill as assessed by
a questionnaire (as in Paris and Upton) was not related
to recall.   Three groups were respectively given positive,
negative or no contextual information about a story.
The two groups given such information were better able
to answer the questions about the characters' motives
or intentions, and the consequences of their actions.
These two groups did not, however, outperform the no-
context group in the recall test.   A second problem for
structural theories of memory is that such inferences
may be the result of deliberate strategies (Paris, 1978a;
Harris et al, 1980).   If this is the case, they may
tell us little about the structure of children's knowl-
edge bases, but more about how children operate them.

The major problem with the research of Bransford and
Paris and their colleagues is that their research
demonstrates that high level semantic factors do influ-
ence recall, but does not suggest what factors may cons-
train the nature and context of semantic inferences.
Although some attempts have been made to provide a
taxonomy of inferences (Nicholas and Trabasso, 1980; Paris,
1978b), this could in no way be said to represent a
theory of how knowledge factors interact with material
to be remembered.

Attempts have been made elsewhere in cognitive psychology
to suggest structures which constrain the nature of

inferencing, or constructive processes. Minsky (1977)
and Schank and Abelson (1977a), proposed the existence
of internal structures corresponding to prototypical
spatial arrangements (i.e. a room frame) or event
sequences (a script). It is the involuntary operation
of these structures which lead to the types of construc-
tive or 'normalising' errors described by Bartlett (1932)
and possibly contribute to the effects reported by
Bransford and Paris. As Schank and Abelson put it:

> In understanding a story that calls up a
> script, the script becomes part of the story
> even when it is not spelled out. The answer
> to the question, 'Who served John the ham-
> burger?' seems obvious, because our world
> knowledge, as embodied in (restaurant) scripts
> answers it.   (1977b, p. 425).

The occurrence of such script-relevant intrusions has
been reported for adults by Bower, Black and Turner
(1979) who asked adult subjects to recall short stories
based on incidents such as visiting the doctor or eating
in a restaurant. Mandler and Parker (1976) showed similar
effects of 'normalisation' when adult subjects were
presented with pictures containing objects normally
found in rooms, but with the spatial positions of
the objects randomised. Brown and Murphy (1975) also
report 'normalisation' effects when pre-school chil-
dren attempt to remember event sequences.

Nelson (1978) set out to address the question of the child's
representational structures in more direct manner. She
wished to establish how young children represented familiar

event sequences such as playgroup routine or eating at
home or at McDonalds. The procedure she employed was
to ask children to describe or enact such sequences. She
found that certain events (one of which was eating) seemed
to be central and appeared in all accounts, whereas other
events were of less importance as judged by their frequency
of mention. More importantly there were few instances of
sequencing errors. A second study showed that knowledge
of playgroup routines depends on familiarity or experience
with the routines. In all cases, however, children seemed
to show sophisticated knowledge of activities, actions,
roles, instruments and their sequencing. In both studies
probing methods were used. It was found that older
children required fewer probes, and what probes they did
require were less specific.

There are a number of theoretical and methodological probl-
ems with this study. First of all, it had a large lingui-
stic component, and young children are always going to
be disadvantaged in both the comprehension and production
of language. One of the indices of scriptal knowledge
was the ability to produce long unprompted "chunks" of
the script. This may well be a poor measure to use
given young children's well documented inability to output
prose (e.g. Brown and Murphy, 1975). Some of the develop-
mental trends may be explained by this factor alone..
Nelson also makes some capital of the fact that children's
answers became more specific with age. In adults the
specificity of the answer depends greatly upon a number

of factors, such as context, and the inferred knowledge
state of the questioner. The pragmatic skills of giving
relevant answers may well develop with age. Changes in
response specificity may therefore have resulted from
a developing awareness of what the questioner requires.
The study requires another skill which young children seem
to lack: the ability to introspect on the structure of
their cognitive routines. Again developmental differences
in this ability may have contributed to Nelson's results.
Finally, the finding that output follows temporal sequence
is no guarantee that information is represented in this
way. As Linde and Labov (1975) have shown, spatial
organisations may well be described in a particular sequ-
ence, because that happens to correspond to a convenient
retrieval strategy.

A second "prediction" of these structural models is that
stimuli which are "well formed" with respect to the inter-
nal structures will be better remembered than poorly
formed stimuli. This effect occurs over and above the
sorts of normalisation effects reported above. Thus,
Carey and Diamond (1977) showed that children's recognition
of upright faces was superior to this recognition of
inverted faces at the ages of 8 and 10 years. This
difference was not present in 6-year-olds. Similarly,
Mandler and Robinson (1978) report a superiority in
recognition memory for organised over unorganised scenes,
which increases with age. Both sets of authors explain
their results in terms of the development of schemata
for faces or scenes. This explanation seems a little

problematic for faces, because one might have expected
a schema for such an important stimulus as a face to
have developed before the age of 8 years.

The concept of stereotypical sequences of incidents being
represented internally led several researchers to propose
that stories could be organised in this way. These resea-
rchers proposed hierarchical 'story grammars' from which
they hoped it was possible to analyse the well-formedness
of particular stories, and to predict where intrusions or
modifications to story order might occur. (Mandler and
Johnson, 1977; Rumelhart, 1977; Stein and Glenn, 1979;
Thorndyke, 1977). At first sight, story grammars do seem
to provide an adequate structural account of story memory.
Mandler (1978) and Stein and Glenn (1979) both report the
sorts of 'normalisation' errors described above, where
intrusions were attempts to fill known, but missing story
categories. Mandler and De Forest (1979) presented
subjects with well-formed and poorly-formed stories. The
well-formed stories consisted of two episodes presented
in canonical fashion. In the poorly-formed stories
incidents from the two episodes were intermixed. The
not unsurprising finding was that subjects at all age levels
recalled more of the well-formed stories, and additionally
they modified what they could remember of the poorly-
formed stories to follow canonical study order. One
interesting developmental trend was that although 7- and
9-year-olds were unable to prevent normalisation, 15-year-
olds did show some modest abilities to follow the original

intermixed story order.

By far the most systematic study of structural theories of
memory development has been conducted by Piaget and Inhelder
(1973) and other experiments which followed their research.
The argument they advanced was that the same set of
internal structures are responsible for both memory and
cognition. Piaget and Inhelder investigated a number of
different effects and attempted to explain them in terms
of the structural systems they had proposed to explain
related cognitive phenomena. These systems include those
responsible for seriation, conservation, horizontality and
verticality concepts.[5]

It is possible to generate a number of predictions from
the theory: (a) the assimilative properties of structures
will lead to the normalisation phenomena reported for
other theories, i.e. intrusions or modifications of the
stimulus will occur which bring it in line with these
structures; (b) well-formed stimuli will be better remem-
bered than poorly-formed stimuli, with this being partly
the result of normalisation. These predictions are common
to the structural theories described earlier. However,
because Piaget and Inhelder's is a developmental theory,

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5 Although there is much dispute about the status of
   these structural systems (Brainerd , 1978a, 1978b;
   Brown and Desforges, 1979; Siegler, 1979) this research
   has an advantage over the other structural theories of
   memory, because there is at least some evidence for the
   independent existence of the proposed structures in
   domains other than memory.

they also include predictions which take structural change
into account: (c) if a stimulus taps certain cognitive
structures, then it will be better remembered by subjects
in possession of those structures; and (d) if a stimulus
taps certain cognitive structures and the subjects' level
of operativity increases (i.e. structures are acquired)
during test and retest, then subjects' memory for the stimuli
will improve.   In her review of the Genevan literature
Liben (1977a, 1977b) refers to predictions (c) and (d) as
the cross-sectional and longitudinal hypotheses respectively.

Predictions (a) and (b) are supported by data from exper-
iments conducted by Altemeyer, Fulton and Berney (1969)
and Liben (1974). Altemeyer et al presented 5-year-old
subjects either with arrays of sticks which were seriated
or in a random sequence.   They found that after
post-presentation intervals of one week and 6 months, the
children tended to normalise the random array, so that
their reproductions were more like the original seriated
array. This resulted in higher memory performance for
the group who received seriated arrays initially. The
data also provide some support for prediction (c)
                    reconstructions became
because/increasingly seriated between test and retest.
According to Piaget's theory, it is at this age that seri-
ation skills first emerge. Liben (1974) found essentially
the same results, but for a different cognitive structure -
horizontality.

Furth, Ross, and Youniss (1974) conducted a study to

investigate hypothesis (c) above, that memory for stim-
uli should be influenced by subjects' operative level.
The cognitive skills tapped were horizontality, spatial
transformation, number sequencing and verticality. The
respective stimuli were pictures depicting: a glass
tipped at an angle of 45°; a stick falling off a table,
a sequence of 1, 2, 3, 5, and 6 dots arranged as on the
side of a die; and a house with a chimney with the smoke
coming out of the chimney at the wrong angle. Children
aged 6, 7, 8 and 10 years were tested on these stimuli
at intervals of 2 hours, 2 weeks, 6 months and one year
after presentation. In addition, half the subjects were
asked to copy the stimuli while they were still visible,
and the other half asked to reproduce the stimuli immed-
iately after presentation.

Collapsed over all sessions, the data support the Genevan
position. Older children produced more correct and
fewer irrelevant reproductions for the glass, stick and
dot stimuli. For the house stimulus, there was an
increase in the number of drawings which corrected the
error in the original drawing by making the smoke come
out of the chimney vertically. These findings substan-
tiate Piaget's claim about the relationship of memory
to operative level: according to his theory drawings
should increasingly conform to high level operative con-
cepts. Thus, there was an increase with age in correct
drawings for the operatively correct stimuli (stick,
glass and dots), and when the stimulus was not correct,

there was an increased tendency to modify it in the
direction of correctness. Liben (1975a; 1975b) also
investigated the cross-sectional hypothdsis over a
range of stimuli and with subjects greatly differing
in operative level. She presented 5- and 9-year-old
subjects with six pictures which were related to three
operative concepts: seriation, horizontality, and vertic-
ality. After one week and five months the subjects were
asked to complete pictures from which the operative
components were omitted.

The predictions for the seriation stimuli were that
these would initially be poorly reproduced by the 5-year-
olds, but their reproduction would improve on retest
because of developments in seriation skills. In contrast,
the 9-year-olds should be adept at seriation and thus
perform well at test and retest. The predictions for
horizontality and verticality are rather different: 9-
year-olds are transitional with respect to both of these
concepts, and so initially reproductions should be mixed,
with an increase in operative skills resulting in higher
level reproductions at retest. Five-year-olds should
perform poorly throughout because of their lack of knowl-
edge about these concepts.

In general the predictions were fulfilled. Reproductions
of the seriation stimulus were mixed for the 5-year-olds,
and at ceiling for the older group. For the horizontality
and verticality stimuli, the only perfect reproductions

were generated by the older children. Additionally,
long term improvements were found on the seriation stim-
uli for the younger group, and on the horizontality
and verticality stimuli for the older group.

In conclusion, both studies which have tested a wide
operativity range over a variety of stimuli would seem
to support the Piagetian position. However, most of the
studies conducted within the framework have focussed
on prediction (d): that changes in operative level should
result in memory improvement for individual children.
It must be noted that the above two studies provide
evidence at the group level.

Piaget and Inhelder's original (1973) experiments
investigated long term memory for a variety of stimuli
requiring seriation and Euclidean spatial concepts. The
seriation data offer strongest support for the hypothesis:
Piaget and Inhelder report 74% of 5-year-old children
improved their reproduction of a seriated stimulus between
an initial test after 1 week and retest after 8 months.
The remaining children's performance was stable over
this interval. Most other studies do not report such
high levels of improvement, 30% is closer to the norm.

There have been at least ten attempts to replicate
the finding of long-term improvement. Altemeyer et al
(1969) in the study cited earlier, investigate this
effect for seriated and unseriated arrays. The subjects

were 5-year-old children and test and retest were one
week and six months after presentation. Children predom-
inantly showed improvements[6] in reproduction of both sets
of stimuli. More importantly, most children showing
improvements had produced very poor performance after
one week, and so their reproductions had little to do
with the original stimulus. This suggests that Altemeyer
et al may not have tested memory, but some strategy for
drawing sticks elicited by the command to remember. An
additional problem was the presence of regressions,
which were about half as frequent as improvements. Dahlem
(1968) also tested 5-year-olds' memory for seriated
arrays. She found 50% improvement and 10% regression
between one week and six months.

Other studies report a rather larger proportion of
children showing regressions. Dahlem (1969) attempted
a replication of her earlier experiment and found equal
numbers of improvements and regressions. Liben (1974,
1975a) investigated Euclidean concepts, as well as seriation.
She found evidence for some long-term improvements, but
these were not significantly more frequent than long-
term regressions.

A number of other studies report a large number of
regressions. Thus Crowley (1975) found 50% regressions
for seriated arrays, and Furth et al (1974) report

6   In this case, improvement is defined as increased
     operatively, thus subjects who saw unseriated arrays
     produced drawings which were more seriated, and hence
     less like what they originally saw.

'massive regressions' for the seriation and spatial con-
cepts reported earlier. Murray and Bausell (1970, 1971)
also investigated long-term memory for seriation of
liquid, length and number. They found very little evi-
dence for long-term improvements, and these are far
exceeded in number by regressions. However, as Liben
(1977b) points out, the criteria for improvement were
unusually stringent: children had not only to reproduce
those points of the drawing that were relevant to the
operation under study, they were also required to reproduce
irrelevant parts of the stimuli in order to achieve a
'correct' response.

A further set of problems for the hypothesis were
raised by the findings of Finkel and Crowley (1973).
They investigated whether long-term improvement depended
on the initial stimulus, and also whether test-retest
effects could account for part of the improvement.
They presented subjects with arrays of seriated, or
partially seriated arrays. Test-retest effects were
assessed by omitting some subjects from the early test
sessions. Overall, Finkel and Crowley (1973) found
approximately equal numbers of improvements and regressions.
In addition, improvements were dependent on the structure
of the original stimulus, with poorly-seriated arrays
showing much more improvement than well-formed ones. In
addition, they report effects due to repeated testing,
for example subjects improved performance between the
first test after one day to the second test after a week

Clearly operativity is unlikely to have altered during this interval.

Following these studies, a number of criticisms have been levelled against the hypothesis of long-term memory improvement. The first concerns the significance of the improvement. Piaget and Inhelder argued: (1) that no other theory of memory makes predictions of improvement with time; and (2) that improvements should be tested against a null hypothesis of no improvements. If improvements are found, these are evidence for the operative account. However as Liben (1977b) notes, there are other theories which predict memory improvement under certain conditions, such as the encoding specificity model of Tulving (Tulving and Thomson, 1973). Improvement may not therefore offer support only for the operative account. The second problem concerns the methodological justification for the null hypothesis. Changes in performance may be the result of factors other than operativity, such as measurement error. Measurement error cannot be neglected because it has been invoked to account for regressions.

If we accept that measurement errors occur, then the hypothesis under test becomes whether there are more improvements than regressions. According to Maurer, Siegel, Lewis, Kristofferson, Barnes and Levy (1979), who have re-analysed the existing data, if we accept the new hypothesis, none of the studies so far conducted

supports the improvement hypothesis. Even if this
were not the case, the very existence of regressions
represents a major problem for the theory. An appeal
to measurement error cannot be justified on theoretical
grounds because of their magnitude and pervasiveness and
also for the reasons described above, i.e. that such an
appeal would explain away improvements also. One solution
to the problem of regressions proposed by Furth et al
(1974) and Crowley (1975) is that these are the results
of the figurative memory function, which does not rely
on operations, but is a 'copy' of the stimulus which
decays with time. Figurative memory produces the high
initial levels of performance, which are not sustained
in the long-term. Not only is this solution post hoc,
in that any and every regression could be explained in
this way, but it is also contrary to the principles of
Piaget and Inhelder's whole model.

> Memory does not conform to the perceptual
> configuration of the model but rather to
> the manner in which the model was assimilated
> to the ... schemes of the subject. (Inhelder,
> 1969, p. 347)

It is clear, however, that memory must contain some
of the figural aspects of the stimulus otherwise it
would not be a memory of that particular stimulus.
In a sense, therefore, the appeal to figurative memory
is justified in that such a notion must be incorporated
into the account, but as formulated by Furth et al and
Crowley it cannot be independently specified and
hence remains an ad hoc and theory-saving modification.

The final attack on the notion of long-term memory improvement has been the suggestion that there may be other, non-operative explanations for improvement. I have already cited the results of Finkel and Crowley (1973) who report "improvements" as a result of retesting. The argument here is that increased familiarity with the test situation and stimuli, (if a recognition measure is used, subjects actually see the correct stimulus during test) may lead to an improvement in memory which does not result from changes in operativity. Dahlem (1969) did not report any such effects for repeated testing, but Crowley (1975) did find that repeated testing influenced recall. As already reported, Finkel and Crowley (1973) found repeated testing effects, but as they included a recognition measure in their tests, this may well have influenced memory.

An alternative non-operative explanation has been offered by Adams (1973) who suggested that "improvements" result from children's increased understanding of the demands of the experimenter. In order to test this, Adams gave subjects pretraining on either a seriation or geometric discrimination task. If repeated testing succeeds by making the children more aware of the relevant aspects of the stimulus, we might expect the group pretrained on seriation to show greater memory improvement over the test-retest period. Adams found no evidence for this hypothesis. Altmeyer et al (1969) attempted a similar manipulation by making explicit

reference to the size of the sticks for one of their groups. They found that this manipulation did not influence patterns of memory change. Another suggestion is that improvements result from increased drawing skills. A number of studies (e.g. Altemeyer et al, 1969; Liben, 1975b) have shown, however, that children older than 5 years can accurately copy a visible stimulus. In addition, long-term memory effects still occur when recognition measures are used.

In conclusion, attempts to explain improvement in terms of non-operative factors have not generally been success- ful. Two studies showed that repeated testing influences recall, but as one of them contained a recognition measure, this may well have produced the effect. In view of this, it is important to establish whether recog- nition does influence memory in repeated testing para- digms, because if it does, this would invalidate the results of several other studies.including those of Murray and Bausell (1970) and several of Piaget and Inhelder's own experiments. While the hypotheses of Adams (1973) and Altemeyer et al (1969) have not been supported, this does not mean that non-operative factors do not influence memory change. It remains to be conclusively demonstrated, however, that such factors are important.

A final prediction derivable from Piaget and Inhelder's position is that changes in memory should be directly related to changes in underlying operative skills. To

test this, it is necessary to independently assess both memory and operativity within subjects.

Piaget and Inhelder's own research did not consistently include measures of operativity. In some cases operational level was inferred by age, and in others by diagnostic questioning which was often not consistent across subjects. In one case, where the expected correspondence was not found, Piaget and Inhelder explain it away by post hoc appeal to the specific experience of the particular group under study.

Dahlem (1969) measured children's seriation skills after the six-month memory test, using a set of stimuli (triangles) which were visually quite different from the memory stimuli. The results suggested moderate support for the operativity theory, most of the children showed correspondence between memory and operativity although there were examples of operativity without memory, and memory without operativity. Murray and Bausell (1970) also measured operativity but made their assessments before the memory test. The particular stimuli they employed tested conservation, seriation and Euclidean spatial concepts. Two of the three conservation tasks showed no relationship, and for the seriation stimuli correspondence only emerged for one of the memory measures. No clear evidence could be obtained for the spatial concepts, because few children had any success on the

operative assessment of seriation.

A better test of the hypothesis would be to employ two
measures of operativity conducted before and after the
memory test, to discover whether changes in operativity
predict memory changes. Liben (1974) used this procedure
for stimuli tapping knowledge of horizontality. She
found weak correlations between operative levels and
memory performance at the beginning and end of the study,
but little evidence to suggest changes in operativity are
paralleled by memory changes. A second study/Liben (1975b)
found substantially the same results for the operations
of horizontality, verticality and seriation. Crowley
(1975) reports similar conclusions for seriated, and
randomly ordered stick stimuli.

The studies which have attempted to demonstrate a close
relationship between operative levels and memory have
largely found weak but significant correlations, although
there have been some disconfirmations (Murray and Bausell,
1970). The hypothesis that memory changes parallel
changes in operative level is not supported by any evi-
dence. These results are not surprising when taken
in the context of other developmental research. Experi-
ments on the context-specificity of both child (Donaldson,
1978; Fischer, 1980) and adult cognition (Johnson-Laird,
Legrenzi and Legrenzi, 1972) indicate that varying the
materials used in psychological tests, produces vast
differences in performance, even though the tasks possess

the same logical strucuture. A number of attempts to
investigate relations between different instances
of concrete- and formal-operational structures have
largely discovered weak but significant correlations
(Hamel, 1974) and longitudinal studies have found little
evidence for concurrence in the emergence of related
operations (McShane and Morrison ., 1981). Another problem
with such studies is that / they may compound two measurement
errors.

What then is the status of the operative theory of memory
proposed by Piaget and Inhelder? Overall, there does
seem to be qualified support for the hypothesis from the
cross-sectional data. The within-subject studies offer
less convincing evidence of weak, but significant correl-
ations. The hypothesis of long-term memory improvement
is much more questionable, however. Piaget and Inhelder
(1973) appear to have employed the wrong null hypothesis
because they fail to take account of measurement error.
When the data are re-analysed to allow for this, the
effects of improvement are no longer significant (Maurer
et al, 1979). In addition the theory has problems in
explaining the presence of long-term regressions, and
the modification proposed to explain these results
severely reduces the predictive power of the theory.
A number of alternative explanations for improvement have
been suggested, but so far evidence for only one of
these has been obtained, that of repeated testing effects.
However, even this effect does not seem to be reliable.
In conclusion, the operative theory seems to have some

explanatory value at the level of group explanations,
but the within-subject designs do not offer the same
support.

2.4   General problems with structural theories

The evidence reviewed in the latter half of this chapter
suggests that there are a number of problems with the
structural models discussed here.   The first of these
concerns the predictive power of structural explanations.
The central problem here is that structural accounts
suggest that memory is the result of stimuli being
assimilated to, and hence distorted by, cognitive struc-
tures.   This does not always occur, however, for sometimes
memory output seems to be an unmodified version of
input.   There are two issues here: how is this "unmodi-
fied" memory possible; and can we derive any model
which will enable us to predict when memory will be
"unmodified" and when it will be the result of assimilation?

If we examine each of the models discussed above, we
find instances of the same problem.   Thus, in the research
on the phenomenon of semantic integration Paris and his
colleagues found that subjects did not always integrate
individual sentences into higher-order units of meaning.
As Liben and Posnansky (1977) and Hayes-Roth and Hayes-
-Roth (1977) have shown, subjects seem to have available
large amounts of information about the surface structure
of the text.   This clearly indicates that subjects do

not process solely for meaning and discard syntactic information. A developmental study by Moeser (1976) suggests that semantic integration is not a necessary feature of encoding but depends on the particular conditions of the experiment. Factors such as the provision of additional contextual information, the sequencing of premises, the instructions, and the number of premises all influence the amount of integration.

The same difficulty of predicting the influence of structural factors seems to occur also with the research on scripts, frames and story grammars. Although these studies report normalisation 'errors', or intrusions which are consistent with the assimilative explanation, the instances of such 'errors' seems to be highly context-dependent and in many cases relatively infrequent (e.g. Brown et al, 1977). The influence of structural factors can be clearly demonstrated if we destroy structural organisation (e.g. Mandler and De Forest, 1979; Thorndyke, 1977) but is it possible to predict when memory will be veridical and when normalisation errors occur? The problem of veridical memory is also highlighted when stimuli contain material anomalous to the proposed assimilating structure. In some accounts (e.g. Bransford and Johnson, 1973) anomaly is ignored or overridden, in contrast, in the schema model of Mandler (1979) and script theory (Schank and Abelson, 1977a) anomaly receives special processing:

> any event that occurred within them that was
> not predicted by them will be placed on a
> 'weird list' to be specially remembered. (Schank
> and Abelson, 1977b, p. 431)

This seems to be another example of material which resists
the process of assimilation.

We have already seen the occurrence of the same phenomenon
in the operative account of Piaget and Inhelder. Again
it can be demonstrated that putative structures influence
memory, but there still remains the problem of explaining
figurative effects in memory. Some attempts have been
made to provide constraints for the operation of struc-
tural effects. Thus, it is possible to predict with
reasonable certainty that structures will not influence
memory when they are absent from cognition. A 5-year-
old is unlikely, for example, to show operative improve-
ment on a stimulus requiring knowledge of Euclidean
spatial concepts. If children do possess the requisite
operations, however, the theory cannot predict the precise
extent to which they will modify the stimulus. One
solution to this problem is to argue that veridical
memory is itself the result of accessing cognitive struc-
tures. While this may be plausible for certain 'well-
formed' stimuli such as a routine meal in a restaurant,
it leads to massive proliferation of internal structures
and one which completely weakens the explanatory power
of the theory.

Perhaps the solution to this problem is not to regard structural effects as a unitary phenomenon, but to look as Moeser (1976) has done, at the conditions under which such effects operate. As Clark and Clark (1977) argue for text, what we remember may very well depend on how we wish to utilise the information.

This leads to a second problem with some of the data. Whereas/the semantic memory data reviewed by Hagen et al (1975) and Brown (1975) are clearly the results of involuntary coding processes the same cannot be said for all the data. Thus, Moeser (1976), Trabasso and Nicholas (1979) and Paris (1978b) suggest that semantic integration may in some cases be a strategy evoked to deal with certain situational demands. Mandler and De Forest (1979) and Brown and Smiley (1977) also discuss the deliberate exploitation of story structure as a retrieval strategy. While the cross-cultural evidence (Mandler, Scribner, Cole and De Forest, 1980) does suggest that story grammars are not always strategic, some of the data on older children may reflect strategy use. It has been shown that deliberate strategy use can influence the structure of recall (Brown and Smiley, 1977). Now if we have not controlled for the presence of strategies in our investigations of structure, we may well have inaccurate structural models. This suggests that structural theories which rely on structures inferred from experiments outside the domain of memory may be more accurate, because they avoid contamination by strategy factors.

A much more serious problem concerns the status of the structural entities proposed to explain the effects described above. In some cases it is not clear what, if any entities are posited to explain these effects. Are the encoding effects reviewed earlier the result of the operation of a semantic memory system (e.g. Collins and Quillian, 1972)? If this is the case, then such explanations are problematic, because of the recent attacks which question the validity of the model. At present there seem to be three competing accounts of the structure of semantic memory.(Collins and Loftus, 1975; Smith, Shobin and Rips, 1974; Glass and Holyoak, 1975).

No such problem arises with the semantic integration and inferencing phenomena investigated by Paris and his colleagues. I have already argued that one major weakness of this research is its failure to propose any underlying structural entities to constrain the types of inferences made.

This is clearly not the case for the research of Nelson (1978) or any of the studies of story grammar. There are some problems with the structures proposed here also. The concept of a script has recently come under attack on a number of theoretical accounts (Dresher and Hornstein, 1976), but its major weakness seems to lie in its lack of generality. Thus, while it does seem very likely that certain events such as visiting the doctor or going to a restaurant, or certain spatial organis ations

such as rooms <u>do</u> have a stereotypical structure which
can specified, it is clear that most events or spatial
organisations are not so rigidly constrained. Schank
and Abelson (1977a) pay this problem some attention,
they build in to their system the notion of <u>plans</u>, which
make it possible to process irregularities, and also
lower level scripts which they call <u>tracks</u> which handle
context specificity <u>within</u> scripts. As G. Bower (1978)
argues, such structures may well be in operation, but
until they can be incorporated into a principled account,
they seem very much to explain away rather than explain
the data.

The theoretical validity of the story grammar has also
recently been called into question. Not only are there
debates about whether story comprehension and memory
can be explained by a single 'grammar' (Anderson and
Pichert, 1978; Baker, 1978; Thorndyke, 1979), there are
also internal debates between those who do accept this
proposition. Firstly, it is apparent that there are a
number of alternative grammars suggested (Mandler and
Johnson, 1977; Rumelhart, 1975, 1977; Stein and Glenn,
1979; Thorndyke, 1977). In particular there are disputes
about the relationship between episodes (Johnson and
Mandler, 1980), and the relationship between position in
the story hierarchy and likelihood of recall (Mandler
and Johnson, 1977; Thorndyke, 1977). Additionally,
Kintsch (Kintsch, 1977; Kintsch and Green, 1978) claims
that the rules for characterising the structure of the

predominantly European folktales which have mainly been
analysed are inadequate to characterise American Indian
stories. These disputes would seem to suggest there are
major difficulties associated with the concept of a
story grammar, and in consequence appeals to such struc-
tures in attempts to explain story memory may well be
suspect.

The final set of cognitive structures to which appeals
have been made are the structures of pre-operations,
concrete-operations and formal-operations in the
Genevan approach to memory. In recent years, Piaget's
whole theory has come under increasing attack (Brainerd,
1978b; Bryant, 1974; Flavell, 1977 ; Gelman, 1978). These
attacks have concerned the generality of cognitive
structures (Brainerd, 1978; Flavell, 1977), the age of
emergence of specific behaviours (Bryant, 1974; Gelman,
1978) and the problem of change (Brainerd,1978b). If
we consider the more specific structures studied by
Piaget and Inhelder, alternative explanations have been
offered for seriation (Young, 1978), and conservation
(Kuhn, 1974). However, as the exact status of such
explanations remains in doubt, we must reserve our criti-
cism of Piaget's own speculations.

In summary, there are a number of problems with cognitive
structures proposed to underlie structural effects in
memory. In all cases, there are problems with these
entities. There are disputes about the psychological

status of semantic memory models, scripts, frames, story
grammars and operational structures. The Piagetian
account seems to be slightly less problematic than the
others, however, for cognitive operations do seem to
have some validity outside the sphere of memory, and
unlike some of the other constructs they were not invoked
purely to explain memory phenomena.

Finally we come to a problem which most of the theories
make no attempt to tackle - the problem of change.
It is clear that as children grow older they encode
words differently, or remember events or stories in
different ways, or remember Piagetian stimuli differently.
It is clear that any purely structural theory must explain
such changes in terms of structural reorganisation. Kail
and Siegel (1977) discuss the problem of change in encoding,
and speculate that a number of factors may be responsible.
One of these , the trend towards selectivity is so vague
as to be useless. The suggestion that there are changes
in the rate of encoding information has experimental
support (e.g. Chi, 1978) but won't explain structural
change. One factor they do suggest which could lead
to change is the addition of 'features' to the nodes
in the child's semantic network, and appeal to Clark's
(1973) semantic feature theory for support. Unfortunately
    on theoretical (see Atkinson, 1982) or empirical
grounds (see Richards, 1979) this is hopelessly inadequate
as a theory of semantic development.

The structural models derived from artificial intelligence also run up against major problems in explaining change. The source of these problems lies in the fact that such theories are fundamentally assimilative. The process of memory, comprehension or perception is generally represented as the construction of a set of inferences or interpretations upon poor quality, possibly ambiguous, information. The environment has so little role to play in the behaviour of the organism, that the existence of change is something of a mystery, because there seems to be no reason why potentially anomalous information should not be assimilated to fit into the organism's structures (cf Abelson, 1973). Most of these models do pay some attention to the problem of change, but the mechanisms of accommodation suggested are vague. Piaget's theory does claim to offer a mechanism of change in the form of the assimilation-accommodation model. However the account is circular:- we can only infer the presence of accommodation when we find that change has occurred! A more promising approach would seem to be the study of the conditions in which change occurs. Thus Bower (1974) and Bryant (1974) suggest that conflict may be a condition to induce structural change and Doise et al (1975) make similar claims for the influence of social interaction.

Although Piaget and Inhelder may provide an inadequate account of how change comes about, their theory at least attempts to describe changes in cognition structures

and relate these to changes or differences in memory.
Thus, the superior recall of older children with stimuli
requiring Euclidean spatial concepts, can be related to
their different underlying cognitive structures. Most
of the other theories make little attempt to describe
differences in structures, much less attempt to provide
evidence for the existence of such structures from else-
where in cognition. Although there is little evidence
that cognitive change is paralleled by memory change,
the Piagetian studies do find weak correlations between
cognitive level and memory.

In conclusion, the studies reviewed here have conclu-
sively demonstrated the influence of structural factors
and knowledge on memory. Encoding studies have indicated
that children have extremely sophisticated semantic knowl-
edge. Additionally research on stories and scripts
has shown it is possible to make a number of predictions
about a limited range of stimuli, e.g. subjects 'normalise'
towards good forms, and they remember good forms better
than bad forms. Such accounts only allow us to weakly
predict the actual structure of the output. The Piagetian
account of memory fares rather better in this respect,
because it suggests some constraints on the structures
operating at different ages. In addition to the normal-
isation and well-formedness, predictions, this account
attempts to relate memory to cognitive change. There
is supportive evidence for these predictions from group
data, but the predictions about long-term memory

improvement have not been validated.

I suggested earlier a number of reasons why mediational theories are inadequate to explain memory development, but can the structural theories reviewed above provide answers to these problems? Some of the problems raised by Chi (1978) can be solved by the model she proposes. The failure of children to perform at adult levels after training in adult strategies and the superiority of adults on novel strategies can be explained in terms of differences in encoding or naming speed. Clearly, structure, in the sense of these basic processes, does influence memory.

The major problem for the mediational account was, however, memory in the absence of mediation, for example, non-rehearsers (Flavell, 1970), adults who are prevented from using strategies (Chi, 1978),, and adults and children on recognition and relative recency tasks, all remember without the use of strategies. It is not clear that appeal to structural theories provides us with any better explanation, for none of the theories reviewed above touches on these phenomena.

Research on structural factors in memory, with the possible exception of the work on Genevan theory does not seem to have enriched an understanding of memory. In addition to their failure to adequately explain phenomena within their domain of application, structural theories do not solve

the problems they were originally invoked to explain.

CHAPTER 3   METAMEMORY

3.1   Introduction

In his review, Flavell (1970) documents several examples
of a paradoxical feature of young children's memory
behaviour: the production deficit. He demonstrated that
young children fail to use spontaneously, cognitive
routines which are in their repertoire and which benefit
memory. The routines can be elicited with minimal training,
indicating they are 'in' the repertoire, but will not be
used in the absence of strong prompting from the experi-
menter.(Keeney et al, 1967). Flavell then goes on to
provide a tentative explanation for this phenomenon,
and suggests what changes may lead to the deficit being
overcome:

> The general change might consist of an increasing
> propensity, both in recall tasks and in many
> others which have a similar means-to-ends
> structure, to search the repertoire for activ-
> ities to perform now, the performance of which
> has no immediate relevance but will facilitate
> some other activity subsequently (in this
> case recall).   (1970, p. 205)

Flavell goes on to refine this explanation. He suggests
that memory be regarded as a problem-solving task,
requiring the representation of some memory goal, the
generation of a plan to meet the goal, and the efficient
execution of that plan. He argues that young children
may not only lack the means-ends problem-solving approach

to memory problems, but they may not know what or how

to remember.

> the human mind knows more and thinks better
> as it grows older, and these changes in what
> it knows and how it thinks have powerful effects
> on what it learns and remembers, how it learns
> and remembers, and even perhaps when it learns
> and remembers.   (p. 273).

He then goes on to suggest the ways in which young

children's lack of knowledge about memory could influence

their memory performance. They may not be sensitive

to situations which require deliberate efforts to remem-

ber (e.g. Appel et al, 1972). This may be the result

of overestimating their memory ability (e.g. Flavell et

al, 1970). They may also not accurately monitor the

extent to which items are remembered and hence fail to

execute strategies efficiently (Flavell, Friedrichs,

and Hoyt, 1970). Finally they may not understand the

implications of stimulus structure for memory (Moynahan,

1973) and hence not study critical parts of the stimulus

(Masur et al, 1973). Flavell also speculates about the

origins of this knowledge. As noted in Chapter 2,

he regards it as part of the child's growing introspective

ability.

In summary, Flavell (1970, 1971) offers a characterisation

of memory as a mediated activity. The accessing of

strategies is the result of intentional problem-solving

behaviour. This is limited in the young child by a

lack of strategies potentially servicable for memory,

but more importantly by the absence of knowledge about

situations, variables and strategies influencing memory.
This knowledge is acquired as a result of general
changes in the child's cognitive system, and the emer-
gence of the ability to reflect on the nature of one's
own thoughts. In addition, Flavell (1971) suggests a
series of techniques by which we might assess this
developing knowledge of memory.

This chapter will review three aspects of the theory.
I shall firstly examine the techniques used to assess
metamemory, and suggest there are problems in that
different measures yield different results. There may
also be inaccuracies in Flavell's characterisation of
young children's metamemory, and an alternative explanation
for some of the phenomena which have been attributed to
metamemory development. Secondly, I shall review a
number of experiments which have examined the relation--
ship between memory and metamemory. It emerges that
such experiments provide little support for the contention
that metamemory determines memory abilities. The studies
investigating how metamemory might develop, suggest that
the opposite may well be the case: that metamemory
depends crucially on strategic skills. These experiments
combined with the context-specificity of metamemory
already mentioned, argue strongly against Flavell's
explanation of metamemory development. Far from being
the result of general developments in introspective skill,
metamemory seems to be the outcome of the piecemeal
acquisition of different memory strategies.

3.2   Assessments of metamemory

A number of different techniques have been utilised
in the assessment of metamemory, and these are broadly
categorisable into two types: questionnaire studies,
and studies which make inferences about metamemory.by
directly observing performance.   I shall refer to
these as declarative and procedural measures respectively.
A third type of assessment technique involves the child
making verbal assessments while carrying out a particular
task.   This will be discussed along with the procedural
measures.

3.2.1   Declarative measures

Most of the major studies of metamemory have relied
on declarative measures of memory (Brown, 1978; Cavanaugh
and Borkowski, 1980; Kreutzer, Leonard and Flavell, 1975)
and several reviews of this literature have been published
(Brown, 1978; Flavell, 1978; Flavell and Wellman, 1977).
The technique involves asking children questions about
memory situations: sometimes with the relevant memory
material present: 'Which set of cards will be easier to
remember, this set or this set?'; on other occasions
children are required to answer probe questions about
hypothetical situations, e.g. 'If you were told a
friend's 'phone number, would you prefer to 'phone right
away, or get a drink of water first?'.   Alternatively,
children may be asked more open-ended questions, such as

how they might ensure they remembered an invitation
to a birthday party. The majority of the research has
focussed on the early school years although there
have been limited investigations of metamemory in pre-
schoolers (Gordon and Flavell, 1977; Wellman, 1977b.
1978) and adolescents (Brown and Smiley, 1977). The
major developmental differences reported in the studies
occur between the ages of 5 and 8 years. Five-year-olds
are a little less sensitive to situations which require
deliberate memory strategies, but seem to know much
less than 8-year-olds about the variables influencing
memory performance, and the memory capabilities of
others. In addition, they have much less knowledge about
potential memory strategies, and what strategies they
do have rely on external storage rather than internal,
in-the-head memorising (Kreutzer et al, 1975; Yussen
and Levy, 1977).

A number of other studies have assessed children's knowl-
edge of text structure (Brown and Smiley, 1977; Danner,
1976; Yussen, Levin, Berman and Palm, 1979). These
studies indicate that this knowledge does not emerge
until early adolescence, and in some cases may never
fully develop. These results are important when compared
with other research into children's knowledge of the
structure of memory stimuli. Kreutzer et al found that
5-year-old children know that the number and familiarity
of stimuli influenced memory. In contrast, children
may not be aware of the effects of relations among stimuli

(e.g. categorisable lists) until the age of 9 years
(Moynahan, 1973). Similarly, it is not until this age
that they realise that a story is easier to remember than
a list (Kreutzer et al, 1975). Taken together, the
results suggest that there is no 'one age' at which
children are able to judge the influence of stimulus
structure on memory. The emergence of such knowledge
depends cruci ally on the type of stimulus material pro-
vided, so that the ability to make accurate judgements
will not emerge at the same age when the stimulus is text
as when it is categorised lists. Indeed, Brown (1978)
argues that even for the same materials (e.g. text) the
ability to make accurate judgements about structure may
depend on the content of the text itself.

The results of two other studies relying on verbal crit-
eria have important implications for issues discussed
later in this chapter. Markman (1973) found that 5-year-
olds believe that older children recall more than younger
ones. Kreutzer et al (1975) report that not until the
age of 9 or 11 years do children realise that this is
the result of older children's different study behaviour.
These studies suggest that young children may not clearly
understand the relationship between strategies and
memory. Further evidence for young children's impoverished
concept of memory is provided by two studies of the com-
prehension of the verbs 'remember' and 'forget' (Johnson
and Wellman, 1980; Wellman and Johnson, 1979). Wellman
and Johnson asked children to make judgements about a

model attempting to locate a hidden object. The 3- and 4-year-old subjects in the study tended to employ a behavioural theory of memory in making their judgements. The model was judged to have 'remembered' if he gave the correct response to the problem, regardless of whether he had previous knowledge of the location (i.e. he had seen the object being hidden). He was judged to have 'forgotten' whenever he gave an incorrect response, even if he had not seen the object being hidden. At the very least, these studies suggest young children have much to learn about memory. It seems that young children focus on the act of recall itself, rather than upon the study behaviour or cognitive activity which makes memory possible.

There are, however, a number of problems with the studies which have employed verbal means to assess children's knowledge of their own memory processes. One criticism made by Wellman (1978) is that such studies underestimate the complexity of memory processes. A study will often investigate the child's knowledge of only one variable influencing performance on the memory task. Wellman argues that decisions about strategy selection and execution are made on the basis of subjects' knowledge of the interaction of a number of variables. Thus, the particular strategy evoked may depend on the structure of the materials used, the familiarity of those materials and the memoriser's own facility with the strategy. When metamemory questions were designed to assess such interactive

effects, Wellman found that children's abilities to make principled judgements was considerably reduced. It may well be that the majority of the questionnaire studies have overestimated metamemory skills.

The above criticism could be answered by modifying the questions used in metamemory tasks. There are however a more serious set of objections, which can be raised against the use of verbal measures to assess cognitions. This problem has been a matter of some controversy in developmental psychology for a number of years. (Brainerd, 1973, Kuhn, 1974; Miller, 1976). The major issue concerns the young child's poor verbal skills and the implication that in such subjects, verbal measures may very well underestimate the child's knowledge. If we are to avoid such false negative errors by simplifying response requirements, we run the risk of overestimating the young child's abilities.[7]

In addition, recent reviews of adult cognitive research employing introspective and verbal protocols has suggested that certain cognitive processes may very well not be introspectible or that information about such processes may not be veridical (G. Bower, 1978; Nisbett and Wilson,

[7] A number of recent studies (e.g. Wellman, 1978, Yussen and Bird, 1979) suggest that these problems may be overcome if sufficient care is taken with the design of non-verbal measures. Both these studies showed children pictures of children in different learning situations and required them to indicate the easiest or most difficult memory task.

1977). The studies cited by Bower suggest that the
processes subjects report during decision-making tasks,
may be unrelated to the criteria they actually use in
making such decisions, and unrelated to their reasons for
acting as they do.

There are more specific problems involved in the use of
metamemory measures concurrently with memory activity.
One difficulty concerns the timing of the verbal measure
i.e. whether to probe knowledge before, after or during
the memory task. For example, Moynahan (1973) and Salatas
and Flavell (1976a) found that children's knowledge about
categorisation was influenced by task experience. Moynahan
tested 7-, 9- and 10-year-old child's knowledge of the
benefits of categorical organisation on memory. She
found that metamemory scores were superior for the group
tested after memory attempts, compared with the group tested before
memory. Salatas and Flavell (1976a) also found effects
of task experience on subject s' knowledge of stimuli
and their categorisability. It is not only subjects' know-
ledge of 'facts' about memory (e.g. that category-structure
aids recall) that may be influenced by the exact time
of test. Wason and Evans (1978) report that subject s'
accounts of the decision processes they executed in reas-
oning tasks were dependent on the solutions they gave to
the probe. Subjects often gave incorrect solution
procedures when the experimenters arranged for their
solution to be correct. Protocols in this task appeared
to be rationalisations of whatever solution had been

arrived at. We should not conclude that subjects <u>never</u>
have access to cognitive processes, but it is clear that
protocols taken after solution are not trustworthy under
certain test conditions. It might be the case that such
rationalisation only occurs for particular tasks espec-
ially those which demand reasoning, where the protocol
is really a form of justification.

One alternative to the problem of post-hoc rationalisation
is to take protocols <u>during</u> the task. There are two diffi-
culties with this approach: (a) attempts to verbalise
may actually reduce performance efficiency or even change
the processes evalued; and (b) the actual protocols may
be less accurate because of the difficulties involved
in engaging in concurrent problem solution.

A final problem with some of the items in the question-
naire studies concerns the cognitive demands they place
upon young children. Such items often require the chil-
dren to imagine themselves in a particular situation,
a demand which may well be beyond the abstractive skills
of the younger group. In this respect at least, proced-
ural measures may be more reliable than declarative ones.

In summary, the results of studies using questionnaire
type are made problematic by a number of factors. Firstly,
knowledge about memory is apparently highly context-
specific: five-year-olds can make judgements about stimulus
structure on the basis of item number or familiarity,

but knowledge of the structure of text may not appear
until adolescence. This would seem to argue against the
emergence of a 'general introspective ability' which
Flavell (1971) suggested. A number of other criticisms
have been levelled at the use of verbal measures as a
means of assessing cognitive processes. Such measures
may seriously underestimate metamemory in very young
children, because linguistic comprehension and production
are not   proficient in this age group. In addition, a
number of objections have been raised to the use of verbal
measures in adult cognition experiments, both as to when
and what subjects should be asked to verbalise. Finally
Wellman (1978) has argued that questionnaire studies may
present oversimplified and hence unrepresentative problems
for children's judgements. Strategy selection seldom
involves assessment of one memory-relevant factor, it
is usually the result of a complex judgement about the
interaction of a number of factors.

3.2.2 Procedural measures

Two features of memory behaviour in adults which are often
attributed to the development of metamemory are the
ability of older subjects to spontaneously make appro-
priate strategies and to modify such strategies to meet
the demands of the particular task.

The evocation data have already been reviewed in Chapter 1.
Flavell (1970) argued that a number of factors such as

stimulus structure, experimenter prompts and initial
instructions do serve to influence strategy evocation. A
generalisation which emerges from these and other exper-
iments which manipulate such factors, is that older chil-
dren require less environmental support (i.e. prompts,
stimulus structure or instruction) in order to produce
strategies. One explanation for this increased indepen-
dency from environmental elicitation is that developments
in metamemory allow children to select appropriate strat-
egies in the absence of explicit elicitation.

A number of other experiments have investigated changes
in children's abilities to modify the stimulus or their
own strategies in order to achieve memory goals. Thus,
Rogoff, Newcombe and Kagan (1974) investigated how 4-,
6- and 8-year-old children modified their study strategy
in response to differing response demands. Children were
given explicit experience of recall over a time interval
of either a few minutes, a day or a week. After this
the children were given a series of pictures and told
they could study them for as long as they wished, but
to make sure they would recognise them after a time inter-
val of the same duration as the first part of the study.
Only the oldest group studied the pictures for longer
when they had to remember them for greater time intervals.
Younger children did not alter their study strategy
in response to different memory demands. Another demon-
stration of the ability to modify a strategy to meet parti-
cular situational demands has been demonstrated by

Salatas and Flavell (1976b). They found increasing flex-
ibility in strategy use with age. Thus 21-year-olds
were able to use a retrieval strategy as an indirect means
to solving another memory problem. Although all subjects
overlearnt a strategy of retrieval by taxonomic category
only the oldest groups were able to utilise this strategy
to answer different memory questions.

Another feature of mature memory behaviour which is taken
to be the result of metamemory development, is the skill
of selective study. A number of experiments have investi-
gated this particular skill (e.g. Brown and Smiley, 1977;
Cuvo, 1974; Hagen and Hale, 1973; Masur et al, 1973). In
these experiments, it is of interest whether children
study the elements of the stimulus which are crucial for
recall. Thus, Brown and Smiley report that older children
show strategies such as underlining key parts of a story
they are required to remember. If given additional study
time, older children also seem to improve their memory
for the important elements of text, whereas younger ones
show no such discrimination in study. In the Masur et al
(1973) study, children were required to remember all of a
list of words. After each recall test, they were allowed
to select half the original items for study. An optimal
strategy under such conditions, would seem to be to select
those items which were not remembered. Masur et al report
that 9-year-olds and college students did largely use this
strategy, but that it was not employed by 6-year-olds.
In other experiments (Cuvo, 1974; Hagen and Hale , 1973)

the experimenter arbitrarily decides which information is to be remembered and which is incidental to the memory task. Despite the arbitrariness of such selection, the results largely support the other experiments. Older children are better able to study 'central' parts of the stimulus and ignore 'incidental' components.

A final piece of evidence for the flexibility of older children's strategies, is the ability to modify the stimulus in order to employ overlearnt strategies. Ornstein, Naus, and Liberty (1975) presented 8- and 13-year-old subjects with lists of items which were taxonomically related. In one condition, items from the same category were presented together, and in the other condition presentation order was random. Both age groups utilised category information in recall in the blocked presentation condition, but in the random condition only the older group did so. They achieved this by re-ordering the original stimulus material, and rehearsing related items together.

There is therefore considerable evidence for the increased flexibility of strategy use with age. Older children require less prompting to produce a strategy, they modify it in accordance with task demands, and in addition they can apply study strategies selectively to important parts of the stimulus. There are, however, a number of problems with some of these studies, in particular those investigating selective study. In addition, such developments

may be attributable to factors other than the development of metamemory.

The selective study experiments of Brown and Smiley (1977), Masur et al (1973) all found an increased tendency to study crucial parts of the text. In the Brown and Smiley study, however, one reason why subjects may not study these crucial parts is because they cannot distinguish the importance of different parts of text. In a later part of the same study, Brown and Smiley found that this indeed was the case: younger children knew nothing about the structure of text. In the light of this, it is not surprising that their study behaviour was unsystematic. A rather different problem arises with the Masur et al study. The experimenters did establish that children could distinguish between items they had remembered and those they had forgotten. Hence, it cannot be argued that children do not select items they have forgotten, because they cannot identify those items. Brown (1978) suggests, however, that one reason why young children continue to select remembered items for study is because they would forget them otherwise. This can be tested by giving the children the items they have forgotten. If Brown is correct, younger children should perform no better with the 'optimal' strategy because they will forget items when they are not able to 'keep them alive' by continuous study. In a study with educable retarded children, Brown and Campione (1977) found support for this prediction. Young children may therefore select remembered items for

further study, because they will forget them otherwise.
The studies of Cuvo (1974) and Hagen and Hale (1973) rely
on the assumption that what the experimenter selects
as important in the stimulus is treated as such by the
child.

A more crucial problem for the metamemory hypothesis is
that such increases in evocation or strategy flexibility
may be explained without appeal to changes in knowledge
about memory. The standard explanation of flexibility or
evocation is that developments in the cognitive executive
system allow the child to modify a limited range of
strategies in order to meet specific memory demands. An
alternative explanation which has been proposed by Baron
(1978) is that we regard such developments as the result
of changes in the strategies themselves. As the child's
cognitive system develops, the number of routines avail-
able as potential memory strategies increases, and hence
children are better able to generate some appropriate
strategy simply because they have more strategies avail-
able. While it is unlikely that all changes in strategy
efficiency and flexibility can be explained in terms of
the development of the strategies themselves, it is
important to note that some of those changes may be explai-
ned without recourse to the concept of metamemory.

The research on the differentiation hypothesis (Appel et
al, 1973) also illustrates the dangers of inferring know-
ledge about memory from strategy use, without taking into
account the development of strategies. This hypothesis

was first advanced in the Russian literature (e.g.
Yendovitskaya, 1971), and the claim is that memory is
entirely involuntary in young children.i.e. they realise
that certain situations require them to remember, but
they never produce strategic behaviour to achieve this
end. They should therefore never use deliberate memory
strategies, and hence behave no differently in situations
which require deliberate memory than in situations where
strategies are not required. Appel et al tested this
hypothesis by presenting 4-, 7- and 11-year-old subjects
with two sets of pictures. Each set of pictures was
accompanied by a different instruction. In one condition
children were told they would have to remember the
pictures at some later time. In the other condition they
were told to look at the pictures on the pretext that this
would help them on the subsequent task. The results
suggested support for the differentiation hypothesis: the
oldest group clearly modified their behaviour to meet
memory demands, while the 4-year-olds responded in essent-
ially the same way following both sets of instructions.
The behaviour of the 7-year-olds seemed to be transitional:
although they showed considerably different behaviours in
the two situations these differences were not reflected
in their recall.

There are, however, a number of reasons why the youngest
children may not behave differently in the two situations.
They may realise that the two sets of instructions
demand different behaviours, but be unable either to decide

which behaviours will aid memory, or to execute the nece-
ssary behaviours. Thus, rehearsal is a strategy which
clearly benefits memory, but young children may not
realise this and may be unable to produce the strategy.

A series of later studies suggest that strategy complexity
may well prevent this group from demonstrating that
they can distinguish the two sets of demands. Yussen
(1974) examined children's behaviour when they were shown a
film of an adult model and told (a) they would play a game
with the model, or (b) they would have to remember what
items the model indicated. Yussen found differences
in looking behaviour and subsequent recall in the two
conditions. Thus, the strategy children are required
to produce in order to indicate differentiation seems
to crucially influence whether such differentiation
is observed. Studies by Wellman, Ritter and Flavell
(1975) and Yussen, Gagné, Gargiolo and Kunen (1974)
support these conclusions.

As Flavell (1978) and Wellman (1977) note, all that research
on the differentiation hypothesis demonstrates is that
strategies develop:- a fact we already know. Indeed,
it may be impossible to establish that there is a stage
at which children realise they will have to remember, but
are unaware that this has any implications for present
behaviour. This is because very young children lack
the strategies to indicate differentiation, and also
because they may not understand the demands of the

situation and that they will be required to remember.
The hypothesis may therefore be untestable in the
crucial age range, because we cannot establish that the
children have actually set themselves a goal of remem-
bering. Indeed, Istomina (1975) provides some anecdotal
evidence that pre-schoolers have some difficulty in
recognising that a particular task has a goal of memory.
It is clear, however, that the ability to recognise
memory demands will be highly situation specific. Chil-
dren as young as 2 or 3 years will respond to certain
retrieval demands (e.g. 'Where's your coat?') which
clearly require some form of search strategy.

In conclusion, there are several problems with the
studies which have employed strategy use and flexibility
as criteria for inferring metamemory. Many such studies
have not taken into account the fact that changes in
strategy flexibility and use may be partially attributable
to the development of the strategies themselves.

3.2.3 Monitoring studies

A different type of procedural measure assesses children's
abilities to monitor and interpret their immediate
mnemonic experiences. Such judgements can take the form
of predicting performance or of assessing the accuracy
of performance after recall.

Studies of prediction have used two different methods

of assessment: span estimation and recall readiness. In
the span estimation procedure (Flavell et al, 1970;
Yussen and Levy, 1975) children are shown a single item
such as a picture and asked whether they will be able
to recall the name of the picture, if it is removed
from view. Items are added one at a time, until the
children no longer claim they will be able to recall all
the items on immediate test. The results of the above
studies consistently demonstrate that children below
the age of 9 years overestimate their ability in such
a task. Fifty per cent of 5- and 6-year-old children
claim they can remember 10 items (the maximum number
presented in the above studies). Such unrealistic esti-
mates are offered by only 5% of 9-year-olds. Replication
attempts by Markman (1973) and Brown, Campione and Murphy
(1977) suggest that the procedures used above may even
have overestimated young children's monitoring skills.
Both studies report that minor procedural modifications
such as asking for several assessments indicate that
judgements are less accurate than Flavell et al and
Yussen and Levy claim.

The recall readiness procedure is similar to the span
estimation task. Children are given a set of items
equal to their short-term span to learn and told they
may study the items for as long as they wish. The
children are told to inform the experimenter when they
are sure they can recall all of the items. Flavell et
al (1970) and Markman (1973) both report that 5-year-olds

are insensitive to their readiness to recall. In contrast, when older children claimed they were ready to recall, they usually remembered all the items correctly.

A different procedure has been used by Wellman (1977c). He investigated the development of children's feeling-of-knowing judgements. Children are shown a set of objects and asked to name them. For those they cannot name, they are required to judge whether they would recognise the object'sname if it were presented. Wellman found that children's ability to make such judgements showed large increases between the ages of 5 and 8 years. In a second experiment, he investigated possible reasons for this and concluded that younger children do not utilise other available information, such as whether they have seen the object before, in order to help make such judgements.

There are, however, a number of problems with the prediction experiments. Kelly, Scholnick, Travers and Johnson (1976) attempted to replicate the span estimation results using a spatial memory task with subjects aged between 3 and 10 years. In addition to asking the children whether they could recall all the items, Kelly et al requested them to point to those items they believed they would recall. There were no developmental differences for either of these estimates. Kelly et al suggest that a crucial difference between their study and those cited above may be the nature of the material to be

remembered, and the response criteria used. The other
span estimation experiments required children to judge
the likelihood of recall of picture names, whereas in
the Kelly et al study the judgement concerned the ability
to place cue cards in their appropriate spatial locations.
It may be that monitoring skills crucially depend on
experience in similar task situations, and as Wellman
(1977a) has noted, preschool children generally perform
better on spatial tasks. This argument gains further
plausibility if we consider the results of Chi (1978).
She found that prediction skill for the task of remem-
bering chess positions generally depended on chess
knowledge not on age. In addition, predictive skill
depended on the nature of the stimulus. Chess experts
were not always superior at monitoring to novices,
because experts often overestimate their ability to remem-
ber highly structural stimuli. A similar finding
is reported by Monroe and Lange (1976) for list learning.
These studies of monitoring suggest that prediction
skill may well depend upon subjects' knowledge of the
task used and upon the exact configuration of the
stimuli employed. Under certain conditions, monitoring
skill may not increase with age.

The Kelly et al study did replicate the findings of
Flavell et al and Markman for recall-readiness. One
problem with this measure of monitoring ability is that
it is confounded by motivational and strategic factors.
Thus younger children might be uninterested in correct

recall, or unable to maintain their attention on study until a state of readiness is achieved. The problem of strategy development is that older children have more efficient strategies for rectifying matters if learning is not complete.

Finally, research on adults suggests that feeling-of-knowing judgements may not be assessing moment-to-moment monitoring of memory states. Gruneberg, Morris and Sykes (1977) suggest that subjects respond to the demand characteristics of the experiment in making such judgements. They present evidence that subjects' assessments are based on what the subjects think they ought to know, and not on direct monitoring.

A number of studies have also investigated children's abilities to make judgements about their performance after retrieval has been carried out. In contrast to the findings of Flavell et al and Yussen and Levy, for prediction, young children seem fairly accurate at assessing their performance after retrieval. Studies by Berch and Evans (1973) for recognition, Moynahan (1976) for free recall, and Bisanz, Versander, and Voss (1978) for paired-associate learning all report that "post-diction" judgements are accurate in 5-year-olds. Although all these studies report developments in this ability, performance does not change as much as in the above studies of prediction. Young children may also be competent at other sorts of judgements about retrieval.

They seem aware that they have or have not completed recall of all items (Neimark, Slotnick and Ulrich, 1971; Geis and Lange, 1976) and can distinguish between the items they have recalled and items they have not recalled (Masur et al, 1973).

These results would seem to contradict a number of studies of strategy maintenance which were reviewed in Chapter 2 (Borkowski et al, 1976; Kennedy and Miller, 1976). Such studies indicate that children will only maintain strategies when they are given direct feedback as to the effectiveness of strategy use. From this it could be argued that such feedback is necessary because children either cannot, or do not monitor the influence of strategies on their performance. However, the arguments advanced in Chapter 2 suggest that failure to monitor may be the result of deficits in processes other than monitoring. In addition, a number of studies have shown that maintenance can occur in the absence of feedback (Bjorklund et al, 1977; Heisel and Ritter, 1981; Ornstein et al, 1977; Ringel and Springer, 1980). The failure to maintain a trained strategy cannot therefore be advanced as evidence of deficits in monitoring skill.

A large number of studies have been conducted to investigate the development of children's abilities to assess the state of items in memory before retrieval, and to make judgements about retrieval completeness and accuracy. It was argued that the ability to make post-diction

judgements is present in children as 5 years. The inter-
pretation of the data on prediction is much more prob-
lematic; evidence from other studies suggests that
monitoring skills depend on the task and stimulus
configuration employed. Under certain conditions young
children may be as accurate as adults in their predictions.
Criticisms were also made of the use of the feeling-of-
-knowing judgement as a means of assessing direct
monitoring.

3.2.4 Conclusions about assessments of metamemory

The research reviewed above suggests that there are
large changes in children's knowledge of facts about
memory, in the case of evocation and flexibility of
the strategies they employ, and in their ability to
make judgements about their performance before or after
retrieval. However, as the earlier sections have
argued there are a number of problems associated with the
assessment of metamemory. In the case of questionnaire
studies there is the general problem of using verbal
methods with younger children. The procedural measures
did not avoid such problems either. It is possible to
explain accessibility and flexibility of strategies
without appeal to metamemory. In addition there are
problems with several of the studies of monitoring
reviewed above.

A second major difficulty in assessing metamemory

concerns differences between measures purportedly
assessing 'the same' knowledge. Measures of prediction
ability appear to depend greatly upon the task (Chi,
1978; Kelly et al, 1976), and Brown (1978) argues that
even within a task domain, metamemory ability may
depend upon the content and complexity of the stimulus
under study. As I have already noted, these results
seem to argue against the general development of a
metamemory function as described by Flavell (1971).

3.3 Metamemory as an explanation of memory performance

The previous sections provided some discussion of the
different criteria which have been employed in the
assessment of metamemory. In the accounts of Flavell
(1971), Brown (1978) and Cavanaugh and Perlmutter (1982)
metamemory is intended to be more than an object of
study, it is meant to serve an explanatory function in
theories of memory. Thus, Flavell (1971) suggests
that young children's failure to realise that certain
memory situations require strategies, their inability
to monitor the state of items in memory, and their lack
of knowledge about what variables affect memory all con-
tribute to inefficient performance. The present section
examines the evidence for these different hypotheses
in the light of recent experiments. Before embarking
on a detailed examination of this evidence, however, it
is worth returning to the conclusions of the previous
section. The above review of techniques for metamemory

assessment, and recent publications (e.g. Cavanaugh
and Perlmutter, 1982), suggest that there are a number
of problems with the measurement of metamemory. If this
is the case, then it may be difficult to draw reliable
conclusions about the explanatory value of metamemory when
the methods used for its assessment are problematic. For
this reason, it is important that each test of the
metamemory-memory relationship takes into account the
reliability of the metamemory measures employed.

One technique of metamemory assessment can give us no
adequate explanation of memory development. This tech-
nique involves the use of procedural measures such as
ease of evocation and flexibility of strategy use. Since
our measure of metamemory is directly derived from
strategy use in this case, any appeal to metamemory
involves a viciously circular argument. Metamemory is
inferred in this case from strategy deployment, and
cannot therefore be called upon to explain deployment.

The differentiation hypothesis also runs into similar
difficulties. Flavell (1971) and Appel et al (1972)
argued that one reason why preschool children may fail
to prepare for retrieval is because their memory is
entirely involuntary, i.e. they do not realise that certain
memory goals can only be achieved if action is taken now
to prepare for later retrieval. As the previous section
argues, a number of false inferences were made about
preschoolers' inability to identify such situations.

This was because experiments did not allow that strategies are poorly developed in this age group, and it was from preschoolers' lack of strategies that they could not identify deliberate memory situations. However when tasks were employed which required simple strategies (e.g. touching or looking at stimuli), it became clear that young children are capable of preparation for retrieval. There is no conclusive evidence that young children ever perceive that a certain task requires them to recall at some later time and yet they fail to realise they should engage in some appropriate mnemonic preparation for this eventuality. The differentiation hypothesis cannot therefore explain any of the deficits observed in young children's strategic behaviours.

Flavell (1978) and Flavell and Wellman (1977) have argued that one source of difficulty for young children may lie in identifying situations which possess implicit demands for memory. In support of this Flavell (1978) cites a number of experiments showing that older children are more likely to keep physical records of previous solution attempts (Siegler and Liebert, 1975) and also of the need to study further items they have just forgotten in a memory test (Masur et al, 1973). However, this interpretation of the evidence may be problematic. The Siegler and Liebert study requires children to take notes of previous solution attempts, a strategy which may be more practiced in older children. As I have already argued children may well not select forgotten

items for study in the Masur et al study, because they are unable to keep remembered items 'alive' in memory if they do so. In addition a study by Istomina (1975) suggests that under certain conditions, 5-year-olds may well respond to implicit demands to prepare-for-retrieval. Despite this, the hypothesis remains plausible, it is just that the present experimental evidence is insufficient to evaluate it.

A different type of argument has been advanced by Flavell (1971) and Brown (1977, 1978) to explain the relationship between monitoring skills and strategy use. The Flavell et al (1970) and Yussen and Levy (1975) studies both seemed to show that young children vastly overestimate their ability for immediate recall. In addition, the Flavell et al and Kelly et al (1976) studies indicated that they are also unable to assess when they have fully mastered the material to be remembered. This may well explain their failure to employ strategies, if children do indeed overestimate their ability for correct recall, it is not surprising that they fail to employ strategies when these are necessary. The argument is suspect, however, because it assumes that children spontaneously make assessments of their likely performance and on the basis of these, decide upon whether or not to use a strategy. Two studies have subjected this hypothesis to experimental test (Flavell et al, 1970; Kelly et al, 1976), and neither has found any evidence for a relationship between monitoring assessments and

subsequent recall.

A number of studies have investigated the relationship between post-test assessment and the level of memory performance (Bisanz et al, 1978; Kelly et al, 1976). It is argued that those subjects who most accurately post-dict will be those who maintain their performance during test most closely and hence determine when material has been mastered sufficiently for recall. This argument is also suspect, because the ability to make post-diction judgements may not be related to children's spontaneous self-assessment. In any case, the Kelly et al study reports no relation between post-diction and recall, and the Bisanz et al experiment found evidence for the relation only in their oldest group who were college students.

Experiments which offer feedback as to the level of performance are sometimes cited in the context of monitoring influencing strategy maintenance. The argument is made that feedback provides children with information about their level of performance when they use trained strategies and this leads them to maintain such strategies. However, feedback typically involves much more than information about performance levels. In the Borkowski et al (1976) and Kennedy and Miller (1976) experiments (see Chapter 2) subjects were not given information about the absolute level of their performance using the 'trained' strategy. Instead they were provided with information about the level of their performance when they used the

strategy and this is compared with performance without the
strategy.   The superiority in the instructed condition
is then attributed to strategy use.   We cannot therefore
use such experiments to make inferences about the relation-
ships between maintenance and monitoring, because other
metamemory information is supplied by feedback in addition
to monitoring.   Other studies (Heisel and Ritter, 1981;
Ringel and Springer, 1980) have separated the different
processes of monitoring, comparing strategy and no-
strategy performances, and interpreting this difference
as being attributable to the use of strategies.   These
studies showed that deficits in each of these processes
do influence children's strategy selections.

Thus of the research on the relationship between monitoring
and strategy maintenance, only the feedback experiments
suggest any real evidence for the hypothesised relation-
ship.   Experiments on the relationship between prediction
and post-diction have not found evidence for a clear
influence of metamemory or memory behaviour.   It seems
that feedback experiments provide information in addition
to monitoring and that such information also influences
strategy maintenance.

The above experiments have evaluated evidence for two
ways in which metamemory can influence memory performance.
The differentiation hypothesis suggests that children's
different conceptualisation of memory is responsible for
their generalised production deficit, and later studies

argue that direct monitoring skills may influence strategy deployment. Flavell (1971) suggests a further means by which knowledge influences memory processes. He argues that young children may not know certain facts about the variables which influence memory and strategy use. Thus, children who do not know that certain parts of a story are more important for memory than others will not structure their study behaviour accordingly.

Several studies have demonstrated that such lack of knowledge does influence memory (Brown and Smiley, 1978; Ritter, 1978; Wellman, Drozdal, Flavell, Salatas, and Ritter, 1975; Yussen et al, 1979). Brown and Smiley (1978) established that recall of prose at all ages character- istically shows the omission of information irrelevant to the theme of the story, and highlighting of this central information. Recall of the different parts of the story is therefore determined by their level of importance. Older school children and adults typically exploited this by using strategies such as underlining crucial portions of text, or using periods of extra study time to focus on these portions. Younger children, in contrast; did not do this. Brown and Smiley therefore asked subjects of all ages to rate the importance of the different parts of the text. They found that younger children were unable to make such judgements. More importantly, the study strategies described above did not emerge until several years after the ability to rate the importance of text units. Thus knowledge about the structure of text recall

would appear to be a prerequisite for systematic study strategies. Similar results have been reported by Yussen et al (1979) and Danner (1976), for text, and by Wellman et al (1975) and Wimmer and Tornquist (1980), for different sorts of knowledge about memory.

One problem with these sorts of demonstrations lies in the precise criteria employed to establish that subjects possess certain knowledge about memory. As Brown (1978) points out, if we modify our criteria we may not find evidence of knowledge about certain aspects of text until late adolescence. Despite the apparent support for the hypothesis, there are a number of problems with the conclusions which have been drawn. The major difficulty concerns the failure to adequately specify what 'facts' about memory are necessary for strategy use. This has led to disputes in the literature about exactly what knowledge is necessary for particular tasks. Thus Cavanaugh and Perlmutter (1982) claim that Tornquist and Wimmer (1980) have used too stringent criteria for assessing metamemory. If the criteria are relaxed, the sequence of metamemory appearing before strategies is not always found. In the experiments on text study there is a similar failure to specify what exactly must be known about text structure before strategies can be employed. Thus, the studies find different time intervals between the ability to make such judgements and the onset of systematic strategies.

The vagueness of the hypothesis is further illustrated
by the inconsistencies in the classification of various
metamemory acquisitions. Thus, Brown (1978) interprets
experiments on short-term span estimation as indications
of children's knowledge of the fact that they have limi-
ted short-term memory capacity. In contrast, Flavell
(1978) and Flavell and Wellman (1977), suggest the results
reveal children's ability to monitor their memory state.
The degree of disagreement between the Brown and Flavell
classification systems is illustrated by the fact that
other metamemory items are categorised in the opposite
manner, with Brown classifying as process what Flavell
classifies as factual knowledge.

These disagreements about the classifications of different
metamemory items, and also the problems of determining what
knowledge is required for a given task suggest severe
problems for the use of metamemory in explaining memory
behaviour. A far more serious problem arises when chil-
dren's knowledge about memory does not relate to their
strategy choice. Thus, Kreutzer et al (1975) report that
children who predicted that increased study time benefits
recall, did not necessarily study longer than other chil-
dren. Brown, Campione, Barclay, Lawton and Jones (cited
in Brown, 1978) also found that predictions about the
relative effectiveness of various strategies bore no
relation to strategy choice in educable retarded children
(MA 6 and 8). Thus, children who possess greater know-
ledge about memory may not always utilise this knowledge

in remembering.

Studies by Salatas and Flavell (1976a) and M°ynahan (1973)
support this conclusion but additionally they suggest
that metamemory is itself highly dependent on memory
experience. Both experiments investigated the relation-
ship between knowledge about categorisation and recall
and its relation to category-sorting strategies with
taxonomically organised lists. M°ynahan tested 7-, 9-
and 10-year-olds knowledge about categorisation either
before or after experience with taxonomic lists. She
found that children with superior metamemory did not
necessarily make more use of category-sorting strategies.
In addition, experience with the memory task influenced
metamemory judgements. The group who were tested after
the memory test recorded higher metamemory scores.
Salatas and Flavell (1976a) employed two experimental
conditions: in the first, children were given instructions
to remember the items in a list, and in the second, they
were told simply to look at the stimuli. Following this,
their knowledge of category effects on memory was probed.
As in the Moynahan study, metamemory was significantly
affected by memory experience. The group given memory
instructions performed better than the incidental instruc-
ting groups. Both groups were given a further test some
weeks later, and it was found that metamemory scores did
not predict strategy use on retest. However Salatas and
Flavell did identify a group of subjects who demonstrated
an interesting set of responses. These subjects showed

no evidence for strategy use on early trials, but demonstrated high levels of clustering in recall. They showed high metamemory scores, and later used category-sorting strategies in the retest. Salatas and Flavell argue that these subjects monitor their initial recall patterns, perceive the influence of categories in recall and introduce the behaviour of clustering at encoding as a deliberate strategy. These speculations are consistent with the theories (reviewed in Chapter 2) which suggest that the origins of strategies may lie in involuntary behaviour. There still remain however, a number of problems of explanation for metamemory theories. Despite the predictive value of the metamemory measure for the group described by Salatas and Flavell, metamemory is not a strong determinant of strategic behaviour for the remainder of the subjects in that study, or the other studies mentioned above (Brown et al, 1978; Kreutzer et al, 1975; Moynahan, 1973). In addition, the knowledge hypothesis suggests that knowledge about memory is a prerequisite for various strategies. The Moynahan and Salatas and Flavell studies suggest the opposite is the case: metamemory seems to be strongly influenced by specific experience of the memory task. This conclusion is consistent with the earlier review of prediction skills, which suggested that such skills depend on memory experience. (Chi, 1978; Kelly et al, 1976).

A different approach to the evaluation of the knowledge hypothesis has been taken by Cavanaugh and Borkowski

(1980). They employed a questionnaire to assess a wide variety of different types of metamemory, and investigated how these measures related to strategy use on three related tasks. These tasks were: (a) a free sort task in which children could sort a categorisable list in any manner they wished; (b) a cueing task in which the experimenter provided pictures which could be used as encoding and retrieval cues; and (c) an alphabet search task in which children were given an unanticipated recall test for a set of alphabet letters which had just been presented. Cavanaugh and Berkowski predicted that metamemory measures relating to the skills required by the three tasks should correlate more highly with strategy use than unrelated metamemory items. This prediction was not supported: metamemory items which seemed to be peripheral to the tasks seemed to correlate as highly with strategy use as did apparently more relevant items. Although 76% of metamemory-memory correlations were significant when the data was collapsed over age groups, this figure dropped drastically when the data were examined for developmental differences, and only 18% were significant. Neither were there any developmental trends in the number of significant correlations. Cavanaugh and Berkowski also conducted contingency analyses on an item-by-item basis to establish whether high metamemory subjects were more likely to use strategies. They found no evidence for this hypothesis on any of the metamemory measures. They then tested whether subjects who showed higher overall metamemory scores performed better than low-metamemory

subjects. This was found not to be the case. Finally

they attempted to isolate a set of 'core' metamemory

items which would predict memory performance. No such

factors could be found. Cavanaugh and Borkowski therefore

conclude:

> No reliable evidence for the contention that
> verbalizable metamemory is necessary for success-
> ful memory was found. A causal hypothesis linking
> metamemory to memory is not supported by the
> present data.   (p. 451)

This conclusion seems to apply to most other studies

which have tested the knowledge hypothesis.

Evidence has been evaluated for a number of different

hypotheses about the relationship between metamemory and

memory. Very little support was found for any of these

hypotheses. The evidence for the differentiation

hypothesis first advanced by Appel et al (1972) is extrem-

ely problematic; when sufficient care is taken to ensure

that young children have the strategic means available,

there is every indication that they can distinguish

situations which require deliberate encoding strategies.

The reliance on strategic competence can be avoided by

using monitoring measures. However, no evidence was found

to support the contention that prediction or post-

diction assessments bear any relation to strategy selection.

and recall. Most research has focussed on the knowledge

hypothesis i.e. that certain facts about memory are pre-

requisites for the use of certain strategies. Some text

studies support this contention, but problems about the

criteria used for metamemory assessment should lead us to

reserve judgement about their conclusions. A number of other studies have failed to find such a relationship. The results of several of these studies also suggest that metamemory may not determine strategy selection, rather that experience in particular memory tasks influences metamemory. While it may be argued (e.g. Salatas and Flavell, 1976a) that this explains the origins of meta-memory, there is little to suggest that even when meta-memory does emerge, that it can significantly influence performance. Some accounts attribute the failure to find the predicted relationship to inadequacies in our methods of strategy assessment. (e.g. Cavanaugh and Perlmutter, 1982). However, such arguments cannot be employed to save metamemory theory: unless more sensitive means of assess-ment can be devised, metamemory can serve no function as an explanatory concept.

In contrast to the above, a number of studies conducted within the framework of metamemory have succeeded in showing some influence of information about memory. The studies in which children are given feedback of various forms (e.g. Kennedy and Miller, 1976; Borkowski et al, 1976) do show that such information affects strategy maintenance. Some accounts e.g. Flavell (1978) suggest that these experiments provide children with metamemory information which they do not possess, (e.g. Rehearsal improves recall). Other experiments (e.g. Heisel and Ritter, 1981; Ringel and Springer, 1980) indicate however that strategy maintenance may be the result of a complex

set of decision making processes. It may well be that if
we can model such processes we may understand how strat-
egies are selected. Such a model may include processes
already mentioned such as monitoring, but they would form
part of a more complex multifactor explanation than has been
advanced by metamemory theorists.

3.4 Explanations of metamemory

Regardless of the status of metamemory as a construct which
explains changes in memory strategies, it still remains
that metamemory itself develops, and any adequate theory
must provide some account of how this occurs. In the
previous chapter I discussed a number of accounts of
memory development which also included speculations about
the origins of changes in metamemory. The majority of
theories of metamemory change suggest it results from
particular experiences in memory tasks (e.g. Brown and
De Loache, 1978; Meacham, 1972; Paris, 1978a). These
accounts stress that metamemory evolves in a highly
context-specific manner, in contrast to the speculations
of Flavell (1971) who argued that metamemory was the
result of a generally emerging introspective ability.

The experimental evidence would seem to weigh heavily in
favour of the piecemeal acquisition account. The data
reviewed in the previous sections indicates that
monitoring skills are highly domain-specific (Chi, 1978;
Kelly et al, 1976), that knowledge about text depends on

the content and structure of text (Brown, 1978) and that
knowledge about the structure of materials in memory
tasks depends crucially on the nature of those materials
(Brown and Smiley, 1978; Moynahan, 1973). A number of
experiments have attempted to train metamemory skills
(Brown, 1978; Brown, Campione and Barclay, 1979; Brown,
Campione, 1977b). All of these studies established the
maintenance of trained strategies, but only the Brown et
al (1979) study showed any evidence of metamemory general-
isation. Although we cannot directly infer the structure
of natural acquisition processes from training studies,
these studies do support the view that metamemory is
acquired in a domain-specific rather than a generalised
manner.

Having established that metamemory is a context-specific
acquisition, precisely what mechanisms are responsible for
its emergence? One position (advocated by Brown and
De Loache, 1978) is that metamemory follows from some form
of reflection on the structure of a previously overlearnt
behaviour. Meacham (1972) and the Russian theorists (e.g.
Leont'ev, 1975) explain this slightly differently. They
argue that it is only when a behaviour has been highly
practised that it becomes servicable as a routine capable
of being subordinated to memory goals. These accounts are
problematic in three respects. They do not state precisely
how much an involuntary behaviour must be exercised before
it becomes a potential strategy. The account of knowledge
of the structure of involuntary behaviours somehow emerging

through use begs the very question it is meant to
explain: how is this sudden insight made possible? Even
if we accept the above, the account   is inadequate in
another respect: it can only explain a limited range
of the phenomena of metamemory. It might therefore
explain the acquisition of strategy knowledge, but not
for example, the process of monitoring.

Neither of the above accounts makes appeal to the
studies which have attempted to train metamemory. The
studies do not show that the procedures employed in train-
ing are the mechanisms which necessarily operate in the
natural acquisition of the cognitive skill in question;
they may, however, suggest the possible mechanisms of
change . The evidence from the studies suggests that
feedback is one such mechanism which leads to changes
in metamemory , but that changes may occur when feedback
is not provided. One possible explanation for metamemory
change in the absence of feedback may be that children
are able to monitor their metamemory judgements and
modify them. Monitoring may therefore influence both
strategy and metamemory change.

The previous sections have described experiments suggesting
that strategy maintenance can be influenced by feedback,
but a number of other experiments show that feedback
may also influence metamemory acquisition. These studies
have attempted to train children to accurately predict
their performance in an immediate memory test (Brown et

al, 1977b; Markman, 1973; Yussen and Levy, 1975). The
results are consistent for older children: all three
studies showed that feedback induced children older than
5 years to estimate their performance accurately. Feed-
back may not modify predictions at all ages, however, for
the Yussen and Levy experiment included a group of
preschool children who seemed to be impervious to such
information. Finally Cavanaugh and Borkowski (1979)
showed that feedback can influence children's knowledge
of what variables influence memory performance. Thus
feedback seems to be a possible mechanism by which we
can modify metamemory as evidenced by these induced
changes in maintenance, prediction and knowledge about
memory.

As was noted above, feedback is not always necessary to
induce changes in metamemory, and a number of experiments
show that changes may occur in its absence. If we employ
strategy maintenance as a criterion for metamemory
then several studies reviewed elsewhere in this thesis
indicate metamemory change without feedback (Bjorklund et
al, 1976; Heisel and Ritter, 1981; Ornstein et al, 1977;
Ringel and Springer, 1980). These studies suggest that
feedback may not be necessary in older children (Heisel
and Ritter, 1981; Ringel and Springer, 1980), or if
strategies are highly effective (Ornstein et al, 1977).
Brown et al (1977b) found that age may also influence
whether feedback is necessary to modify metamemory.
They employed a different measure of metamemory, that of

span estimation, in educable retarded chilren (MA 6 and
8 years). Both groups were given 10 trials in which
they had to predict recall performance, and then actually
recall. Half the subjects at each age level were
given feedback. The older subjects became more accurate
at prediction whether or not feedback was provided,
whereas feedback was necessary to induce more accurate
monitoring in the younger group.[8] The studies of
Moynahan (1973) and Salatas and Flavell (1976a) also show
that verbal knowledge about memory can be modified
by task experience, without feedback. Moynahan found
that subjects who made their metamemory judgements _after_
performing the task were substantially more accurate
than those making them before the memory test. Salatas
and Flavell (1976a) found that metamemory judgements
were better in subjects who had been instructed to
'_remember_' than in subjects asked to '_look_ _at_' the same
stimulus materials. Experience in the particular memory
task, it seems, can influence metamemory, even in the
absence of feedback. This is consistent with the results
of Chi (1976) and Kreutzer et al (1975) who all found
that metamemory was superior in task settings in which
the child is familiar. This still does not provide a
mechanism for metamemory change in the absence of feedback,
but the above results are consistent with the view that
spontaneous monitoring leads to changes in metamemory.
Thus, older children, with their superior monitoring

8   This analysis only includes children who were initially
    inaccurate in their predictions.

skill are more likely to modify judgements in the absence
of external feedback. If we return to the speculations
of Brown and De Loache (1978) and Meacham (1972), it
is possible to square their account with the one offered
above. Monitoring and feedback may provide the mecha-
nisms by which metamemory evolves from strategy use.

In conclusion, there has been little theorising or
research conducted into the origins of metamemory, and the
mechanisms responsible for its change. The available
data do, however, suggest that Flavell's (1971) specul-
ations about there being a general increase in intro-
spection ability are incorrect. Brown and De Loache
(1978) and Meacham (1972) offer an account in which meta-
memory is dependent on developments in particular strat-
egies. While their account is little more than a
redescription of the data on strategy change, evidence
from a number of training experiments   suggests that
feedback and monitoring may be mechanisms which induce
change.

3.5 General Conclusions

The present chapter discussed a number of issues relating
to metamemory, including methods of assessment, its
relationship to memory and explanations of change in meta-
memory. In the section on methods of assessment I
suggested there were a number of difficulties with the
procedures used in assessing the construct. In the case

of questionnaire methods, this was related to the poor
verbal skills of very young children, and the consequent
problem of them understanding questions and producing
answers about memory. Other methods which rely on
strategy changes as indicators of metamemory development,
fail to take into account developments in the strategies
themselves, which may contribute to the observed
increases in evocation and efficiency. A special case
of procedural measurement, is the differentiation para-
digm, and this is subject to the objections voiced
above. Leaving aside the problems of measurement, as
Brown (1978) and Cavanaugh and Perlmutter (1982) point
out, research on metamemory has generated little more
than a mass of data showing that aspects of knowledge
about memory increase with age. No explanation is
offered as to the relations between the different aspects
nor is there any attempt to suggest why certain elements
emerge before others.

The second problem with metamemory is that it does not
explain memory phenomena as early accounts (e.g. Flavell,
1971; Hagen, 1971) argued it would. Explanations of
memory development which rely on metamemory measures
derived from strategy use, cannot be accepted, as they
are circular. This is not the case with the overestimation
and post-diction hypotheses about monitoring. In these
experiments it is possible to generate independent
measures of metamemory, and it is clear how these measures
should influence behaviour. The limited available

evidence does not, however, provide support for the
hypothesis. A third major hypothesis advanced by
Flavell (1971) was that young children's lack of knowl-
edge about certain metamemory variables may be responsible
for their failure to use strategies. Some of these
experiments have found experimental support for the
hypothesis. (Brown and Smiley, 1978; Danner, 1976; Yussen
et al, 1979). However several other experiments have
arrived at the opposite conclusion, i.e. that knowledge
has no effect on strategy choice (Brown et al, 1978;
Mandler and De Forest, 1979; Moynahan, 1973; Salatas
and Flavell, 1976a). Furthermore, a large-scale correl-
ational study by Cavanaugh and Borkowski (1980) tested
variants of the knowledge hypothesis and found little
evidence for any of them. The available evidence suggests
that rather than metamemory providing an explanation
for the development of memory, metamemory itself
depends on experience in particular memory tasks (cf. the
suggestions of Salatas and Flavell, 1976a). Modifications
have been made to the original theory (e.g. Flavell, 1978
Flavell and Wellman, 1977), arguing that metamemory
and memory may only be closely linked in older children
and adults. These suggestions are problematic in two
respects: firstly they are motivated by research
findings contradicting the theory; and secondly, no
attempt is made to specify when close metamemory-memory
links might emerge. Analogous arguments have been made
by Cavanaugh and Perlmutter (1982) who claim that meta-
memory knowledge may not be used in all appropriate

situations. A clear difficulty here is that Cavanaugh
and Perlmutter are silent on what might determine the
use or non-use of metamemory 'facts'.

Finally, the different accounts of metamemory develop-
ment were individually examined. The available data
suggest that Flavell's (1971) characterisation of the
process as general in scope is incorrect, and the explan-
ations in terms of a Vygotskyan model (e.g. Brown and
De Loache, 1978; Meacham, 1972) were found to be little
more than a description of the available data. A number
of studies have looked into the conditions in which
metamemory changes occur. It is possible that mecha-
nisms such as monitoring and feedback may be responsible
for the changes which Brown and De Loache and Meacham
describe.

The overall evidence seems to favour the interpretation
that in the early stages of development at least, meta-
memory development is largely dependent on specific
memory experiences. Although this is contrary to the
position advocated by Flavell (1971) and Brown (1978),
it may offer some clues as to which 'bits' of metamemory
may develop first. Flavell (1978) may be correct in
asserting that metamemory may only be influential in
determining memory behaviour in older children and adults,
but this has yet to be demonstrated.

CHAPTER 4   USE OF INFERENCING STRATEGIES AND THE ROLE

OF SELF-ASSESSMENT IN CUE USE

4.1   Introduction

As we noted in Chapters 1 and 2, a large amount of exper-
imental evidence has been accumulated to demonstrate that
young children have a production deficit for many memory
strategies. The finding that children fail to employ a
routine which is in their repertoire bears some relation
to the recent demonstrations of context-specific thought
in preschoolers. The latter have largely shown that
cognitive skills which are not demonstrated in Piagetian
tasks can be elicited under other conditions (Donaldson,
1978; Gelman, 1978, Siegler, 1978). A major differende
between this cognitive research and recent research on the produc-
tion deficit has been the emphasis in cognitive research,
on finding the reasons underlying this context-specificity,
and numerous factors have been suggested to explain why
children may fail to manifest particular skills. The
picture is somewhat different for memory developmental
research. Although there has been some theoretical spec-
ulation (e.g. Meacham, 1972; Wellman, 1977a) and some
research on differentiation (Appel et al, 1972), there
has been little attempt to provide explanations for very
young children's strategic deficiencies. One aim of
this chapter is therefore to investigate the reasons

underlying these deficiencies.

A second, and related point, concerns the young child's ability to use cognitive routines in an _intentional_ manner to benefit memory. Early research into this issue suggested that preschoolers did not use intentional strategies (Appel et al, 1972), but there is now a considerable body of evidence showing that this is not the case (Acredolo et al, 1975; Wellman et al, 1975; Yussen, 1974; Yussen et al, 1975). These experiments undoubtedly indicate that intentional strategies are _sometimes_ used by preschoolers, but they do not demonstrate that such strategies are always used. In fact, evidence from other studies suggests that memory may sometimes be the incidental byproduct of the child's activities when they are directed towards a goal other than remembering (Ryan et al, 1970). In addition, preschoolers may not always fully understand the implications that their activities have on remembering (Gordon and Flavell, 1977; Ritter, 1978; Ritter et al, 1973). A second focus of this chapter will therefore be on the intentional nature of the young child's memory behaviours.

The present chapter describes a series of experiments which investigate the development of a particular retrieval strategy: inferencing. There are a number of reasons for the choice of this particular strategy: firstly, there is a long tradition in developmental psychology of studying inferences, originating with Piaget,

Inhelder, and Szeminska (1960); secondly, the development
of the ability to 'go beyond the information given' is
claimed to be of crucial importance in education; and
thirdly, adult models of memory have stressed that
remembering often involves generating information from
an incomplete knowledge base and that inferencing is
the mechanism by which this is achieved (Collins, Warnock,
Aiello, and Miller, 1975; Lindsay and Norman, 1972).

4.2   Experiment I: Do children make inferences in spatial location tasks?

Introduction

This experiment investigated preschool children's ability
to use an inferential strategy to supplement what they
could directly remember in a spatial location task . The
task required subjects to remember the identity of four
toy animals hidden at four different locations .

Previous research on indirect retrieval strategies (e.g.
Salatas and Flavell, 1976b; Keniston and Flavell, 1979)
suggests that the skill of accessing one memory in order
to cue another does not emerge until adolescence. Simili-
larly, experiments investigating the role of inferential
skills in spatial memory tasks also suggest these are
acquired during the school years (Drozdal and Flavell,
1975; Wellman, Somerville, and Haake, 1979).

If an inferential strategy is used, however, it may operate

in the following way: if the subjects cannot directly remember all the necessary information, they may use what they can remember to infer likely solutions to the memory problem. Thus, subjects who can recall which of the animals are at three of the locations can infer the identity of the fourth by elimination, provided they can remember the identity of the four animals originally hidden. Other variants of the same strategy are possible; children remembering the locations of two of the animals may guess the locations of the final two animals, with a 50% chance of getting both correct. A complete analysis of the expected distributions is presented in Footnote 1. The analysis leads to a specific prediction: if children are using an inferential strategy more children should score four than three items correct. This prediction is independent of what the children directly remember.

Pilot studies of older children and adults suggested that this strategy may well be employed. The present study was designed to investigate whether such processes occurred in preschool children.

Method

Subjects: The subjects were 51 children from a number of different playgroups in the St. Andrews area, who ranged in age from 3;0-5;2. The children were divided into three age groups: 3;0-3;9 (n=14, mean age=3;5); 3;10-4;6(n=22, mean age=4;3); and 4;7-5;2 (n=15, mean age=4;10). Approximately equal numbers of boys and girls were present

in each age sample. Two children in the youngest group failed to complete the experiment and are excluded from the above description and the analysis.

<u>Procedure</u>: The children were tested individually and were shown four toy farm animals, a toy policeman and four plastic cups.* The animals, a pig, a sheep, a dog, and a duck, ranged in height from 0.5 cm to 2.5 cm and could all be hidden under the cups. The children were first asked to name the animals, which they were all able to do, although some of the names were idiosyncratic. They were then told that the animals were going to play hide-and-seek with the policeman. The children were told: 'The policeman's going to close his eyes while the animals hide in these houses (gestures to four cups). I want you to keep your eyes open and watch where the animals all hide so you can help the policeman to find them all.' At this point the policeman doll was moved away from the array, so he "couldn't see" where the animals were hiding. On one of the two trials the child hid the animals, and on the other they were hidden by the experimenter. Once the animals were hidden, one under each cup, the policeman declared that he was coming to look for them. The policeman approached the first cup and knocked on the top of it , saying "Who's hiding in this little house?". After two such attempts without getting any response, the policeman asked the children if they knew who was hiding in the "house". When the children had given a response or said they did not know which animal was under the cup, the experimenter "opened the door of the house" by lifting the cup and briefly exposing the hidden animal. The policeman continued

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*The cues were arranged in a semicircle in front of the child, and care was taken to ensure that obvious spatial cues such as one cup being nearer, were avoided. The apparatus is shown in Appendix V, Fig. 1.

his search until each house had been probed. The
houses were probed in a random order, and all the
children received two trials with four animals hiding.
These were counterbalanced as to whether the child
or the experimenter hid the animals on the first trial.

Results

Preliminary analyses indicated that there were no differ-
ences due to sex, and so the data were collapsed across
sex. The distribution of scores for the three groups
is shown in Table 1 and Table 2. It is clear that a
large percentage of children did obtain scores of three
correct (20% on the first and 16% on the second trial).
A 3 (Age) X 2(Identity of hider) unequal cell numbers analysis of variance
was conducted on the data. The effect of age was signifi-
cant ($F_{(2,48)}=3.84$, $p<0.03$), but the identity of the hider
made no difference to recall ($F_{(1,48)}=2.86$, $p>0.05$).

Discussion

The distribution analysis generated a prediction about
the probability of various scores if the children were
using the strategy. This prediction was not supported by
the data. Many children obtained scores of three correct
(21%, 14% and 20% of the respective age groups). Also
the prediction that there should be more scores of four
than three items correct was only verified for one of
the three groups on one trial only. Although these results
are suggestive, they do not conclusively demonstrate that
inferential strategies are not employed. It is just

possible that many of the children who obtained scores of 0, 1 or 2 items do employ the strategy. This speculation cannot be verified without a measure of direct memory, which is not possible using this procedure.

Evidence from a different source suggest that some of the children were using such a strategy. They either requested information from the experimenter which would enable them to make the inference e.g. 'Which ones haven't I said yet?'. Alternatively they directed such enquiries to themselves e.g. 'I've said X, Y, and Z, now let me see, what does that leave me?' (without appeal to the experimenter).

The second experiment attempted to establish whether inferencing would take place, when the information processing load was reduced, by giving children cues about which animals are at previously probed locations, and which animals made up the original array.

4.3 Experiment II: Do cues facilitate inferencing?

The first experiment offered weak evidence that preschool children are unable to use an elimination-based inferential strategy to increase what they directly remember on a spatial location task. There are a number of possible reasons why this may be the case: (1) they may be unable to remember the animals which constitute the original array; (2) they may be unable to keep track of the animals

at previous locations and hence eliminate them as possible
solutions; and (3) they may be in possession of all this
memory information, but be unable to make the elimination
inference.

Other research in cognitive development suggest inde-
pendent evidence that all these factors may be responsible
for the absence of strategy use. There is some controversy
in the literature on transitive inferences as to whether
memory for premise information, or an inability to combine
this information, is responsible for developmental trends
in such tasks (Breslow, 1981; Bryant and Trabasso, 1971;
Trabasso, 1977). Alternatively experiments on problem
solving (e.g. Eimas, 1970), suggest difficulties in keeping
track of previous solution attempts, and Flavell et al.
(1981) and Markman (1977, 1979) document children's
inability to monitor their own performance.

The present experiment allowed the children to avoid the
necessity of remembering the original array and monitoring
previous solutions, by providing two types of cues: (1)
Array cues, which consisted of a set of four animals
identical to the animals of the original array: These
cues remained visible throughout the experiment; and
(2) Monitoring cues, which avoided the necessity of remembering
previous solutions by leaving each animal outside the
cup after that location has been probed.

Thus, children who utilise the cues should possess

sufficient information to make the inference by the time the fourth location is probed. The array cues give information about which animals constituted the original set. The children should also be able to eliminate as possible solutions those animals which are visible at the previously probed locations.

The experiment addressed a number of questions concerning the development of cuing and inferential skills:-
(1) Do preschool children spontaneously make use of indirect retrieval cues? A number of recent studies have shown that whereas young children may be proficient at employing high associative cues (Gordon and Flavell, 1977; Ritter et al, 1973, Expt. I; Ryan et al, 1970), they are poor when the associative relationship is less direct (Gordon and Flavell, 1977; Kobasigawa, 1974). Measures of cue use were obtained by direct observation of children's eye-movements. The array cues were arranged slightly out of the children's line of vision, and monitoring cues were placed just behind their cups so they were partially obscured (see Fig. X, Appendix V). In both cases it was apparent when either set of cues was used.
(2) If children do look at array and monitoring cues are they able to use this information to make inferences? Again the available data on indirect cue use (Gordon and Flavell, 1977; Kobasigawa , 1974) and the research on transitive inferences (Breslow, 1981) suggests this may not be the case. It should be possible to detect use of the inferential strategy by the distribution of memory

scores. Use of the strategy should lead to enhanced recall at the fourth location to be probed, because at this location, children should have sufficient information to make the inference.

(3) Are children who do not spontaneously utilise the cues able to employ the strategy, if their attention is drawn to the cues by the experimenter?

It should therefore be possible to detect whether poor performance is due to a failure to utilise information relevant to the task, or to an inability to make inferences. The experiment also investigates the development of indirect cuing skills.

Method

Subjects: The subjects were 128 children who ranged in age from 3;0-5;3. They were divided into the same age groups as in Experiment I. They were further divided into an experimental and a control group consisting of 67 and 61 subjects respectively. For the experimental group there were 16, 24 and 27 children in each age group, and the mean ages were 3;5, 4;1, 4;9 respectively. There were 18, 23 and 20 children in the control group with mean ages 3;6, 4;2, 4;9 respectively. None of these children had participated in the previous experiment.[*]

Procedure: The control group of subjects received four trials, and the procedure was identical to that employed in Experiment I.

[*] Two subjects in the youngest experimental, and one in the youngest control group, failed to complete the procedure, and are excluded from this description.

The experimental group had two pretrials with the same
procedure, but were given the monitoring and array
cues on both the third and fourth trials. The array
cues were introduced by the experimenter who claimed
that the four cues were "friends" of the animals who
were hiding under the cups, and that the friends
wanted to watch the game. The four original animals
were placed alongside their "friends" and the experi-
menter asked the children whether they noticed anything
about the animals and their friends. A series of
hints was given, until the children agreed that the
two sets were the same. The hiding animals were then
put alongside the cups and the game commenced and
no further reference was made to the array cues.
After probing each location the experimenter simply did
not replace the cup over the exposed animal, but
alongside it, so that the animal was partially obscured
in the manner already described. No mention was made
of the fact that this procedure differed from that
employed in the first two trials. If a child failed to
respond at the fourth position to be probed the experi-
menter silently pointed to both array and monitoring
cues. This was to ensure that inferencing was not due
to a lack of information. The experimental-set-up is
shown in Figure 1 (Appendix V).

Results

The results of the experiments will be reported as three
separate sections. The first concerns the direct obser-
vations of cue use, the second the analysis of the memory
scores, and the final section will examine children's

failures and errors at the fourth location to be probed.
This final section also includes analysis of the effect
of the experimenter's prompts.

Cue use

Cue use was scored in a categorical manner, either chil-
dren used a particular type of cue , or they did not. The
criterion for use of the monitoring cues was that the
child scrutinised all the exposed animals after any one
of the four probes . Array cue use was inferred when the
children shifted their gaze to the array following the
probe question. The number of children using the monitoring
cues on neither, one or both of the trials is shown in
Table 3. Overall cue use was high, 81% of children
made use of monitoring cues. Only two of the youngest
group did not use the cues at all, although there was an
increase in cue use with age. A χ^2 analysis comparing
the number of children employing cues reveals that the
two older groups are more likely to use cues than the
youngest group ($\chi^2(1) = 6.05$, p<0.015). Table 4 shows
the
array cue use for three age groups. Fewer children made
use of the array cues than monitoring cues (McNemar's
$\chi^2 = 8.93$, p<0.01) and there were no developmental differ-
ences in array cue use when the youngest group was com-
pared with the two older groups ($\chi^2(1) = 1.81$, p>0.05).

Distribution of memory scores

The influence of cues on memory performance was investi-
gated by a 2(cue v. no-cue) x 3(age) x 4(serial position)
                for unequal numbers of subjects
analysis of variance/for the two experimental trials.*
Children were taken as "remembering" the item, if they
generated a correct response without prompting by the
experimenter.

The data are shown in Table 5. There were a number of
significant main effects:age $F(2,122) = 9.44$, $p<0.001$;
in addition, cues significantly influenced performance
 $F(1, 122) = 28.05$, $p<0.001$; and there was a serial
position effect $F(3, 366) = 16.76$, $p<0.001$. In addition,
the data suggest that the advantage of cues is limited
to the last two locations to be probed. This is mani-
fested by an interaction between the presence or absence
of cues and serial position $F(3, 366) = 21.18$, $p<0.001$.
Planned comparisons using the Tukey   statistic
showed significant differences between cue and no-cue
groups at third and   fourth locations to be probed.**
These results are consistent with the hypothesis that
children are using the information afforded by the cues
to make eliminative inferences.

There was no age x cue/no cue or age x serial position
effect $F (2,122) = 1.02$, $p<0.05$, $F (6, 366) = 1.33$,
$p<0.05$. Both of these results might have been expected
if older children make more use of cues, but as Table 5

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*/** See over (p. 172) for FNs.

* The analysis was conducted on a computer using the unequal cell numbers analysis of variance (UNEN) from the ALICE statistical package. This programme computes within group means and then pools these for the between groups analysis. (Grubin, Baner & Walker, 1976).

** The middle and older groups both outperformed the youngest group (Neuman-Keuls = 9.47, 13.48; both significant at the 0.01 level). The planned Tukey test showed that groups with cues performed significantly better at the third and fourth locations (CR_T = 29.82, $p < 0.01$; CR_T = 69.88, $p < 0.01$).

indicates, there is a ceiling effect for the older groups at the final two locations.

Failures at the fourth location

Despite the presence of array and monitoring cues, a number of children made errors or failed to respond when the fourth location was probed. Such failures accounted for 13% of the responses in the experimental group. The number of children who always responded correctly at this location did show a developmental increase. A χ^2 analysis comparing the youngest group with the older children demonstrated this. ($\chi^2(1) = 10.14$, $p<0.0015$). This change is not necessarily the result of increased inferencing ability, however, as the measure confounds this with changes in cue use and direct memory. There were a number of reasons why children failed to respond correctly at the final location. There were seven incorrect responses, four of these followed the failure to use the cues, which is likely to be an error in direct memory. The other three which followed the use of cues, may have resulted from some error in inferencing, or may have been a direct memory response. If children did not respond, or they made an error, the experimenter indicated the cues and repeated the question. It is clear that failure to use cues is not sufficient to explain inference failure; seven of the responses came when children had spontaneously looked at the cues. So, although the children possessed

sufficient information to make the inference, they did not do so. On ten occasions children failed to respond correctly, without using cues, and on five of these occasions they did not make the inference even when given assistance by the experimenter. It was not possible to subject these different response patterns to statistical analysis, as the number of responses in each category were small.

Conclusions

This experiment was designed to investigate children's ability to use indirect retrieval cues in order to employ an inferential strategy in spatial memory. The results indicated that preschool children do show an increasing ability to make use of externally provided information. This information enables them to bypass the problems of internally storing the information necessary for the inferential strategy. It is clear from the serial position data that such a strategy is being employed by the experimental group. The failure of the control group to show the same serial position effect suggests that deficits in monitoring and memory skills are two reasons why the strategy is not always employed. In this respect, the results are consistent with the work of Trabasso and his colleagues who argue that one reason for young children's failure on Piagetian transitive inference problems results from an inability to retain premise information.

Other data from this experiment suggest there may be
a number of additional reasons why young children fail
to use the strategy. Some children were in possession
of sufficient information to make the inference and yet
did not do so. This immediately suggests an _inability_ to
make the inference. However, an alternative possibility
exists: very young children may well interpret the task
instructions to remember, as an indication that their
responses should be generated by direct memory alone,
and not by other means such as inferencing. This could
also explain error responses at the final location.
Young children may attempt direct memory solutions even
when simpler, more certain, means are available. While
this experiment indicates that premise information alone
is not sufficient for the inference, it does not differ-
entiate between an inability to inference and a failure
to evoke the inference in appropriate situations.
Experiment IV tests these alternative explanations.

A number of conclusions may be drawn about why young
children fail to manifest this particular strategy. The
advantage of the cued over the experimental group suggests
that deficits in auxiliary skills such as memory for
the original array, or monitoring previous solutions,
may leave the child with insufficient information to
employ the strategy. Interestingly, the data on cue
use indicate that older children are better able to bypass
such monitoring and memory deficits by their more
active use of external cuing aids. Other reasons for

failure may be more directly related to the inferencing skill itself. The failure to respond correctly when given sufficient information may be due to an inability to make inferences or result from the failure to access the relevant skill. This failure to evoke the appropriate strategy could be due to a belief that only direct memory solutions are appropriate to the task.

4.4 Experiment III: What type of cues facilitate inferencing?

The previous experiment suggested that preschool children failed to employ inferential strategies because of deficits in memory for the original array and monitoring of previous solutions. However, as the experiment provided both forms of information in the cued condition, it was not clear which deficit was the more crucial. The present experiment employed the same procedure, and provided either array or monitoring cues, but not both. It should therefore be possible to determine which is the more important for the inferencing strategy.

Method

Subjects: The subjects were 68 children in the age range 3;2 - 5;1. They were divided into the same age groups as in the previous experiments. Thirty-five children received only monitoring cues. There were 9, 14 and 12 children in each age group respectively, and

their mean ages were 3;5, 4;2 and 4;8 respectively.

The remaining 33 children were given only array cues.

There were 9, 9 and 15 in each age group respectively

and their mean ages were 3;5, 4;2 and 4;9 respectively.
None of these children had participated in any previous
experiment.*

Procedure: The procedure was similar to that used

in the previous experiments. The children were given

two trials without cues and then received two more

trials with either array or monitoring cues. The

' instructions varied slightly for the two groups, as

the set of instructions used to draw attention to

the array cues was, of course, omitted in the mon-

itoring condition. The experimental set up is ident-
ical to Fig. 1** except that each group only received
one cue type.

Results

The results are reported in the same format as the last

experiment, i.e. cue use, memory scores and failures at

the fourth location are analysed separately.

Cue use

Cue use was measured exactly as in Experiment II, and

the results largely replicate that experiment. Tables

6 and 7 show the number of children who employed moni-

toring and array cues on the two trials. As Table 6

indicates, use of monitoring cues was again frequent with

80% of subjects using the cues on both trials. There

were more children using monitoring cues in the two

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* One child in the middle age group failed to complete
the procedure and was excluded from the analysis.

** See Appendix V.

older groups than in the younger group $X^2(1) = 4.52$, $p<0.03$.

As in Experiment II, more children made use of monitoring than array cues ($\chi^2(2)=17.31$, $p<0.001$). The overall percentage of children using array cues on both trials was 30%, and there were no age differences for cue use $\chi^2(1)=0.03$, $p>0.05$.

Cue use was also directly compared with that in Experiment II. There was no difference between the experiments for monitoring cues, $\chi^2(2)=0.0001$, $p>0.05$. However a difference was found for array cues:$\chi^2(2)=8.00$, $p<0.01$. This was due largely to the oldest groups showing a reduced tendency to use cues in Experiment III.

Distribution of memory scores

The percentage of correct responses at each location is shown in Table 8. As can be seen, monitoring and array cues seem to have very different effects. Elevation of recall occurred at the third and fourth locations to be probed only with monitoring cues.

The data were subjected to a 3 (age) x 2 (cue type) x 4 (serial position)/analysis of variance.* Although unequal cell numbers changes in performance with age did not reach signifi-cance there was the distinct suggestion of a developmental trend. (F(2, 62)=2.72, p=0.07). There were also

* Again the UNEN programme from the ALICE package was used.

significant main effects of cue type ($F(1, 62) = 12.77$, $p < 0.001$) and serial position ($F(3, 186) = 5.71$, $p < 0.001$) and a cue type x serial position interaction ($F(3,186) = 3.24$, $p = 0.02$), which were due to the superiority of monitoring cues, and their effect in elevating recall at the third and fourth serial positions. Planned Tukey tests showed both these locations were significantly better recalled with monitoring cues ($CR_T = 14.79$, $p < 0.05$, $CR_T = 27.03$, $p < 0.01$). The results of the present experiment were also compared with those of Experiment II. Performance on these trials is illustrated in Table 9. This table shows a clear differentiation in the usefulness of the different cue types. Performance is comparable for the no-cue and array-cue conditions, which show no elevation at the fourth location. In contrast, performance is elevated at these locations for the other two cue conditions, when monitoring cues are present. The data were analysed in a 3 (age groups) x 4 (cue types) x 4 (serial position) unequal cell numbers ANOVA and the results are shown in Table 10. As can be seen from this table, the two groups who received monitoring and array and monitoring cues, performed better than the array and control groups. The effect of cue type was significant ($F(3,184) = 12.37$, $p < 0.0001$). More importantly cue type interacted with serial position ($F 9, 552) = 6.31$, $p < 0.0001$) which resulted from enhanced recall at the third and fourth locations. Planned comparisons using Tukey's test indicated that both groups who received monitoring cues showed significant elevation of recall at the third and fourth location.[*] This was not true of the group who were

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[*] The respective Tukey values for the third location were 27.75 and 22.83, and for the fourth location 46.06 and 53.51 for the monitoring and monitoring and array cue groups. All these are significant ($p < 0.01$)

provided with array cues only, due to the use of the
inferential strategy. Strategy use in the two monitoring
conditions was sufficient to produce an overall serial
position effect ($F(3, 552)=18.74$, $p<0.0001$). Overall
performance did increase with age ($F(2, 184)=4.42$,
$p<0.02$).[*] There was a suggestion that older children may
make more active use of cues, although this effect was
not significant $F(6, 552)=1.80$, $p=0.09$.

Failures at the fourth location

Of the children who received monitoring cues, 23% made
errors. Half the errors followed a failure to use the
cues. Following spontaneous or experimenter-induced cue
use 75% of the children were able to give correct
responses. Comparison with monitoring and array group
in the previous experiment suggests that although the
error rate is slightly higher due to the absence of array
cues in the monitoring condition, there is no significant
difference in the types of errors made (Fisher Exact
$p=0.30$.) Error rates were much higher in the array only
group, and few children (6%) benefitted from the experi-
menter drawing attention to the cues. Chi squared
analysis demonstrated that there were more children making
errors in the array than monitoring condition, both before
the experimenter indicated the cues ($\chi^2(1)=40.00$, $p<0.001$).
The data suggest that experimenter assistance may well
benefit subjects when monitoring cues are available but
be of little use for the array cues.

[*] A post-hoc Neuman-Keuls test showed the two older groups
outperforming the youngest ($CR_{N-K}=23.16$, $p<0.05$, $CR_{N-K}=25.30$
$p<0.05$).

Discussion

The results of the present experiment replicate and
extend the findings of the previous study. The memory
data strongly suggest that array and monitoring cues
differ in their usefulness for the inferential strategy.
Both the higher performance, and the presence of enhanced
recall at the later locations only, with the monitoring
cues, indicates that monitoring cues are mainly responsible
for the strategy use detected in the previous experiment.
Providing array cues alone does not elevate performance
above the control, or give serial position effects, which
suggests that array cues alone are of little benefit. In
addition, there is weak evidence from the memory data
that older children may make more efficient use of monit-
oring cues. A more extended discussion of this finding
will be presented later.

These conclusions are supported by the analysis of errors.
Errors occurred much more frequently with array cues,
and the experimenter drawing attention to the array cues
did not seem to assist inferencing as it did with the
monitoring group. It is interesting that only 6% of the
array only group improved performance when the cues were
indicated, when a random guess at one member of the array
would have improved it by 25%. This would seem to suggest
the problem for young children lies in realising how
the array cues might be used. The opposite holds for
monitoring cues. An animal cannot be in two places at

once - if it has already been exposed it clearly cannot
be under the remaining cups. The use of monitoring cues
is therefore much more obvious. The error data are
consistent with Experiment II, in that all the same types
of errors are detected. Thus, some children fail to make
the inference,but when provided with monitoring infor-
mation are able to do so. A small proportion of the
subjects were unable to give the correct solution even
when such information was provided. Other children res-
ponded incorrectly, but gave a correct solution when
the monitoring cues were indicated, suggesting they may
have attempted to solve the problem by memory. The
differential usefulness of the two cue types is also
reflected in the direct measurements of cue use. The
monitoring cue data are almost identical to the previous
experiment, with the majority of subjects making use
of them. In addition, fewer children use array than
monitoring cues in this experiment. One result does
differ from the previous experiment. Array cue use
is less frequent than in that experiment. It is the
oldest group who are responsible for the reduced use of
array cues in Experiment III, which seems to indicate
that some children at this age level are sensitive to
the fact that array cues do not aid memory. It cannot
be argued, however, that this reduction in array cue use
is responsible for the absence of array cues effects on
memory, because over 60% of subjects were using array
cues in this experiment, and also because array cues do
not assist performance when they are presented along with

monitoring cues.

The major finding of this study is that the presence of
monitoring rather than array cues assist memory. This
suggests that young children have distinct difficulties
in monitoring previous solutions in memory problems. This
monitoring deficit may, however, be more general; for
the younger children's persistence in using array cues
which do not benefit memory, indicates they are not
evaluating the effects of their memory activities.

4.5 Experiment IV: Are there deficits in underlying inferential skills?

The previous set of experiments suggest a number of
reasons for the failure to employ an inferential strat-
egy in memory. Children may lack auxiliary skills such
as monitoring which means they have insufficient inform-
ation to make the inference. Even when such information
is provided in the form of cues, children may sometimes
fail to utilise it. Further, even when cue use is
spontaneous or when it is experimenter induced, a number
of children fail to make the inference despite the fact
that they have sufficient information to do so. In
the previous experiments I have argued there are two
possible explanations for this failure. Children may simply
be unable to execute the necessary operations, i.e. they
are _unable_ to inference. Alternatively, they may be
influenced by the perceived demand characteristics of

the task. They may obey the instruction to remember too literally, and rely on direct memory, to the exclusion of inferential strategies.

The present experiment attempted to establish whether children failed to make inferences when there were no memory instructions, but the children were all in possession of sufficient information to make the inference. Failure under such circumstances cannot be due to attempts to solve the problem by means of direct memory, and would seem to result from an inability to inference.

If it were discovered that children in possession of sufficient information failed to make inferences, this would have interesting implications for the debate on transitive inferences. While Bryant (1974) and Trabasso (1977) argue that being in possession of premise information is necessary and sufficient for inferencing, this position has been opposed by Breslow (1981), who argues for changes in ability to inference.

The task employed in the present experiment was a modification of that used in earlier experiments. It differed from those experiments because the children did not observe the animals being hidden, and were given no instructions to remember. All children had previously overlearnt the set of animals in the array, and were given monitoring information explicitly by the experimenter.

They were thus in possession of information sufficient to make the inference, and were simply asked if they knew the identity of the animal at the final location. No direct memory solution was possible, because the children had not observed the animal being hidden, and so inferencing was the only means available for solution. None of the children had taken part in any of the previous studies.

Method

Subjects: The subjects were 59 children in the age range 3;0 - 5;3. They were divided into the same age groups as the previous experiments. There were 11, 26 and 22 children in each group and the mean ages were 3;6, 4;3 and 4;11 respectively.

Procedure: The procedure was a modified version of that employed in the previous experiments. Before the start of the experiment itself, the children were given a series of pretrials until they could correctly name all the animals in the array on two consecutive trials. They were then told to close their eyes while the animals were hiding. Each location was probed, and at the final location the experimenter supplied monitoring information by pointing to the exposed animals and saying, 'There's the (named the three animals), now who's hiding under here? (indicating to the final location)'. If children gave a response, the experimenter expressed

his amazement and asked them how they knew the
identity of the concealed animal although they had
not seen it being hidden. It was possible by this
means to elicit justifications of inferencing from
the children. All children received one trial.

Results

The percentage of children at each age level who made
the inference is shown in Table 11. There was a sig-
nificant increase in performance with age, with the
two older groups performing significantly better than
the younger (Fisher exact p = 0.037). The figure also
shows what percentage of children giving correct
responses to the inference question were also able
to give justifications. The ability to give justi-
fications also increased with age ($\chi^2(2) = 5.97$,
p<0.05) with the older groups outperforming the youngest
group ($\chi^2(1) = 5.21$, p<0.03).

Discussion

The present experiment eliminated the possibility
that strategy failure resulted from lack of informa-
tion or from the misunderstanding that the task required
direct memory solutions only. The results therefore
suggest that one reason why some children fail to
demonstrate the inferential strategy is because they
cannot make inferences. Children who are unable to

demonstrate the strategy in the simplified procedure
of this experiment are unlikely to exhibit inferencing
on the memory task. We cannot conclude from this,
however, that an inability to access the correct strategy
plays no role in the memory task. Failures of this
type may well occur; what the present experiment
demonstrates is that failure to access is not the only
explanation of strategy failure when the child has
sufficient information to make the inference. The
results would also seem to support the position of
Breslow (1981) on transitive in ferences. He mentions
that premise information is necessary but not sufficient
for inferencing - a claim which is consistent with the
findings of this experiment, for a different type of
inference.

None of the 59 children made errors in inferencing.
This suggests that the errors made on the memory task
were the result of erroneous direct memory solutions.
If this is the case, then the   errors on the memory
task are themselves evidence for the use of memory
when inferential strategies are possible.

The finding that the ability to give justifications
of strategy use increases with age has important theor-
etical and methodological implications. The theoretical
implication is that there may be a number of different
ways in which a cognitive skill can be in the repertoire.
In this case, younger children may be able to use a

strategy some time before they are able to describe it. The methodological point is that verbal protocols are not suitable as a means to tapping strategy use, particularly in this age group. Young children may well be employing a strategy but be unable to describe their activity.

4.6 Inferences as memory strategies and the failure to employ strategies

The group of experiments just described had three main aims:

(1) To investigate when inferences are employed to supplement direct memory, and to provide explanations as to why young children do not employ such a strategy;

(2) To assess whether young children are able to make use of indirect cues to aid recall;

(3) To assess the intentional character of the young child's memory behaviours.

Inferences

The exact level of inferencing is impossible to assess directly in these experiments, because of the possibility of direct memory solutions. The fact still remains, however, that the groups with monitoring cues generally performed twice as well as control groups, despite the presence of ceiling effects. These results are interesting because they apparently contradict two

generalisations often made about preschoolers, that
they do not often make use of memory strategies (Brown,
1975; Flavell, 1970) and that they lack logical
abilities (Piaget, 1946).

If we deal first with the use of strategies, a number
of recent studies have convincingly demonstrated the
use of simple strategies by this age group (e.g. Wellman
et al, 1975; Yussen, 1974; Yussen et al, 1975). The
eliminative inference may in reality be simpler than
Its complexity in logical terms would have us believe.
This is especially true if the environment provides
cues which avoid the necessity of monitoring previous
solutions , as in the case of these experiments. The
formal logical account might describe the process as
the internal search of the original array, eliminating
previous solutions. However, the process may be more
accurately described in the present experiments as a
realisation that the animals exposed at previously
searched locations cannot possibly also be concealed
at the final location. This suggests that the findings
of the present experiment may not in reality contradict
the research of Piaget, because in the present experi-
ment the presence of external cues simplifies the
making of the inferences in two ways: (a) it reduces
the information processing demands on the child by
avoiding the necessity for internal storage of premise
information; (b) the presence of the cues suggests the
use of the inferential routine to the child.

Explanations of strategy failure

The experiments also suggest a number of reasons why
children may not employ the strategy.

(a) Auxiliary skills Experiment II indicated that
inferencing was vastly increased when/problems of
the
monitoring and memory for the original array were
bypassed. Experiment III established that deficits
in monitoring of previous solutions was the more crucial
of these deficits in explaining strategy failure. These
results are consistent with the literature on transitive
inferences, in which performance is massively improved
by pretraining on premise information (e.g. Trabasso,
1977). The research of Eimas (1970) also shows that
7-year-old children have difficulty in keeping track
of previously rejected incorrect hypotheses in problem
solving tasks. Thus, deficits in skills other than
those directly under test may explain why inferences are
not employed.

(b) Failure to seek out relevant information Experiments
II and III suggest that a small number of children
may fail to demonstrate inferencing even when cues are
provided, not because they cannot make inferences, but
because they fail to make use of the information
provided. We might expect this type of deficit to
have decreased with age, given that older children
made more use of the monitoring cues. However, the num-
ber of children showing this type of deficit was small,
and so it was impossible to test the hypothesis directly.

In general, the likelihood of this type of failure will depend very much on the way in which cue information is provided. It has already been argued that the way in which monitoring cue information is to be used is almost self-evident. Array cues offer a less obvious source of information. In addition it seems that the information afforded by array cues is not useful to children of this age. More will be said about this type of failure in the discussion of cue use.

(c) <u>Failure to select the appropriate routine</u> Another reason why inferencing may not be employed is that an alternative means of solution is available. It is highly likely, given the task instructions, that some children selected a direct memory solution. Experiment IV found that no children who made inferences produced errors. Children do make errors, however, in Experiments II and III. This may well be because they are attempting such/solutions. One problem with the error based measure is that it ignores those children who rely on the direct memory solution, but who are correct, and are thus indistinguishable from children who use the inferential solution. Again, selection errors may well be highly task-dependent. The monitoring cues in these experiments make the strategy obvious, but the memory development literature is full of demonstrations of production deficits, when children fail to spontaneously manifest a strategy and yet can be induced to use it with minimal training.

(d) <u>Inability to use the strategy</u> It has just been argued

that children may fail to use the strategy because
they attempt alternative means of solution, e.g. direct
memory. Experiment IV eliminated this possibility,
and also pretrained children to give them the informa-
tion necessary for the inference. Despite this, some
children still failed the task, which suggests that
they may be <u>unable</u> to make inferences. If this is the
case, it is hardly surprising that they fail to manifest
the strategy.[9]

Cues

In many ways, the conclusions concerning cue use con-
verge on those made about inferencing. Firstly, there
is an apparent anomaly with related research; other
studies have suggested that young children's cue use
is highly limited in nature. Preschoolers may be
capable of utilising identical or highly-associated
objects as cues at encoding (Geis and Lange , 1976;
Gordon and Flavell, 1977; Ryan et al, 1970) but their
performance is massively reduced when cues are indirect
or esoteric (Gordon and Flavell, 1977; Ritter , 1978)
or if cued retrieval must be exhaustive (Kobasigawa, 1974,
1977).

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9 It is possible that the inability to produce a strategy
   is not as distinct from the failure to access it,
   as this analysis suggests. It may be that the
   children who failed to inference in Experiment IV
   could be induced to do so if explicit enough instruc-
   tions were provided. The distinction between
   inability and access may not therefore be as sharp
   as has been argued.

At first glance, the results obtained with the monitoring cues would appear to contradict these findings. Very young children are apparently bypassing deficits in their monitoring ability by utilising information about previous solutions provided by the experimenter. A priori, both monitoring and array cues must be characterised as indirect, because both require combination with some other information for solution. However, as I have argued in the section on inference failures, the nature of the task makes it extremely obvious to see how monitoring cues might be used. This may explain why even very young children have little difficulty in seeing how the monitoring cues are to be used, and in actually using them.

The data on array cue use support the claim that preschoolers' cue use is limited in nature. In the array condition children at all ages made use of the cues, despite the fact that array cue use had no effect on memory. It is as though the children realise that in some way the cues ought to be useful, but cannot quite see how they might be used. Cue use may very well be induced by the fact that the experimenter has directly referred to the array cues and stressed their relation to the concealed animals.* Similar results were found in the monitoring and array condition where again there is a high level of array cue use, without memory pay-

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* An additional factor may be the direction of the experimenter's eye gaze. It may be that the children look at the cues because the experimenter does so. This could be examined by conducting the experiment with the experimenter behind a screen.

offs.[10] Interestingly the use of array cues seemed to
be context-dependent. Array cue use was significantly
increased by the presence of monitoring cues. In contrast,
monitoring cue use was independent of the presence of
array cues. We may therefore conclude that although
preschool children may make increasing use of indirect
cuing strategies, such as using the monitoring cues,
the exact nature of the cues used means that the results
are not inconsistent with other recent research. The
data on array cue use suggests that young children have
difficulty in making use of more indirect forms of cues.
Even at this age, children do show some sensitivity to
cue usefulness, with the two older groups looking substan-
tially more at monitoring than array cues.

The finding that young children may engage in "strategic"
behaviour without memory pay-offs may suggest an important
mechanism in the development of strategies. Particular
situations may elicit certain behaviours in children.
Some of these behaviours may well be inappropriate (e.g.
array cue use), but it is only by engaging in a number
of such behaviours that a child can discover or be instr-
ucted which of these have memory pay-offs and should be

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10 A similar argument has been advanced by Ryan et
    al (1970) in their study of preschoolers' use of
    pictures to cue hidden animals. They suggested that
    young children may place pictures of animals out-
    side their hiding places because such matching
    behaviour isa"high-frequency behavioural response".
    The difference between the Ryan et al study and
    the present ones, is that in their study the eli-
    cited behaviour always had memory payoffs.

retained in the repertoire of strategies.

4.7 Experiment V: Does self-assessment relate to cue use?

The experiments on cue use suggested a number of interesting results:

(a) Some children make very little use of cues;

(b) There is an increase with age in the use of the monitoring cues which do benefit memory;

(c) Some children make use of the array cues, which apparently do not aid memory.

One possible explanation for some of these deficits may lie in children's inability to assess the accuracy of their own performance. A number of studies have found massive overestimations in 7-year-old children's ability to assess their own performance on memory tasks (Brown, 1978; Flavell et al, 1970; Kelly et al, 1976; Yussen and Levy, 1975). If children genuinely believe their performance will be excellent, it is not surprising that they fail to employ strategies, because there seems little need to do so. Unfortunately, the two studies which have attempted to find the predicted relationship between prediction and strategy use (Flavell et al, 1970; Kelly et al, 1976) have failed to do so.

Pilot studies attempting to obtain predictions from preschoolers encountered severe difficulties, so children

were asked to assess performance after rather than before
completing the task. The same argument holds for post-
diction and prediction, for if children believe they
have performed well without using strategies, there is
no necessity for employing them. Other studies have
not investigated this possible relationship, because they
have studied older children, who are usually remarkably
good at postdiction (Berch and Evans, 1973; Masur et
al, 1973). The lack of post-diction data available for
this age group also offered a further reason for conduc-
ting the study.

The first study therefore had a number of aims:
(1) To assess preschool children's ability to assess
their own memory performance (post-diction);
(2) To investigate whether self-assessment was related
to cue use, in particular, whether young children's
failure to employ strategies can be traced to overestim-
ation of their own performance;
(3) To assess whether post-diction was related to the
type of strategy used. In particular we might expect
children who are better at self-assessment to use only
monitoring cues, because they/detect that array cues do
not influence memory.

Method

Subjects: The subjects were 67 children in the age
range 3;0-5;3. They were divided into the usual age
groups with 16, 24, and 27 children in each age group

respectively. The mean ages were 3;5, 4;1, and 4;9 re-
spectively. All children had participated in Experiments II
or III some two or three months previously.[*]

Procedure: The experimental procedure was essentially the same
as Experiments II and III. The children were given a number
of pre-trials in which the experimenter demonstrated what was
required, by giving post-diction responses himself. The
children were then given two memory trials in which no cues
were presented. After recall was completed on each trial,
the experimenter exposed all the hidden animals and asked the
children to make post-diction judgements ("Show me which ones
you remembered in the right places"). There then followed
two trials with both monitoring and array cues as in
Experiment II. No post-diction judgements were requested for
these trials: The experimental set-up is depicted in Fig. 1,
Appendix V.

Results

Table 12 indicates the extent to which young children over-
estimate their own performance. On average children over-
estimated what they had remembered correctly by 70%. Errors
were almost exclusively over-estimations, and on 51 out of a
possible 134 occasions the children incorrectly claimed to
have remembered all the items on a trial correctly (an 'all
right' response). Only one child underestimated his memory,
although five other children failed to correctly identify
individual items they had correctly remembered.

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[*] One child in the youngest group failed to complete the
experiment and is not included in the above statement or
the analysis.

Children were scored by item according to whether they
correctly stated whether they had remembered the item
or not.   The scores were subjected to a 3 (Age) x 2
  unequal cells
(Trial)/ANOVA.* There was a main effect of age (F(2, 64)
=4.01, p=0.02) and no other effects were significant. **

In order to investigate whether children who overestimate
the efficiency of their memories fail to employ strat-
egies, children were classified as cue users if they
utilised cues on both possible trials. The children
were also classified for their monitoring ability: if
they gave two incorrect 'all right' responses, they
were deemed overestimators; if they gave no incorrect
'all right' responses they were classified as realistic
            The two
estimators./ children who did not fall into either of
these categories were discarded for the purpose of this
analysis. The relationship between monitoring ability
and cue use is indicated in Table 13. A Fisher Exact
analysis was conducted to see whether post-diction skill
was related to tendency to use cues. The cue use data
were dichotomised as to whether cues were or were not
used. Children who were bad at post-dicting were signi-
ficantly less likely to make use of cues (Fisher exact
p=0.03). It was also predicted that children who were
better at post-dicting should also be more likely to use
only monitoring cues. A χ^2 analysis was conducted on
all those children who used cues, but post-diction skill
was not predictive of efficiency of cue selection
$\chi^2(1)=1.08$, p>0.05. However, it is possible that by

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* Again the ALICE UNEN statistical package was used.
** Post-hoc comparisons by Neuman-Keuls showed the oldest group
   performed better than the youngest (CR$_{N-K}$=51.14, p< 0.05)

dichotomising children into good or bad post-dictors we lose some of the data. One initial prediction was that children who made use of monitoring cues alone, should be better at post-diction than those who used array cues. It was found that children who used monitoring cues on two trials formed 84% of the sample, and these were divided according to whether they used array cues on 0, 1, or 2 trials. The mean post-diction scores (compiled as for the ANOVA described above) for the three groups were 5.82, 6.09, and 5.20. "T"tests did not support the prediction that children who use monitoring and array cues should be better at post-dicting than children who use monitoring and array cues on both trials $(t_{(33)}=0.73, p=0.47)$. In fact, children using array cues on one trial were actually superior at assessing their own performance although this difference was not significant $(t_{(36)}=0.41, p=0.68)$.

Conclusions

One major result of this experiment is to document young children's inability to assess the accuracy of their performance on this type of task. Their errors consisted almost exclusively of overestimations, which averaged 70% above their actual level of performance. Although other studies such as those of Berch and Evans (1973) and Masur et al (1973) report that self-assessment is almost at ceiling, they in fact tested children 2-3 years older than those in the present sample. Indeed it is not

difficult to see why performance should be so poor. In
order to respond to the experimenter's request to "tell
me how many you remembered in the right places" the
children must retain their own pattern of responses
throughout the trial, and then compare them with the
'correct solutions' on questioning. Alternatively they
may remember each location and tag it with information
as to whether their response was correct. In either
case, it is clear that information processing demands
are high, because of the demands on memory and comparative
skills. It was also proposed that the ability to assess
one's own performance might be related to cuing strate-
gies. There was weak support for the prediction that
children who vastly overestimate their own memory (as
many of this sample did) should see no need to employ
cuing strategies. However the strong version of the
hypothesis does not hold, because almost all the chil-
dren who claimed to have perfect memories did make some
use of cues. This should not be the case if they are
influenced by their estimates. The results of the
study are thus consistent with those of Flavell et al
(1970) and Kelly et al (1976) who found little or no
relation between prediction measures and strategy use.

There was also little evidence that self-assessment skills
related in any way to the type of cue selected. Children
who showed optimal cue use, i.e. they used monitoring
cues only, did not perform better on the self-assessment
tests, than other groups. Before rejecting any type

of relationship between cue selection and self-assessment,
it is important to consider two other possibilities.
Children may well realise that performance is improved
when using monitoring and array cues but be unable to
isolate which cue type is responsible. They may therefore
persist with both types. Alternatively, we may argue
that insufficient measures of self-assessment have been
taken because there is no reason why assessment scores
on the previous two memory trials should directly relate
to performance on the trials with cues. Any relationship
between cue use and self-assessment may critically
depend on judgements made on cued trials, because any
decision about strategy efficiency is going to require
a comparison of performance on memory trials with
performance on cued trials.

4.8 Experiment VI: Does self-assessment relate to the type of cues used?

The present experiment attempts to eliminate the con-
founding of monitoring / and array cues, by presenting the
cue types separately. It was argued that cue selection
may depend critically on comparisons on trials with
and without cues, and so four self-assessment measures
were taken i.e. one on each of the trials.

If self-assessment does affect strategy selection we
should expect a number of relationships to hold: first,
children who vastly overestimate their own performance

should see no need for strategies, and consequently not use them. Also we might expect cue use to relate to self-assessment. Thus, children who accurately check their own performance should realise the usefulness of monitoring cues and hence make maximum use of them. Conversely, they should detect that array cues do not increase performance and therefore not use them. We should consequently predict that children making use of monitoring cues should be accurate at self-assessment, whereas the opposite should be the case for those using array cues. Finally, cue selection should be related to perceived changes in performance when cues are used. Thus, we might expect children who use cues and accurately check their performance to realise that the improvement is due to cue use. They should therefore retain the strategy. If, of course, perceived performance drops when cues are used then we should expect use of the strategy to be discontinued.

There are thus three separate hypotheses concerning the relationship between post-diction and cue use:

(a) Children who overestimate memory on the two initial trials when no cues are present should not use cues when they are provided.

(b) Children who are good at monitoring should use monitoring cues and not use array cues. No such differentiation should occur for the group who are poor at monitoring.

(c) Changes in performance should be related to monitoring.

If children perceive that their performance is improved
they should persist with their current strategy. If
performance is not improved by cue use, they should not
maintain that strategy.

It is important that hypothesis (a) is subjected to
test, because the results of the last experiment suggest
some evidence for this claim. In contrast, other experi-
ments have found no such relationship (Flavell et al,
1970; Kelly et al, 1970). The rationale for hypothesis
(c) is derived from experiments which suggest that infor-
mation about performance change can influence strategy
maintenance (e.g. Borkowski et al, 1976; Kennedy and
Miller, 1976). In those experiments such information
was provided by the experimenter: the present study
investigates whether children use information they them-
selves have generated.

Method

Subjects: The subjects were 68 children divided into
the usual age groups. Thirty five children received mon-
itoring cues and 33 received array cues. There were
9, 14, and 12 children in the monitoring group (mean
ages 3;5, 4;2, and 4;8) and 9, 9, and 15 children in
the array group (mean ages 3;5, 4;2, 4;9). All children had
participated in Experiments II or III some 6 months previously.

Procedure: The procedure was identical to that employed
in Experiment V except that after every trial the
children were asked to assess the accuracy of their

performance, and children were given either array or
monitoring cues, not both.

Results

The self-assessment data for the three age groups under
the different cueing conditions are illustrated in Table
14.   The results for the no cue condition replicate
the data reported in the previous experiment, and for
all three conditions children overestimate their actual
memory scores by 71%. Again a large proportion of the
overestimations are contributed by those children who
claimed erroneously to have remembered every item corr-
ectly on all of the trials. Altogether 24/68 children
incorrectly claimed to be completely correct on all
                                 completely
trials, and a further 8 claimed to be/correct on three
of the trials. Again, there were few failures to identify
items correctly remembered, and only two children under-
estimated their memory aggregates. It is interesting
to note that despite the inaccuracy of children's
absolute estimates of memory performance, they were to
some extent sensitive to the changes in performance
resulting from monitoring cue use. Thus in all three
age groups, performance assessments were higher in the
monitoring cue condition.

The data were analysed separately for the groups who
received monitoring and array cues, and analysis took the
                                for unequal cell numbers*
form of two 2 (Cue/No-Cue) x / (Age) ANOVA's. The data

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* Again UNEN from the ALICE package was used.

were scored in the manner described in the previous experiment, with one point being given for a correct response as to whether or not the item had been remembered. Both analyses found main effects of age, but there were no other effects. Thus, there were developmental trends for the group who received monitoring cues ($F(2, 64)=3.97$, $p<0.02$),* but there was no difference in assessment accuracy between the cue and no cue conditions. A developmental trend was also evident in the array cue analyses ($F(2, 62)=3.32$, $p<0.05$),* but again there was no effect of cueing Thus, although children's assessments of memory increase in accuracy with age, they are not influenced by whether or not they are employing cues.

The data are again amenable to the investigation of the overestimation hypothesis (see Experiment V). The hypothesis that gross overestimators were less likely to make use of cues than children who were accurate at self-assessment was not verified ($\chi^2(1)=0.44$, $p>0.05$). In addition, 14 of the 24 overestimators used cues on both trials. Finally, it was found that overestimators were indistinguishable from accurate self-assessors in their use of both types of cues.

Children were also classified according to whether they used cues on neither one or both trials. The two separate 3-way (cue use) ANOVA's for both monitoring and array cues indicated there was no difference in monitoring

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* Post-hoc comparisons using a Neuman-Keuls test showed the two older groups were superior in both conditions. $CR_{N-K}=22.99$, $p<0.05$, $CR_{N-K}=24.15$, $p<0.05$).

scores between the three groups, for either of the cue types analysed.

The relationship between strategy maintenance and perceived effectiveness of the strategy was also analysed. All children who incorrectly claimed to have remembered all items were rejected from the analysis. Children were categorised according to whether their self-assessment scores indicated they perceived that available cues improved, reduced or did not influence memory. It was argued that children who used cues, and perceived their performance as improving with cues, should maintain that strategy over both cued trials. Table 15 shows strategy maintenance in the three groups. Two features of the table are worth noting: ten children continued to employ the strategy despite the fact that they perceived it as reducing performance and secondly few children did not maintain a strategy they felt did improve performance. Thus while fifteen children behaved in accordance with initial predictions, sixteen did not.

Conclusions

The majority of the results obtained in the present study are consistent with those of Experiment V. Again there is strong evidence for gross overestimation of performance by younger children, although this has improved somewhat by the age of five. However, although children of this age may not be able to estimate absolute

levels of performance, their estimates do change when
the level of performance changes, indicating they are
in some way sensitive to performance. Thus, children's
estimates of their performance reflect the fact that
their actual performance is better when monitoring cues
are present, i.e. when such cues are present, their
estimates are higher.

The experiment was also designed to investigate how
children's estimations of their own performance influence
their strategy use. There was no evidence that children
who grossly overestimate memory, and claim to perform
perfectly, actually make less use of cues than more
accurate estimators. It was also predicted that chil-
dren who assess accurately should make maximal use of
monitoring cues, and minimal use of array cues. It
was found that children following either of these optim-
al strategy paths did not demonstrate greater ability
to assess their own memory.

However, this may not be conclusive proof that no relat-
ionship holds between self-assessment and strategy use.
The above hypothesis need not be correct that optimal
strategy users should be best at monitoring their own
performance. As the assessment data indicate, children
may not be able to judge their absolute level of perfor-
mance but be able crudely to detect when performance
changes. It is this skill, rather than absolute judge-
ments, which may be crucial in determining strategy

maintenance. A more sensitive test of the relationship between self-assessment and strategy use follows from this. Children should maintain a strategy if it is detected as improving memory, and to this end, it is not crucial that absolute levels of performance are detected, rather than they can isolate a relative change in performance. The experiment attempted to assess whether strategy maintenance was influenced by children's detection of such relative changes. Again no relationship was found, although there may be other post-hoc explanations for this. It may be that children find it difficult to remember assessments of performance when they have to retain this information across trials. In addition, relative changes may be small (e.g. one or two items) and therefore difficult to detect. If changes in performance due to strategy use were made sufficiently large, it might be that young children could detect such changes and consequently modify strategy behaviour. *

4.9 Conclusions

seem to
The last two experiments/provide further counter-evidence against metamemory theories. In Experiment V, two, and in Experiment VI, three hypotheses derived from metamemory theory were subjected to test. Only one of these hypotheses was supported by the evidence, and it was not replicated in the following experiment.

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* This may be a somewhat insensitive test of the relationship between maintena nce and effectiveness because children have only two trials in which to assess the effectiveness of various cues.

The strength of these claims must, however, be
questioned in the light of the reservations expressed
above. If the experiments are indeed insensitive, then
they do not provide convincing evidence against the
metamemory hypothesis. Despite this, the results are
consistent with two studies investigating the relationship
in older children (Flavell et at, 1970; Kelly et al,
1976).

CHAPTER 5   FEEDBACK, MONITORING AND STRATEGY ACCESS

5.1   Introduction

This Chapter addresses the problem of strategy access.
There are both general and specific reasons for addres-
sing the problem. The general reasons lie in the pervas-
iveness of the phenomenon of the production deficit, and
the implications of this deficit for theories of both
memory and cognitive development. The specific reasons
lie in the findings of the previous set of experiments,
which investigated the use of cueing strategies. Both
Brown (1978) and Flavell (1971) have predicted that
access should be related to monitoring skills, but no evidence
was found for this.

Chapters 1 and 2 reviewed a number of studies which
indicate that young children have problems in spontan-
eously accessing cognitive routines which are in their
behavioural repertoire and which benefit memory. The
failure to access can occur both before and after instru-
ctions in strategy use, as the Keeney et al (1967)
experiment shows. They found that children could be
induced to engage in simple rehearsal after a minimal
amount of training, but that children would not continue
to use the trained strategy when the experimenter no
longer prompted them to do so. The phenomenon of failure

to access appropriate cognitive routines is not limited
to memory, however, for both Bruner (1966) and
Donaldson (1978) offer accounts of conservation failure
which appeal to the notion of access. Other studies
(e.g. Gelman, 1969) have employed training procedures to
demonstrate that children are capable of generating
conservation responses some years before the spontaneous
appearance of these skills. The problem of access is
therefore an important one, because of its pervasiveness
in different development domains.

A number of accounts of memory development (e.g. Flavell,
1971; Brown, 1978) suggest that strategy access may
be influenced by monitoring: more specifically that
children's assessments of their memory performance
determine the nature and extent of their strategy use.
Experiments V and VI found little evidence for the pre-
dicted relationship. It was suggested that there may
be a number of reasons for this: (a) children may not
monitor accurately; (b) they may not be able to retain
the results of the assessments of performance over trials,
and thus not be in a position to compare any changes
in performance resulting from the use of different
strategies; (c) they may actually have difficulty in
making the comparison between differences in performance;
(d) they may not correctly attribute such changes to
changes in strategy use.

Some recent studies of strategy maintenance provide

evidence that these factors may be important. The
experiments of Kennedy and Miller (1976) and Borkowski et
al (1976) bypassed the problems which monitoring, eval-
uating and rationalising changes in memory may
provide for young children. They achieved this by
directly informing children of the relationship between
their performance changes and strategy use. Children
given such feedback on the effects of training strategy
use were found to maintain those strategies. In contrast,
children who were not given this information did not
maintain.

As I argued in Chapter 2, however, feedback is not the
only mechanism by which strategy maintenance can be
achieved. Not only is strategy maintenance possible
in the absence of feedback (e.g. Björklund et al, 1977-
Ornstein et al, 1977) but the above manipulation of
providing feedback confounds the various explanations
of maintenance failure suggested previously. Other
feedback experiments do allow us to separate out the
various explanations. Thus Ringel and Springer (1980)
and Heisel and Ritter (1981) have shown that children
have difficulty in monitoring strategy effectiveness,
in evaluating it, and in attributing performance changes
to strategy use.

Ringel and Springer employed a task of memorising lists of
categorisable words. Subjects were given one of three
types of feedback about their performance. One group

were told they were performing better, and that this was because they were employing the trained strategy. Another group were simply told after the session in which they used the strategy, that they were performing better, but no attention was drawn to the fact that the strategy was responsible. The final group received no feedback. Ten-year-olds maintained the strategy if informed about their improvements in performance, and 6- and 8-year-olds only did so when this information was related to strategy use. Control groups not given this information did not maintain. Heisel and Ritter (1981) used a similar manipulation of feedback-and-explanation, feedback and no information. They employed a spatial location task. The results showed a similar pattern to those of Ringel and Springer. Five-year-olds maintained when given information only about strategy effectiveness, whereas 3- and 4-year-olds required that this connection be made explicit before they showed maintenance.

Thus we have evidence that children have difficulty in evaluating changes in performance, and also in interpreting these changes as being the result of strategy use. These conclusions are consistent with the results of Moynahan (1976) who found using questionnaire methods, that information about performance level was related to strategy use. Experiments V and VI also suggest children may have difficulties in accurately monitoring their performance.

The present chapter examines some of the conditions
under which children can be induced to monitor trained
strategies and also investigates the possible explanations
of the failure to monitor suggested earlier in this
section.

5.2   Experiment VII   Does feedback influence strategy maintenance?

Introduction

The present study attempted to replicate the results
obtained by Kennedy and Miller (1976), whose experiment
is itself a modification of Keeney et al (1967). The
experiment differs from the Keeney et al study only in
that feedback is given to one group of trained producers
before the maintenance task. In the Kennedy and Miller
experiment, non-rehearsing children were first instructed
in the use of rehearsal. Following instruction, half the
subjects were told they were "doing much better" when
they used the strategy. The other half of the subjects
were not given this information. Only the subjects given
feedback maintained the strategy when they were not
explicitly requested to use it. The present experiment
consists of three phases: diagnosis, training and transfer.
In the first phase, children are tested to see whether
they spontaneously employ verbal rehearsal when required
to remember the serial order of a set of pictures indi-
cated by the experimenter. It is predicted that children

who rehearse should outperform those who do not. Children
who do not rehearse are then taught to do so, which should
elevate their performance to the level of the spontaneous
rehearsers. Following training, half the children
induced to rehearse are given verbal feedback about
their performance. It is predicted that these children
will continue to use the strategy when not directly instruc-
ted to do so. In the absence of such reinforcement,
maintenance should not occur.

Method

Subjects: The subjects were 53 children aged between 6
and 7 years. All subjects took part in the initial session,
and 24 subjects participated in both sessions. *

Apparatus: The stimuli consisted of pictures of six common
objects: chair, cup, brush, saw, clock and pan. These
were randomly arranged before each test trial. In order
to prevent the children looking at the cards during the
retention interval they wore a space helmet with an
opaque vizor. The vizor was put down during the retention
interval, and raised for presentation and test.

Procedure: The children were tested individually.
Both presentation of the tasks, and the scoring were
conducted by one experimenter. The children were
initially given training in the concept of "same order"
using toy animals. They were given a series of pretrials
to familiarise them with the task and with the use of

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* All subjects attended the same primary school in Cupar, Fife.

the helmet. The children were told to look at each picture as the experimenter pointed to it, and then to lower the vizor on instruction. A 15s retention interval elapsed during which the experimenter modified the array. The children were then told to raise the vizor and to point to the same items as the experimenter in exactly the same order. They were also told that it did not matter if the spatial location of the items had altered. Following Kennedy and Miller (1976) the number of items on 10 subsequent trials was 5-4-3-4-5-3-2-3-4-5. Following the series of 10 trials the children were asked how they had tried to remember the pictures, and also asked to name all the pictures.

The criterion used for identifying producers was whether they employed rehearsal on nine of the 10 test trials. If they rehearsed on none or one and failed to report a strategy they were categorised as Non-producers. Only the children classified as Producers (6) or Non-producers (18) were involved in the second session which took place 3 days later. The children's recall was also scored for how many items they correctly remembered.

The second session which took place 3 days later, only involved the Producers and Non-producers as indicated above. The Non-producers were paired according to their recall scores in the first session. They were

then randomly assigned to Feedback or No-Feedback
groups. All the children were given a brief pretrial
to confirm the diagnosis of Session 1. None of the
children showed strategy use in this pretrial which
differed from their previous diagnosis.

For the Producers, the procedure was identical with
the first session; they received 10 trials in the
order previously given. Non-producers in both groups
were given instructions in strategy use with a differ-
ent set of pictures. The experimenter told them, "This
time when I point to each of the pictures, I want you
to say its name. When I've finished pointing at the
pictures I want you to put the vizor down like you
did last time, but this time you've got to keep
on saying the names of the pictures over and over again
to yourself" (Experimenter then demonstrates). There
then followed a series of practice trials. On the
initial trials, the experimenter rehearsed the items
with the child during the retention interval. This
continued until the experimenter was convinced the
child was conversant with the strategy. Following this
instruction, the children were given the same 10-trial
sequence as they had received in the first session.
Before each trial the experimenter reminded the chil-
dren of the need to repeat the names of the pictures
in order.

Following these 10 test trials the experimenter

suggested that both he and the child probably
needed a rest. During the brief rest period he said
to the child in the Non-producer-Feedback group
"Goodness me, you're doing much better when you're
saying the names over and over again to yourself.
Saying them over and over again must help you to
remember them, mustn't it?" This was not said to
either the Producer or Non-producer-No-Feedback groups.
They were told, "My, you must be tired after trying
to remember all those pictures. Let's have a rest
before we do last few".

The experimenter then said to both the Non-producer
groups: "We're going to have three more shots now.
I'm not going to tell you to say the names over and
over again any more. You can say them if you want to,
but you don't have to. Okay?" The transfer trials
were then administered. They consisted of 3, 4 and
5 items and were identical to the last three instruc-
ted trials.

The rehearsal and recall data were scored as in the
previous session. The present experiment departed
from the Kennedy and Miller (1976) procedure by not
awarding children prizes after each session.

Results

Three different analyses were conducted; the first

investigated the relationship between rehearsal and performance; the second analysed the effects of training on memory; and the third examined the effects of feedback on strategy maintenance.

Session 1 The recall data indicated that Producers (Mean = 24.50) performed significantly better than Non-producers Mean = 16.94 , $t_{(22)}$ = 2.85, p<0.01.

When asked about how they had attempted to remember the pictures only four children claimed to have employed a strategy. All these children said that they had rehearsed the names of pictures. All these children were in the spontaneous rehearsal group according to their overt strategy use.

Session 2 Following training for the Non-producer groups, recall scores for the 10 test trials were compared for the Producer and Non-producer groups. The respective mean scores were 23.84 and 21.86 and there was no overall difference between the groups, $t_{(22)}$ = 1.25, p = 0.22 . The fact that there is now no statistically significant difference in performance between the groups suggests that rehearsal training has been successful and also that the rehearsal strategy was largely responsible for the initially observed differences in performance between the groups.

If we compare observed rehearsal on the final three trials

of Session 2 (i.e. the maintenance trials), we find that of the No-Feedback group, one child abandoned rehearsal completely, two now rehearsed on two trials and five maintained the strategy. For the trained group who received feedback, three children rehearsed on two trials, and the remaining six rehearsed on all three trials. The difference between Non-producer-Feedback and Non-producer-No-Feedback groups was not significant (Fisher Exact p = 0.27), nor was there a difference in rehearsal levels between Producers and the Non-producers-No-Feedback groups (Fisher Exact p = 0.18).

Analysis of strategy maintenance in the three groups was conducted by a comparison of trials 8-10 (henceforth known as Block 1) and trials 11-13 (Block 2). The reason for comparing these trials is that the items in them are identical, but they are separated by the rest period, during which the feedback group were informed of their effectiveness of strategy use. The recall data for these blocks are shown in Table 16. The table suggests that although the performance of the Producers is relatively unchanged over the two blocks, both Non-producer groups are influenced by feedback and the new instructions. The data were subjected to a 3 (Group) x 2 (Block) ANOVA for repeated measures. In contrast to Kennedy and Miller, there was no overall effect of blocks $(F(2, 47) = 0.01,$ ns), nor was there a group x block interaction $(F(2, 47) = 0.75, p = 0.47)$.

In conclusion, there were no differences between the
experimental groups either for observed rehearsal, or for
concomitant recall.

Discussion

The results for the first session and the first ten
trials of the second session provide evidence for a much
documented phenomenon in memory development: the produc-
tion deficit. Children who showed no signs of spontaneous
rehearsal could be induced to use the strategy when they
were given minimal instruction. The effectiveness of
the strategy was demonstrated by the fact that their
recall performance when rehearsing was elevated almost
to the level of spontaneous strategy producers.

The present study also replicates two other results repor-
ted by Kennedy and Miller. In the test of strategy
maintenance, when the children were not directly instructed
to use the strategy, Producers and Non-producers given
feedback both maintained strategy use. The results are
not consistent, however, with respect to the Non-
producer-No-Feedback condition. Kennedy and Miller and
the earlier experiment of Keeney et al (1967) both report
that children given no feedback information do not con-
tinue to employ the strategy when they are not under
direct instruction.

How, then, are we to account for this discrepancy? One

explanation may lie in the procedural differences between the experiments. Both the two earlier studies employed relatively long time intervals (of six weeks) between Sessions 1 and 2 (Keeney et al) and 3 weeks (Kennedy and Miller). Children may realise that a strategy is effective by means other than being informed this by the experimenter. They may, for example, compare performance with and without strategy use and spontaneously decide on the benefits of the strategy. In order to do this they must remember their assessment throughout the period, between the Sessions. We must bear in mind, also, that children do not realise that such a comparison may be helpful and so are unlikely to make deliberate attempts to remember the level of performance in Session 1.

These problems may be much reduced by the procedure used in the present experiment. The interval between Session 1 and Session 2 was 3 days. In the present task, spontaneous judgements about strategy effectiveness may be possible, given that the effects of strategy use are large (i.e. it almost doubles performance) and thus easily detectable. In addition, other studies indicate that children in this age range are well able to assess their own performance accurately (Berch and Evans, 1973; Bisanz et al, 1978).

In conclusion, information about strategy effectiveness may well be a sufficient condition for strategy maintenance. It is not necessary, however, for under the

conditions reported in the present experiment, children maintained a strategy without such information. This suggests that under certain circumstances children may spontaneously infer strategic effectiveness, a speculation which is examined in Experiment VIII.

5.3   Experiment VIII: Does strategy effectiveness influence maintenance?

The previous experiment indicated that under certain circumstances strategy maintenance occurs in the absence of feedback. This result is contradictory to most of the received literature on attempts to train strategies, but there have been a number of studies which have found maintenance without the provision of feedback. Thus the studies of Keeney et al (1967), Cole, Gay, Glick and Sharp (1971a), and Scribner and Cole (1972) report no transfer of trained studies,in contrast to the findings of Bjorklund et al (1977) and Ornstein et al (1977) who did find maintenance without feedback.

These contradictions may be resolved, however, if we

analyse the exact conditions of the experimental tasks.
It was argued in the introductory sections of this
chapter, that children may have difficulty both in
evaluating the effects of strategy use, and in inter-
preting these effects. The processes of evaluation and
interpretation may well be simplified if the effects of
strategy use are large and hence easily detectable.
Thus, if using strategies results in massive changes
in performance, then these effects will be easily moni-
tored. The size of strategy effects may also be crucial
if children are not adept at monitoring: effects may
have to be large before they are detectable. Inter-
pretation may also be influenced by the size of strategy
effects, because small effects could be explained by
factors other than strategy use, such as practice. If
effects are large, such interpretations of performance
change are not possible.

The present experiment therefore set out to examine
whether maintenance in the absence of feedback is related
to strategy effectiveness, i.e. the amount by which
a strategy improves performance. Two groups of
subjects were taught the same strategy, but the con-
ditions of the experiment were arranged so that for one
group strategy use produced massive changes in performance.
For the other group, strategy use did not result in
such large changes. It was hypothesised that the group
whose performance underwent massive changes following
strategy use would be more likely to maintain the

strategy in a number of related tasks.

The experiment involved two groups of 3 - 5-year-old
children who were taught the strategy of using pictures
of animals to cue the locations of animals they had
hidden. Each child hid the animals at different loc-
ations, and the experimenter placed pictures of the
animals face-down outside their hiding-places. The
strategy under study was whether children would use the
pictures to help them remember where the animals were
hiding.[11] Both groups were taught the same strategy
but the perceived improvement resulting from strategy
use differed for the two groups. This was achieved
by giving the two groups different numbers of items to
remember in the no strategy and training phases. The
control group who were given 3 items to remember in the
no strategy and training phases, performed reasonably
well without strategies, and so when they were taught
the strategy of cuing, the change in their performance
was not enormous. In contrast the experimental group
had to remember the locations of 7 animals. They per-
formed poorly in the no strategy phase, but performance
improved to ceiling when they were taught the cueing
strategy. For this group, the changes in performance
resulting from strategy use were therefore highly
detectable. The experimental group should therefore

11 The inferential cuing strategy of Experiments I-VI
    was not used in this study, because it was necessary
    to find a strategy which leads to large improvements
    in performance when it is used. This does not
    occur with the inferencing strategy.

perceive that strategy use is highly effective; it elevates performance from floor to ceiling levels. In contrast, performance changes should not be as large for the control group, who were performing reasonably well before they used the strategy. The influence of strategy effectiveness on transfer was assessed by examining strategy use in two other tasks. The first differed from the training task in the materials and locations used, but the trained cueing strategy could still be used. This was labelled the near transfer task. In the far transfer task, it was investigated whether children could use a variant of the strategy in encoding the location of an animal in order to remember it later. In both these transfer tasks it was predicted that the initial differences in perceived strategy effectiveness between the groups would lead to greater transfer for the experimental group.

Method

Subjects: The subjects were 60 preschool children who ranged in age from 3;3 - 5;2. They were equally divided into the usual three age groups, and the mean ages were 3;4, 4;2 and 4;11. All of the children had taken part in earlier experiments on cueing.*

Procedure: The experiment consisted of a pretrial phase, a training phase and two transfer tasks. The training phase and transfer tasks were identical for both experimental groups, but the pretrial phase differed in the number of items used on each trial.

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* Two children, one from the youngest and one from the middle age group, did not complete the procedure. They were replaced by other, matched, children.

<u>Pretrial and training</u>: The procedure for the pretrial
phase was identical to that of Experiments I - III, with
the children being introduced to the policeman and the
hiding animals. The hiding animals were the small
plastic farm animals used in the previous experiment.
The 7-item group hid a pig, a dog, a sheep, a duck,
a hen, a cow and a goat. The 3-item group hid the pig,
sheep and hen. The animals were hidden in the plastic
cups used in previous experiments. After the two pretrials
the experimenter produced a set of photographs identical
in size to the original animals, and asked the children
to put the animals together with their pictures. Again,
a series of hints were used until the children finally
agreed that the animals were identical to their photo-
graphs. The experimenter then said "This time, we're
going to do it a bit differently, you hide the animals
and I'll put their pictures outside like this (Models
hiding and putting picture outside). Now when you want
to remember which animal is in this house, you just
look at the picture and then you'll know".

The children were then given two further trials in
which they hid the animals and the experimenter placed
the appropriate cue outside each location. The locations
were then probed by the policeman, and if the children
failed to use the cues the experimenter employed a series
of hints to ensure that they did so. If the children
did not use cues initially the experimenter said "Is
there anything we can do to help us remember which animal

is hiding here?" If the children still didn't use the cues, the experimenter said, "Why don't you look at the picture?" There was a possibility that the few-item group would be less likely to use the cues than the many-item group even on the training sessions. This was controlled by matching the 7-item and 3-item groups for the strength of prompting required to initially induce the strategy. Nine children in each group required prompts, and a total of 28 prompts were given to each group.

Near transfer: After the 2 trial training phase the experimenter told both groups of children that they would now play a different game. He showed them five brown boxes which were placed on a circular turntable. The children were shown 5 zoo animals:- a tiger, an elephant, a polar bear, a kangaroo and a monkey. They were told, "this time when the animals hide you have to close your eyes while I turn this (indicates turntable) round (the experimenter then hides animals). Now look, because I turned it round the animal (names it) who was here, is now over here. (Repeats for two other animals)." The use of the turntable on the transfer task means that direct memory solutions are not possible. Children must therefore employ some other means if they are to respond correctly. The experimenter than produced a puppet, who he said wanted to 'play the game first'. The experimenter was thus able to show the children what they were supposed to do by modelling with the puppet. Following

this, the experimenter said that the puppet would now
watch while the children had their turns. The experimenter
then produced photographs of all the animals and told
the child that each animal had a picture. He then told
the children to hide the animals while he would put the
pictures in the right places. This time the picture cue
was placed on top of the box. The children all received
two sets of trials on this task. On the first trial the
experimenter (in the guise of the policeman) searched
every location. If children did not use cues, then he
did not prompt them to do so. On the second trial he
did prompt, using hints similar to the pretrial, asking
first: "Is there anything we could do to help us remem-
ber which animal is hiding here?" and if this failed:
"Why don't you look at the picture?" Prompts were
used for each location probed.

   Far transfer: All the children were given a second
transfer task which was substantially different from the
first and similar to that used by Ritter (1978). In
this task, six cups were placed on the turntable, and
the children informed these were 'houses'. In addition
six model pigs were placed at one side of the turntable.*
They were then introduced to 'the naughty little pig' -
a model piglet of the same type as the animals used in
previous experiments. They were told "This is the naughty
little pig. Do you know why he's naughty? Because he's
always running away and hiding. He hides in one of these
houses (Experimenter hides piglet) and I turn them round

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 * The apparatus   is shown in Fig.2
   (Appendix V).

while you close your eyes. Now, can you find him? The
game is that you have to find him first time. Do you
want a shot?[12] Remember, you've got to find him the first
time." The experimenter then gave the child at least
two pretrials, explaining if the child was unsuccessful,
that the idea of the game was to find the piglet first
time. If the children happened to correctly guess where
the piglet was hidden they were given the pretrial until
they had failed the task twice. These pretrials were
to indicate to the children that they could not rely on
the strategy of searching each location until they found
the piglet, because the rules of the game forbade this.
In order to correctly locate the piglet, the children had
to find some way of making distinct the location where
it hid. What was of interest was whether the children
would think to employ the large pigs for this purpose.
Again it was predicted that children receiving the 7-item
pretrial in the first phase of the experiment would be
more likely to transfer the cuing strategy.

Again a graded series of prompts was used to induce
the strategy; if children did not employ it spontaneously:
P[1] "Can you think of anything we could do to help us
find the little pig the first time?"
P[2] "Can we use these (indicating six large pigs) to help
us find the little pig right away?"
P[3] "Would putting any of these (pointing to six pigs)
.on here (indicates cups and turntable) help you find the

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12 'Shot' is the Scottish idiom for 'go'.

little pig right away?"

P_4 "If we put this pig on here (revealing hidden piglet, concealing once more and putting pig onto baited cup) will that help?"

Once the children had actually baited the cup, whether spontaneously or under prompting, they were given a retrieval trial. They closed their eyes, the experimenter rotated the turntable, and asked them to find the little pig the first time.

The children were then asked a series of questions probing their knowledge of the cueing strategy. This was tested by presenting several situations in which the original successful strategy could not be used, and asking them for predictions of performance given these circumstances. In addition they were given a modified version of the strategy and asked to predict its success.*

The first question (Q_1) involved a single distinctive cue (only one pig) but the pig was placed on a cup two positions away from the baited container. The additional information of identifying and remembering the piglet's spatial location relative to the cue, is necessary for success. Every child underwent a retrieval trial. It was clear from this trial whether children were using the strategy in a strict rote-reproductive fashion, using a modification of the strategy or simply answering 'yes' to every question.

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* The stimulus configurations for the various knowledge questions are shown in Figure 3, Appendix V.

The ambiguous cue condition (Q_2) comprised   'the-pig-on-the-baited-cup-strategy', but also three other pigs arranged to make the cue ambiguous.

The final question (Q_3) required prediction for a modified version of the strategy. This time the baited cup was rendered distinct by placing pigs on every other cup.

It was predicted that if children did not grasp the principle of distinctiveness, but believe that the presence of a cue somehow 'induces' the piglet to be underneath, they should respond incorrectly to all these questions.

Results

Pretrials As expected the 7-item group performed worse than the 3-item group on the no-strategy pretrial illustrated in Table 17. The group scores are not directly comparable, however, because they receive different numbers of items. The data were thus reclassified into three categories: (a) children who failed to remember any items on at least one trial; (b) children who remembered all the items on one trial; (c) the remaining children. A χ^2 analysis on this data indicated differences between the groups ($\chi^2(2) = 21.83$, p< 0.001). Table 18 shows the number of children who required explicit prompting to use the strategy during the training phase.

where an explicit prompt included one or more references to the pictures. Several children did require one prompt of the form "Is there anything we could do to help us remember..?", but these were not scored as requiring explicit prompting. The number of children requiring explicit prompts decreases with age, although it is not statistically significant $\chi^2(1) = 2.07$, p = 0.15 .

Near transfer Table 19 shows the effect of perceived efficiency on the first transfer trial, with children receiving the 7-item pretest showing more cue use on the first (unprompted) transfer trial. Those who saw the strategy as efficient were significantly more likely to use cues on one or more occasions $\chi^2(1) = 5.83$, p = 0.015 . Overall, the tendency to transfer also increased with age $\chi^2(2) = 7.98$, p = 0.02 .

On the second near transfer trial children received prompts if they did not spontaneously use the picture cues. The children were then given scores, depending on the explicitness of the prompts they required. An implicit prompt ("Can you think of anything we could do to help us remember..?") was scored 1 point, and explicit prompts ("Why don't you look at the pictures?") was scored as 2 points. The mean totals for each age group in each condition are shown in Table 20. The number of children who required at least one prompt decreased with age, although this trend was not significant $\chi^2(1) = 2.95$,

p = 0.09 .

The findings that older children were more likely to transfer irrespective of perceived effectiveness, combined with the fact that young children required more explicit cues to elicit the strategy initially suggested a further hypothesis: children who required little initial prompting should be more likely to transfer than children who needed explicit prompts. This was not verified for either transfer trial $\chi^2(1) = 0.27$, p = 0.60, $\chi^2(1) =$ 1.60, p = 0.20.

Far transfer Table 21 shows the mean number of prompts which were required to elicit the distinctive cueing strategy in the far transfer task. For the purpose of analysis childen were classified according to whether they required explict prompts ("If we put this pig on here, will that help?"). There were no effects of perceived strategy effectiveness $\chi^2(1) = 0.12$, p = 0.73 . In addition there were no age trends $\chi^2(1) =$ 0.74, p = 0.39 .

The questions about the far transfer task suggested similar conclusions. Children were credited with correctly answering a question, if they gave the correct verbal response, and searched the location consistent with their response. Thus, for Q_3 when pigs were placed at every location except the baited cup, the child must respond correctly that this configuration will help search

and also search under the cup without the large pig.
Table 22 indicates the number of correct responses, but there
was no overall effect of perceived strategy success
$X^2(1) = 1.17$, p = 0.56 . The number of correct responses
also showed a developmental increase $X^2(2) = 8.1$, p =
0.005 .

The hypothesis that children who required prompting to
employ the strategy on pretrials should show less tendency
to transfer was also tested for both measures of the far
transfer task. Again there was no indication that initial
prompting on the picture cues, predicted far transfer
as measured by prompting, or questions respectively
$X^2(1) = 0.17$, p = 0.69, $X^2(1) = 1.01$, p = 0.31 .

Finally, it was hypothesised that for the far transfer
task alone, children's knowledge about cue application
may be related to their readiness to use a particular
strategy. They were dichotomised into low (or 1 question
correct) versus high (2 or 3 correct) knowledge subjects
and strong (0-3 prompts) versus weak (4-5 prompts)
required to elicit the strategy. No relationship was
found between knowledge and initial prompting necessary
to elicit the strategy.

5.5 Conclusions

The experiment indicates strong support for the hypothe-
sised relationship between strategy effectiveness and

maintenance. Subjects who received 7 items on no-strategy
pretrials greatly improved performance following training,
in contrast with the 3-item group who underwent much
smaller performance changes. The size of these changes
appeared to influence application of the strategy in new
situations. The 7-item group continued to use the
strategy under conditions where no experimenter prompts
were given, and several aspects of the task were modified.
This was not true of the 3-item group who did not show
the same level of maintenance.* Strategy effectiveness
did not however influence transfer to a task which required
a rather different form of the strategy.

It was argued that young children may have problems in
evaluating performance change and attributing this to
strategy use. The present experiment was designed in
order to make the evaluation of performance change simpler,
by making the effects of strategy use large and hence
detectable. It may be, however, that children's prob-
lems lie not in evaluating performance change, but in
interpreting it. Children may, for example, believe
that performance changes are the result of practice,
rather than strategy use. The above experiment may
have induced maintenance, not by making the evaluation
component simpler, but the result of making strategy
effects large may be to exclude interpretations in terms
of practice which cannot produce such effects.

One problem with this interpretation lies in the fact that the
7-item group received more practice with the cuing strategy in
the instruction condition. Thus, they used cues to find animals
at 14 locations, compared with the 6 locations of the 3-item group.

5.4   Experiment IX: Is information about effectiveness sufficient for transfer?

This experiment attempted to distinguish between the explanations of maintenance failure. Two groups of children were given different feedback as to the results of their strategy use. One group was given no information about how strategy use had changed performance. The other group was given evaluative information that they were performing better, but no interpretation of this improvement was offered.

It was argued that if children's problems with strategy maintenance lie in their inability to evaluate performance change, then providing this information should lead to maintenance. However, if their problem lies in interpretation and not evaluation then both groups should be as likely to maintain, because both groups will be in possession of the same information.[*]

Children from the youngest age group in the last experiment were tested. This is because most of the older children in the previous experiment maintained the strategy even in the 3-item condition, suggesting experimenter evaluation would not be of much benefit to them. Additionally, Experiments V and VI have shown that self-assessment skills are poor in this age range.

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[*] This procedure should also control for possible practice effects. It was suggested that one reason why the 7-item group transferred, was that they received 14 cued-recall trials in contrast to the 6 received by the 3-item group. The present experiment gives both groups the same initial training.

Method

<u>Subjects</u>: The subjects were 20 children in the age range

3;2 - 3;9. Their average age was 3;6. All children
completed the procedure and none had participated in the
previous experiment.

<u>Method</u>: The children were divided into two equal groups.

The control group received the instructions and tests

given to the subjects in Experiment IX. The only

difference for the experimental group was that the experi-

menter gave them some indication of their performance.

by saying after the instruction trials "You know you're

really doing much better than you were before". Both

groups were given 3-items only in the pretrial and

instruction phases.

Results

Table 23 illustrates the effects of evaluative information.

The group who were given this information made more spon-

taneous use of cues on the first trial of the near

transfer task, and required fewer prompts to induce them

to use cues on the second trial. A t test was conducted

on the number of locations at which the children spon-

taneously employed cues over both trials. Children who

were given evaluative information were much more likely

to employ cues spontaneously ($t_{(18)} = 2.32$, $p = 0.03$).

In the previous experiment, it was suggested that transfer

may be related to the ease with which a child evokes the

strategy under instruction. It was predicted that initial

prompting should be negatively correlated with transfer as measured by spontaneous cue use. However, this relation was not significant for either control ($r_{(8)} = 0.39$, $p = 0.27$) or experimental ($r_{(8)} = 0.56$, $p = 0.10$).

The data were also analysed to investigate whether evaluative information influenced performance on the far transfer task. There was no difference between control and experimental groups either in degree of initial prompting necessary to induce the strategy, or in the children's answers to the prediction questions $t_{(18)} = 0.268$, $p = 0.21$; $t_{(18)} = -0.006$, $p = 0.99$.

Conclusions

It was argued that two reasons may underlie children's failure to maintain strategies they have been taught: either they cannot detect changes in performance or they can detect such changes but fail to attribute them to strategy use.

The experiment presented children with information about the change in their performance following strategy use. It was found that children seemed to have few difficulties in attributing such changes to strategy use, because nearly all of them spontaneously used the strategy on all transfer trials. The control group, not given this information, showed much lower levels of maintenance. Verbal feedback did not influence performance on the

far transfer trials, when the task demands were radically altered. The experiment supports the conclusion that an inability to monitor and assess performance changes underlies the failure to maintain.

5.5 Conclusions

One of the initialaims of this chapter was to investigate the reasons underlying children's general failure to maintain or transfer strategies they have been taught. Any conclusions drawn from these experiments may well additionally apply to spontaneously occurring strategies. The corollary of explaining failures to transfer is that we are able to find conditions in which transfer does occur, and also suggest possible mechanisms by which changes occur in the type and area of application of the child's memory strategies.

It was initially hypothesised that children have problems in evaluating changes in performance due to strategy use and also in interpreting these changes and correctly attributing them to strategy use. Experiments VIII and IX indicate that for the cueing strategy studied here, children have problems in evaluating or detecting changes in performance. Thus, if children are directly informed about performance changes (Experiment IX) or performance changes are made extremely obvious (Experiment VIII) *
we do find evidence for transfer to a similar task. These results apparently contradict a number of studies

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* Although in Experiment VIII strategy effectiveness is confounded with the original amount of training each group received.

which suggest children also have a problem in interpreting performance change, even if evaluation is achieved (e.g. Heisel and Ritter, 1981; Moynahan, 1976; Ringel and Springer, 1980). As was noted above, the process of interpretation may well depend on the strategy under study and on the size of the performance changes it induces.

The suggestion that children have difficulty in evaluating performance change is consistent with the results of Experiments V and VI which demonstrated young children's inability to accurately assess the accuracy of their memory performance. It may well be that the improvements in monitoring skills in the preschool years can explain the increases in maintenance with age in both 7-item and 3-item groups in Experiment VIII.

In order to evaluate, children do not only have to assess the level of their performance, they must also retain this assessment during the interval between no-strategy and strategy training trials. This problem of retention was made simple by reducing the interval between these trials in Experiments VIII and IX, however, Experiment VII suggests the duration of this interval may well influence spontaneous maintenance. Thus, Keeney et al (1967) and Kennedy and Miller (1976) report no spontaneous mainten- ance of a trained rehearsal strategy. In contrast, Experiment VII did find such maintenance using a procedure in which the no-strategy/strategy instruction interval was 3 days. In both the above experiments this interval

was much longer in duration. Thus, remembering
one's assessment of performance may present problems to
the young child, especially when the procedure used in
training experiments do not suggest a reason for paying
attention to one's level of performance.

These conclusions allow us to explain a number of other
experimental results. Bjorkland et al (1977) and Ornstein
et al (1977) both report maintenance only when children
were taught highly effective category sort and rehearsal
strategies. These results are completely consistent with
those of Experiment VIII. Effective strategies induce
greater performance changes and are thus more detectable.
Also Heisel and Ritter (1981) report that older children
spontaneously maintain a spatial retrieval strategy, but
children below the age of six years require information
about changes in performance following strategy use, before
they will transfer. A similar result is also reported by
Ringel and Springer (1980) for categorisation study
strategies. These experiments are perfectly consistent with
the above explanations of maintenance failure, in terms of
inability to assess and remember assessments of performance.
As both of these abilities increase with age, they will make
it unnecessary for the experimenter to supply information
about evaluation to older children.

In conclusion there are a number of reasons why young
children may fail to transfer or maintain strategies, and
the present set of experiments offers evidence that the
effectiveness of the strategy in modifying performance,

and the presence of external feedback may influence transfer. The results of Experiment VII, combined with those of Kennedy and Miller (1976) and Keeney et al (1967) also suggest that the time interval between pre-trials and instruction may be crucial. I obtained transfer with a short time interval, and no feedback, in contrast to those experiments which report no transfer without feedback. The importance of such a factor must at present remain speculative, because it has not been experimentally demonstrated. In addition to these external factors, transfer will be influenced by the abilities of the particular subject group. Changes in the ability to monitor and remember assessments of performance may well interact with these factors.

Finally, it was suggested in the opening sections of this chapter that studies of maintenance and transfer might offer information about mechanisms of change in memory. It might be argued, however, that the present set of experiments can tell us nothing about developmental change because they have only demonstrated maintenance of strategies, and not that trained strategies are generalised to different situations. As I have argued elsewhere, the criterion of generalisation is too strict, because it misrepresents changes in naturally occurring behaviours. Naturally occurring behaviours are initially limited in their zone of application, and so maintenance is an adequate criterion for inferring change.

If this is the case, then the present set of experiments suggests two mechanisms which are responsible for change in the use of memory strategies. The first, feedback, occurs

when some other person (experimenter, teacher, parent or
peer) is present to interpret the results of the child's
behaviour. This may well be a powerful mechanism because
many of the teaching situations in our society do have this
set-up. The second, self-assessment, occurs in the absence
of such information, and may well emerge much later in
development. The importance of self-assessment probably
greatly depends on the strategies being monitored and the
exact learning situation.

CHAPTER 6   CUE USE, INTROSPECTIONS AND THE STUDY OF
            TEXT

6.1   Introduction

One recent focus of research in developmental psychology
has been on the preschooler. The aim of this research
has mainly been to dispute what Gelman and Gallistel (1978)
call "the negative characterisation of the preschooler"
by demonstrating that very young children do possess
some social, logical and memory skills (e.g. Brown, 1975;
Donaldson, 1978; Gelman, 1978). A common theme in all
this research is that the nature of the task itself may
be crucial in determining the level of the child's
performance. Tasks which fit into the ecology of the
young child, i.e. those which "make human sense" (Donaldson,
1978) or "fit the head of the child" (Brown, 1975) are
far more likely to elicit precocious competence.

The early chapter describe a number of experiments which
investigated children's use of different types of cues
in making inferences in the service of memory. The cues
consisted of objects identical to those hidden (array
cues) or leaving the animals at previously searched
locations exposed (monitoring cues). (See Chapters 4 and
5 for a more detailed explanation.) In neither case do
the cues or memory task model a natural memory situation.

This same criticism can be made of most other studies
of cueing. Given the importance of ecological factors
in the accounts cited above, it was thought important
to investigate similar issues to those dealt with in
Chapters 4 and 5, i.e. those of cues and inferencing, but
using more naturalistic materials.

6.2   Experiment X: Do children use pictures to disambiguate text?

This experiment investigated children's use of a picture
as a source of information about the text. Three issues
were examined:

(1) Will young children make use of pictures to disambig-
uate stories which are read to them, and if they do, is
it the case that older children are more efficient in
their use of pictorial information?

(2) What insights do young children have into their own
mental processes? In particular, can they introspect
about how well they have understood or remembered a
story?

(3) What is the relationship between introspections
and strategy behaviour? Is children's study behaviour or
memory influenced by their knowledge of their own mental
processes?

Introduction

The procedure used in this experiment is based upon a

number of studies conducted on adults by Bransford and
his colleagues (Bransford and Johnson, 1973; Bransford
and McCarrell, 1977). In a series of studies they
demonstrated that both comprehension and recall of ambig-
uous text is vastly improved by providing information by
means of a picture or story title. One of the stories
used by Bransford and Johnson (1973) ran as follows:

> The procedure is really quite simple. First
> you arrange things into different groups
> according to their make-up. Of course,
> one pile may be sufficient depending on
> how much there is to do....

Subjects provided with the title of the passage (Washing
Clothes) reported that it is easily comprehensible and
were able to recall much of the passage verbatim. Subjects
not given such information rated the passage as difficult
to comprehend and recalled very little in the memory
test.

An explanation for this result is offered by Haviland
and Clark (1974) who account for the results in the
following way: comprehension is seen as a process of
inference construction in which a picture or title can
provide information which constrains the range of infer-
encs which can possibly be made. Thus, the knowledge
that the passage is about washing clothes allows the
subject to infer that 'arranging things into different
groups according to their make-up' is the process of
separating white from coloured clothes or that 'pile'
refers to a pile of clothes. It is clearly far simpler
to construct an internally consistent chain of inferences

when setting information is provided than when it is
absent.

If memory and comprehension are indeed dependent on a
process of inference-construction, using setting informa-
tion as a source of premises, we may expect developmental
trends in performance on this task for the following
reasons:

(1) Young children may fail to use setting information
altogether. A study by Ritter et al (1973), in which
pictures were provided as retrieval cues demonstrated
that on some occasions, young children aged 3 - 5 years
failed to make use of the pictures to recall the names
of absent objects. Similar results with older children
have been reported by Kobasigawa (1974) who also used
a retrieval task. Seven-year-old children failed to
use cards to cue sets of highly associated objects
(e.g. a picture of a zoo to cue bear, lion and camel).
Other studies (e.g. Gordon and Flavell, 1977; Kobasigawa
and Middleton, 1972) also show the failure of young
children to exploit cues provided to aid their retrieval.

(2) Even if children do think to consult cues, evidence
suggests they may make less efficient use of the cues
provided. Kobasigawa (1977) found that some children
may use the cue cards provided, but instead of using the
card to access all category-related items, they recall a
single category item, and then refer to the next card.
Since in the present experiment the context is visual,

evidence from experiments on visual search strategies is
also relevant. Mackworth and Bruner's (1970) research
on recognition memory suggests there may be qualitative
changes in visual search strategies in young children.
If such changes do occur, it may well be that older chil-
dren will elicit more relevant information from picture
cues.

(3) Assuming that children can efficiently access inform-
ation from picture cues, there may be a final reason to
expect developmental changes in performance on this task.
It may be that the ability to combine information   .
i.e. inferencing, develops. While this has been a conten-
tious issue as far as transitive inferences are concerned,
the general consensus is that the types of inferences
required for text processing should develop with age,
(e.g. Paris, 1978b; Trabasso and Nicholas, 1980). These
sorts of inferences are largely inductive but require
much social, motivational and causal knowledge of the
world, and should consequently increase as children's
knowledge base becomes enriched.

Despite the persuasiveness of these theoretical arguments,
empirical studies have failed to find evidence for older
children's more efficient use of contextual information
in text processing. Indeed, some of the studies which
follow have failed to find any effect of contextual infor-
mation on memory. Brown, Smiley, Day, Townsend and Lawton
(1977a) provided children with two different contexts

or no context and tested recognition and recall for a core story given to all groups. Recognition measures showed no qualitative effects of context, nor did the groups provided with context out-perform the no context group. Recall measures, however, did show developmental trends,with older subjects tending to produce more context-relevant intrusions. This suggests both that context does influence recall, and that older children are more likely to make use of it.

In contrast, Omansen, Warren and Trabasso (1978) found no influence of contextual information on recall. The three groups of 8-year-olds were given one of two contexts or no context and the same core story. A recall test showed no advantage to the groups given context, although a questionnaire which tested children's ability to make inferences about material not explicitly stated in the story did depend on the provision and type, of context provided.

A third study conducted by Harris, Mandias, Meerum-Terwogt and Tjintjelaar (1980) is perhaps closest to the original Bransford and Johnson (1973) experiments. Unlike the Brown et al and Omansen et al experiments the story was genuinely incomprehensible without context. Harris et al found that context (provided by a title) massively improved the recall of 8- and 10-year-old children. They did not find that older children make more efficient use of this information.

The above experiments suggest two factors may be crucial
to any attempts to investigate young children's use of
contextual information. The first concerns the importance
of the context in disambiguating the text. Both the
Brown et al and Omansen et al stories were comprehensible
without contextual information. Under such circumstances
context may make possible certain elaborations or embell-
ishments to the text, but not radically influence compre-
hension and consequently, memory. In contrast, very
little understanding could be derived from the Harris
et al stories without their titles. In the present study,
an attempt was made to ensure that certain parts of the
story would be ambiguous without context.

The other issue concerns the measure used to assess the
influence of context. It was decided to assess this by
asking a series of questions about the story. This method
was employed because of its greater sensitivity to context
effects (as evidenced by both Brown et al, and Omansen
et al) and also because young children have difficulty
with any form of recall task (Brown and Murphy, 1975).

A second problematic feature of the above experiments is
the inconsistent evidence for developmental increases
in the use of context. They only appear in one measure
in the Brown et al and Omansen et al experiments, and
Harris et al found no effects. This lack of evidence for
developmental trends may well be attributable to the
ecological factors referred to earlier. All the

experiments reviewed investigate children of school age.
It may be that by this stage of development children
have already had large amounts of practice at information
integration. Recent accounts of language development
stress the role of context in the child's comprehension
(e.g. Shatz, 1978; Clark, 1977; Macnamara, 1973). In
addition, children may well be familiar with the specific
skill of integrating information from different sources
(e.g. adults' comments, pictures, peer reactions) with
the story itself. This may explain why previous studies
which had not looked at children younger than 5 years have
failed to find the predicted interaction. For this
reason, it was important to investigate the relationship
in very young children, and so preschoolers were used.

Another problem with previous studies is that the effects
of context have been inferred from various memory measures
without investigating processes underlying this. It
has already been suggested that young children may not
use contextual information in the way older ones do, and
so the study behaviour of subjects was also recorded.
Contextual information was provided in the form of pictures
accompanying the spoken text, and it was predicted that
young children would not study the pictures for as long
as older children. The differences in study behaviour
should be reflected by performance in the memory test for
the contextualised stories.

A second aim of the study was to investigate very young

children's abilities to judge their state of comprehension
and memory. A recent review by Flavell and Wellman
(1977) suggest that such abilities undergo large changes
in the early school years. Studies indicate that chil-
dren younger than 8 years are poor at making judgements
about the adequacy of instructions (Markman, 1977), the
importance of different parts of text to its central theme
(Brown and Smiley, 1977) and at detecting contradiction
or .anomaly (Flavell et al, 1981; Harris et al, 1981;
Markman, 1979). All the above experiments require sophis-
ticated judgements and it may be that even preschoolers
are capable of answering simple questions about their
understanding of memory for text.

This is an important problem, because the ability to
monitor comprehension has implications for both study and
memory behaviour. In the present experiment, children
realising they have not understood a part of the text
may attempt to clarify this by consulting an alternative
source of information (the picture). We should therefore
expect a close relationship between the ability to monitor
memory and study behaviour.

Self-monitoring was assessed by asking the children a
number of questions about comprehension and recall before
and after recall had taken place. Before recall, children
were asked first which story they had understood better,
and then which they had remembered better. After recall
they were asked which had been best remembered. On all

occasions they were asked to justify their choice. This
made it possible to investigate whether children realise
the relationship between comprehension and memory,
i.e. that what they best understand will be best recalled.

The speculations about the relationship between self-
monitoring and strategy use are not limited to text
comprehension and memory. Recent theoretical accounts
of cognitive development (Brown, 1978; Flavell, 1978) have
stressed the importance of highly general skills like
self-monitoring for many cognitive tasks. However a
recent series of empirical studies (Bisanz et al, 1978;
Cavanaugh and Borkowski, 1980; Kelly et al, 1976;
Moynahan, 1973, and Salatas and Flavell, 1976a) have
all failed to find evidence for s strong relationship
between memory performance and knowledge about memory.
The present study should enable us to investigate that
relationship on a task and with a age group which have
not been much studied.

Method

Subjects: The 36 subjects were randomly drawn from three
playgroups in St. Andrews, Scotland. They were equally
divided into three age groups, 3;0-3;9, 3;10-4;6, and
4;7-5;3. Their mean ages were 3;5, 4;2 and 4;10 respec-
tively. All of them had taken part in Experiments II or III.

Materials

Two stories, one about a girl called Mary and her dog

Fido, (M and F) and another about a girl called Jenny
and her mother (J and M) were used. Each story had an
associated picture, but this was not presented in all
experimental conditions. The stories were made as similar
as possible; both took approximately the same time to
read aloud, and both had a similar story structure (see
Stein and Glenn, 1979). Both stories and questions are
presented in Appendix 2.

Procedure: All the subjects were read two stories, one
with a picture providing setting information, the other
without. Half the subjects in each age group were
read Mary and Fido with its associated picture and
Jenny and her Mummy with no picture. The other half
were given the picture with Jenny and her Mummy, but
not with Mary and Fido. The order of presentation was
counterbalanced across subjects. In order to engage
interest in the task of remembering the stories and
also to allow systematic questioning, the children were
introduced to a monkey puppet called 'Silly Monkey'.
The experimenter explained that Silly Monkey had an
appalling memory and asked them whether they would
help the monkey by trying to remember the stories and
answer the questions he asked about the stories.

The experimenter then read each story to the child and
the monkey, mentioning in passing that one of the
stories had a picture and drawing the child's attention
to the picture before the story was read. (This story

is called Jenny and her Mummy and here's the picture
which goes with it).

After both stories had been read, the experimenter
consulted the puppet and asked the children whether
Silly Monkey could ask them some questions about the
stories. The monkey then posed the first metacognition
question which was either to predict comprehension or
memory - 'Which story was easier to understand?/Which
story will be easier to remember?'. These will be
referred to as comprehension and prediction questions.
The child was then asked to justify this choice. The
order of the comprehension and memory questions and
the order of mention of the two stories in the quest-
ions was again counterbalanced across subjects.

The monkey then asked the child a series of ten specific
questions about each story (see AppendixII). The
questions probed structurally similar parts of the
two stories and required answers only a few words long.
If a child failed to respond, the monkey repeated
the question.

After this memory test, the child was asked another
metacognition question - 'Which story was easier to
remember?' - to test the child's ability to assess
his own performance after recall. This will be refer-
red to as the post-diction question. The whole experi-
mental procedure was video-taped.

Results

Memory performance   Table 24 illustrates the performance
of the three groups on the memory questions. Two features
of the figure are worthy of comment. Firstly the ability
to answer such questions increases with age, and secondly
performance is superior when pictures are provided. The
importance of both these features is verified by the
results of statistical analysis. A 3 (Age) x 2 (Picture/
No Picture) x 2 (Story Order) x 2 (Picture with J and M/
Analysis of Variance
Picture with M and F)/confirmed that both Age (F(2, 24)
=10.53, p<<0.001) and Picture/No Picture (F(1, 24)=
33.89, p<<0.001) effects were significant.* There was no
Age x Picture/No Picture interaction, suggesting older
children do not make more active use of contextual infor-
mation (F(2, 24)=0.34, p=0.71), although this result may
possibly be contaminated by a ceiling effect, as the oldest
group were performing at 91% in the picture condition.
There were no effects due to story differences, order of
presentation or which story was accompanied by the picture.

Study behaviour   The amount of time children spent looking
at the picture during story telling is shown in Table 25.
No clear pattern emerges and a 3 (Age) x 2 (Order of
Presentation) x 2 (Picture with M and J/Picture with M
and F) ANOVA confirms this. There were no effects for
any of these factors. This is contrary to one of the
experimental predictions.

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* Post-hoc tests using Neuman-Keuls revealed that this was
  due to the superiority of the oldest group.

<u>Monitoring</u>   Self-assessment skills were computed for the subjects by comparing their responses to the monitoring questions, with their performance as assessed by memory probes.[13] Table 26 shows the percentage of children at the different age levels who responded correctly to the three monitoring probes.   The scores for the three quest-ions are collapsed together, and categorised according to whether children obtained either scores of 0 or 1, or scores of 2 or 3 correct responses.   A χ^2 analysis on this data indicated developmental trends ($\chi^2(2)=6.30$, p=0.04).   When the questions were analysed separately, there was only a trend for the memory prediction questions ($\chi^2(2)=7.25$, p=0.03).*   This result suggests that the overall developmental trend is mainly the result of improvements with age, of responses to this question.   Although justi-fications were requested following probes, only eight children actually offered them and six of these were in the oldest group.   Of these only three children made any any reference to the picture.   The main explanation offered by the other children, was that the 'easier' story was the one which was shorter.

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13   The use of the subjects' own performance scores, as the criteria for assessing self-monitoring is in contrast to other studies (e.g. Harris et al, 1980) which assumed that subjects would perform better on the stories with pictures, and assessed monitoring scores against this.   Not all subjects in the present experiment did remember more of the picture-story and so the use of the Harris et al procedure would have been inappropriate.   Even if children are inaccurate in their comprehension monitoring and select the incorrect story as being best understood, if they understand the relationship, they should, select the same story (incorrectly) for memory prediction.

*   In both cases this was due to the superiority of the oldest group over the two others ($\chi^2(1) = 3.98$, p 0.05; $\chi^2(1) = 4.03$, p 0.05).

In addition to demonstrating that monitoring skills increase with age, it is important to establish the accuracy of children's responding given that chance responding would result in 33% correct performance. Children's responses to the questions were either to select one of the stories or to say that neither was easier. If they made such judgements without monitoring, they would therefore have a 33% chance of responding correctly. Application of the Binomial test indicated that performance for the Memory Prediction and Memory Post-diction questions was above chance (z=3.36, p<0.01, z=2.65, p<0.01) respectively, although this was not true for the Comprehension question (z=1.23, p=0.22). Separate analyses at each age level indicated that only the oldest group performed above chance, and they did so on all three questions (z=2.14, p=0.03; z=3.98, p<<0.001; z=2.14, p=0.03; for Comprehension, Memory-Prediction and Memory-Post-diction).

A second aim of the monitoring analysis was to test whether children appreciated the close relationships between comprehension and memory. If children do realise the association between these processes, one might expect the same response to both comprehension and memory prediction questions. This prediction was tested against chance for all groups, using the Binomial test. Although there was an overall effect (p<0.03), only the oldest group showed it when the groups were individually analysed (p<0.001).

Finally memory prediction and post-diction scores were

compared for the three groups. There were no group effects,
nor was there a superiority of post-diction over prediction
in the overall analysis (Overall McNemar χ^2=2.50, p=0.11).
To summarise the results of the self-assessment data:
monitoring skills increase with age during the preschool
years, and by the age of five years children perform above
chance on simple questions about comprehension and memory
for text. In addition, this oldest group appreciates the
relationship between comprehension and memory. There was
no evidence for the contention that young children are better
at post-dicting than predicting memory.

Monitoring, Study Behaviour and Memory Performance
A correlational analysis was conducted to examine the effect
of study time on memory. It is clear that other factors, in
addition to study time, may influence children's memory for
the story with the picture. Memory need not be mediated by
study alone, as is demonstrated by the fact that children
can remember the story without a picture. The contribution
of this factor and the contribution of age were both
partialled out. Such an analysis revealed no relationship
between study time and memory for the story with the picture
$(r'(32)=0.30, p=0.12)$, where r' is the Pearson product-moment
correlation when both factors have been partialled out.

It was also suggested that children who were better at
assessing the state of their memories would be more
systematic in their study behaviour, and so the relation
between self-assessment scores and study time was examined.
The partial correlation coefficient was   significant
$(r'(33)=0.55; p=0.001)$, when age was partialled out.

These relationships were also analysed for each age group individually. There was no support for the view that the relationship between self-assessment and study time, increased with age.

In summary, study time predicts memory in the picture condition, but the correlation is not significant if we allow that study time is also related to memory in the no-picture condition. Self-assessment skills do however, seem to induce more careful study behaviour.

Discussion

The present experiment demonstrates that providing contextual information in the form of a picture helps very young children to remember stories more accurately. It therefore supports the findings of Bransford and Johnson (1973) for adult subjects, and Harris et al (1930) for older children. who tested memory by recall measures. A number of other studies do not report consistent effects of context for recall measures of memory (Brown et al, 1977a; Omansen et al, 1978); however, both those studies did find effects of context when questionnaire methods like those in the present experiment were employed. The present result is therefore not discrepant with any of the above findings. Additionally, as was argued in the introduction, whether or not contextual effects are

obtained in recall depends on the ambiguity of the text itself. If context is <u>necessary</u> for understanding the story, it is likely to influence memory. If context provides superfluous or redundant information it may not be incorporated in this way.

There was no evidence that older children made more active use of the contextual information. Younger subjects were as adept at combining information from pictures and text in order to answer memory questions. This is consistent with the data of Harris et al (1980) who used an almost identical procedure. In contrast, Omansen et al (1978) found developmental increases in the ability to answer questions requiring inferences combining text and context, and Brown et al (1977) report an increase in theme-relevant intrusions in recall. It may well be, however, that such inconsistency may be explained by differences in <u>the types</u> of inferences required.and ability to make these may well differ across inference types. As Paris (1978b), Nicholas and Trabasso (1980) and Trabasso and Trabasso and Nicholas (1980) argue, there are many types of inferences and we lack an adequate taxonomy to analyse their differences. Although it remains to be demonstrated that there are actually differences in the inference types used in the inconsistent studies, this is a highly plausible explanation.

In addition to the empirical studies, a number of theor-etical arguments were advanced supporting the view that

use of context should increase with age. Other studies
showed that young children sometimes completely failed
to use cues (Kobasigawa, 1974; Ritter et al, 1973) or
used them inefficiently (Kobasigawa, 1977); they were
poor at visual search (Mackworth and Bruner, 1970) and
finally there may be developments in the ability to make
inferences (Paris, 1978b).

One possible explanation of the failure to find such
developmental trends is that the above experiments all
investigated the deliberate use of inferencing.
Now, while this experiment actually gives children instru-
ctions to remember, it may well be that their behaviours
such as picture study are not deliberate strategies to
remember, but simply attempts to understand a story
which interests them.

The study also attempted to establish the relationship
between study time and performance. There was no evidence
that children who studied the pictures for longer actually
remembered better. It may be that study time is not a
good means of tapping the processes underlying study,
because it confounds how long children look with what
they look at.

The experiment also investigated young children's abili-
ties to make judgements about the state of their own
memories. It was found that 5-year-olds can correctly
judge which of two studies is easier to understand and

can pre- and post-dict memory performance, although few
subjects were able to justify their responses. This
result is in marked contrast to other studies, e.g.
Markman (1977), Brown and Smiley (1977) and Harris et al
(1981) which conclude that the ability to assess one's
own performance does not emerge before the age of 8. This
discrepancy may be resolved by consideration of both the
complexity of the tasks used to assess metacognition in
those experiments and the simplicity of the judgements
required in the present study. For example, Markman
required that subjects not only realise that the instru-
ctions they had been given were inadequate to play a
game, but that they demonstrate this by questioning an
experimenter. Similarly the ability to rate units of
text in terms of their relation to the central theme of
a story (Brown and Smiley, 1977) and the detection of
anomaly (Harris et al, 1981) would seem to demand fairly
sophisticated metacognitive skills.

This provides further support for the arguments of Chapter
3, that there is no single age at which a particular meta-
memory item develops. Children's ability to assess their
memory for text is clearly dependent on   the complexity
of the judgements we require them to make in order to
demonstrate that knowledge, and also the means by which
we allow them to demonstrate it.

The study also investigated the relationship between
self-assessment skills and study behaviour. While it

was found that self-assessment predicted study time,
there was no relationship between study time and memory
performance. The data do not, therefore support the
argument that self-assessment closely determines memory.
In this respect they are consistent with the data reported
in the earlier experiments on the inferential cueing
strategy.

6.3 Experiment XI: How efficient are children in their use of pictures to aid text comprehension?

The present experiment attempts to extend the results
of the previous experiment, by investigating children's
use of an array of pictures to answer questions about
a story they had just heard. There were three major
questions to which the study addressed itself:
(1) How readily do children think to consult pictures
as a means to answering questions about a story they
have been told? (Evocation).
(2) How skilled is children's search of a picture array?
(Efficiency).
(3) Are evocation and efficiency related? Are children
who are adept at a particular strategy more likely to
evoke it than those who are less proficient?

Introduction

The previous experiment demonstrated that very young
children were remarkably skilful at combining information

from a single picture with a story they had just heard read aloud. It may be that experience in listening to stories with adults drawing attention to accompanying pictures may well contribute to this skill.

This experiment was therefore designed to investigate in more detail the extent of children's skill in using pictures to help understand and remember text. Children were first told a story aloud, and as the experimenter read, he placed the card relevant to each part of the story, face-down in front of the children. Afterwards he asked them a series of questions about the story. The questions probed information which was not actually stated in the stories, but could be found by combining information from the stories with that in the pictures.

The first aim of the study was to investigate how readily children would think to consult the pictures in order to answer the questions. A study by Ritter et al (1973) found that children would readily employ high-associate pictures to cue hidden objects when the cues were visible, but not when the cues were face down upon the floor. Similarly, Kobasigawa (1974) reported that 7-year-olds failed to use high-associate cue cards to access the names of a set of pictures. In the present study, children's readiness to employ cues was assessed by the number and explicitness of the prompts required to elicit cue use.

The study also investigated the efficiency of cue use.

There are a number of reasons to suggest young children may not be adept at picture search. Kobasigawa (1974) also reports that young children used multiple retrieval cues (i.e. one card to cue several animal names) in a highly unsystematic manner. Instead of retrieving all the names associated with one cue, they would remember one, and then look at the next cue. On returning to the cue, they would often access the name they had retrieved on the last occasion. In addition, experiments on children's search of small-scale and natural environments suggest that preschoolers are incapable of limiting their search to appropriate areas (Drozdal and Flavell, 1975; Wellman et al, 1979). For example, Wellman et al found that children would search certain locations, despite possessing information which would lead them to infer that the missing object could not be there. In the present picture search task, it is also possible to limit the area of search. If the question probes information late in the story, there is little point in searching the early cards. It was of considerable interest to see whether children would realise this. This skill was examined under two different retrieval conditions. In the first, the experimenter asked questions in a sequence which followed the order of events in the story. In the second, questions probed the events of the story in a random order.

A final question concerns the relationship between the ability to use a strategy, and the ease with which it is

evoked. Flavell (1970) and several Russian authors
(Istomina, 1975; Leont'ev, 1975) have argued that efficiency
and evocation are related, but it is not clear whether this
has ever been tested. If the relationship does hold,
we should expect children who show systematic search to
require little prompting to access the strategy.

Method

Subjects: The subjects were 36 children between the ages
of 3;2 and 5;2. They were divided into the usual age
groups, with mean ages, 3;5, 4;2, and 4;10 respectively
with 12 children in each age group.[*]

Procedure: Prior to any testing the experimenter spent
some time in each nursery school introducing the chil-
dren to a glove puppet called 'Silly Monkey'. (The
same puppet was used in the previous experiment). By
means of a number of memory games, the experimenter
impressed upon the children that Silly Monkey had an
appalling memory and required a lot of assistance in
any game of this kind.

When this introduction was complete the experimenter
tested the children individually in a separate room.
They were then shown Silly Monkey again, and it was
suggested that they play Silly Monkey's favourite
game, which is listening to stories. The experimenter
said "Now we're going to listen to some stories. I
want you to help Silly Monkey to remember the stories,

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[*] None of these children had participated in any previous
experiment.

'cos you know he's got a very bad memory. If you remember the stories you'll be able to answer Silly Monkey when he asks you about the stories. Are you both (points to child and puppet) ready, because I'm about to tell the stories? I've got the stories here, written underneath these pictures (offers child a very brief glimpse of the set of pictures, each with part of the story written underneath). Now as I tell you the story, I'm going to put the pictures down here in front of you."

The experimenter then proceeded to tell the story, placing cards so that they lay/in order from left to right in front of the child. There were seven pictures in total. When the story was complete, Silly Monkey whispered something in the experimenter's ear. The experimenter then said to the child, "Oh dear, guess what's happened. Silly Monkey has forgotten the story. Can he ask you some questions about it?".*(PTO)

The Monkey then asked the child a series of six questions, all of which required the children to look at the cues in order to answer. If children failed to employ the pictures the experimenter prompted them with the following series of hints:

E_1: Can you think of anything you could do to find out the answer? (Repeat question).

E_2: Why don't you look at the pictures? They might help you to find the answer. (Repeat).

* Previously the experimenter had only briefly shown
the children the pictures. There then followed a
series of hints suggesting that the picture would
be useful in recall. So although there was nothing
in the initial part of the procedure to suggest
picture consultation, the hints were increasingly
explicit in indicating this. What was of interest
was how often the children needed to be told to
use cues during the question phase.

If children still failed to look at the pictures, the experimenter then explicitly indicated the relevant picture and if necessary the relevant part of this picture:

E_3: I think we should look at this picture. Now.... (Repeat question).

E_4: Look here (Experimenter indicates relevant part of the picture) Now.....(Repeat question).

Many children spontaneously or under implicit prompting began to search the pictures. The experimenter noted their pattern of search as they turned the pictures over. If the child terminated the search unsuccessfully, the experimenter offered a further prompt:

P_1: Why don't you look at another picture? (Repeat question).

If the children again terminated search unsuccessfully, or if they found the correct picture, but failed to answer the question, the experimenter said:

P_2: I think it's this picture we should look at. (Repeat question).

If the child still failed to answer, then the experimenter explicitly indicated the relevant part of the picture.

P_3: Look here......Now, (Repeat question).

The children received two stories with six questions for each story. The stories were called George the Owl has an Idea and Mick the Duck goes on an Adventure. They were adaptations of two children's stories using

7 of the 12 pictures which went with the original story.

They were of approximately equal length. The stories and
pictures   III and IV respectively
/are included in Appendices/. As already described, in

one case question order followed story sequence and

in the other the questions were random. Story order,

randomness of which story, and whether questions were

initially sequential or random was counterbalanced at

each age level.

Results

The data for the amount of initial prompting to induce

picture-use, prompting during search, and the number of

cards searched are all analysed separately. This has

been done despite the fact that the measures are not

independent (e.g. a high degree of initial prompting or

prompting during search should reduce the number of cards

searched). The fact that the measures are not independent

does mean, however, that the separate analyses are con-

servative in any results they yield.

(a) Prompting to evoke strategy use

Table 27 indicates the mean score for prompts required to

induce strategy use at the different age levels, over all

trials. Children requiring the most explicit hint (E_4)

were given a score of 4, those requiring E_3 to produce the

strategy were given a score of 3, and so on for the resp-

ective cues. These scores were summed over questions and

stories. As Table 27 indicates, very few hints indeed

were required to induce the children to consult the pictures. Despite the fact that few prompts were required to initiate picture search only one child spontaneously consulted the pictures. In addition, there were no developmental trends. This was verified by conducting a 3 (Age) x 2 (Order of Presentation) x 2 (Story) x 2 (Random/Sequential Question Order). There were no significant effects.

(b) Efficiency of Search

Two different measures were taken of efficiency of search. These were the number of prompts required and the number of cards searched to arrive at the correct answer.

The scores for the prompt analysis were analysed in an identical manner to the above analysis. Prompts P_1, P_2 and P_3 were scored 1, 2, and 3 respectively and the data are shown in Table 28. The data were again subjected to 3 (Age) x 2 (Order of Presentation) x 2 (Story) x 2 (Random/Sequential Question Order) ANOVA. This time, age differences did emerge $(F(2, 24)=3.53, p=0.04)$*, and it was also clear that with random questions more directive prompting was required $(F(1, 24)=5.72, p=0.025)$. Table 28 indicates that while older children are equally good under conditions of random or sequential questions, and younger children equally poor under such conditions, the questions' manipulation does seem to influence the behaviour of the middle group. This interaction was not, however, statistically significant $(F(2,24)=1.292, p=0.29)$.

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* Post-hoc comparisons using Neuman-Keuls indicates the oldest group required less prompting than either of the younger groups $(CR_{N-K}= 17.00, p<0.05)$.

The second measure of efficiency was the total number of cards searched. The results are indicated in Table 29. Overall the number of cards searched does decrease with age, and random questions again produce less efficient search than sequential questions. The data were analysed in a 3 (Age) x 2 (Order) x 2 (Random/Serial) analysis of variance. The effects of Age $(F(2, 24)=3.45, p=0.048)^*$ and question type were significant $(F(1, 24)=8.78, p=0.007)$.

The data for card search were also subjected to a further set of analyses to establish why older children needed to search fewer cards to arrive at solution. Table 30 shows the frequency with which children were able to select the correct card first time. It is clear from the table that Serial questioning leads to far more direct solutions than Random questioning. This conclusion was supported by a χ^2 analysis, when data from the 0-3 cells and 4 and 5 cells was collapsed. $(\chi^2(1)=24.99, p<<0.001)$. A χ^2 analysis of the data collapsed across these cells also indicates age differences in direct search $(\chi^2(2)=9.72, p=0.03)^{**}$. If the data for random and serial question order are considered separately, a different picture emerges. There are no age trends for direct search for the random order questions, but analysis for serial questions suggests large differences between the age groups $(\chi^2(2)=11.70, p=0.003)$. This was because of the superiority of the two older groups $(\chi^2(1)=6.3, p<0.02)$. The reason for the greater direct search skill of the older

*Post hoc comparisons using Neuman-Keuls showed a difference between the oldest group and the two youngest ones $(CR_{N-K}=28.08, p<0.05)$.
**This was due to the two older groups showing more direct search than the youngest $(\chi^2(1)=3.86, p<0.05)$

children emerged from a detailed analysis of search
patterns. It was found that a large number of children
were employing a search strategy in which they started
at the left of the array, and turned over each card from
left to right in sequence. If the questions follow story
sequence, then children are able to produce a large number
of direct searches, simply by turning over the card next
in sequence to the one they used to answer the previous
question.

Children were classified as using this strategy if they
accessed five of the six cards in correct sequence,
starting at the first card. Sixty percent of the children
were classified as employing this strategy on the serial
questions, and twenty-five percent of the children used
it on the random order questions. The differential use
of the strategy according to question order was statis-
tically significant (χ^2(1)=6.91, p=0.009). Separate
analyses for the different question orders showed·that
older children were more likely to use the strategy than
younger children for serial questions (χ^2(2)=6.17, p=0.04),*
but not for random questions (Fisher exact p=0.23).

A number of other strategies were also isolated. One
involved a sequential search from left-to-right, or·right-
to-left. The criterion used for such a search was any
three pictures accessed in correct sequence. Children
were more likely to search left-to-right (i.e. in story
sequence) than right-to-left. (z=2.80, p=0.005). Older
children showed slightly more use of such exhaustive

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* Again this was the result of the superiority of the two
  older groups (χ^2(1) = 4.53, p< 0.04)

strategies although this trend was not significant.

The final prediction of the experiment concerned the
relationship between evocation and efficiency. Two
separate analyses were conducted for the directive
prompts and for the number of cards searched. In each
case, the contribution due to age was partialled out. The
initial prompt-directive prompt analysis yielded a corr-
elation of $r'_{(2,33)}=.35(p=0.10)$ and the initial prompt-card
search yielded a correlation of $r'_{(2,33)}=0.26$ $(p=0.32)$.* A
group by group analysis did yield two significant/corr-
elations for the oldest group $(r_{(10)}=0.54$, $p=0.03$;
$r_{(10)}=0.51$, $p<0.05)$.

Pearson

Discussion

The data on initial prompting suggest that children
require some assistance before they will consult face-
down pictures even when they know these pictures relate
to the text they have just heard. This may not be surprising,
since the children may not have known that they were
supposed to use pictures. Even given this problem of
realising picture relevance, the children still need to
be told a number of times to use the pictures.

In addition, there were no developmental trends for the
evocation prompts. The younger children would turn over
the pictures as readily as the 5-year-olds. What was
interesting, however, was the difference in efficiency
of search among the groups. The younger children seemed
to understand that it was appropriate to look at the cards,

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*The correlation coefficients and their significance levels
are derived from the analyses of Cohen and Cohen (1975).

but they were unable to find the relevant card without the assistance of the experimenter.

The older children showed greater skill at accessing the appropriate card, and combining the information in it with the information from the story they had heard. This was demonstrated by them requiring fewer prompts to find the appropriate card and give the answer. Older children also searched fewer cards before finding the relevant one.

In addition to these developmental differences, it was clear that there was a massive difference in performance between the random and sequential question conditions. This cannot be explained by memory factors, as the presentation was the same for both stories. A closer examination of the search patterns suggests the reason for the superiority of the sequential condition. In this condition, children searched efficiently by closely following the story sequence by their search. Questions about the early part of the story elicit immediate search of the appropriate (left-hand) end of the array. On later questions, the children bypass the early pictures which they have already searched, and directly access pictures later in the sequence. Some measure of the accuracy of their sequential search is shown by the fact that ten of the oldest group managed to access the appropriate picture on four out of five trials, at their first search attempt.

The results reported suggest precocity in initial cue use by the younger children, who require the same amount of initial prompting as the older group. Analysis of their search behaviour suggests, however, that initial cue use may not be the result of deliberate strategies. These children will readily consult the array of pictures, but require much prompting before they can isolate the appropriate picture. It is as though they realise that consulting the pictures is somehow appropriate, but have no idea of exactly how they are to be used. Their willingness to consult pictures may also be influenced by the experimenter's hints and their previous experience of listening to stories from which they have derived the notion that pictures 'go with' stories.

The above analysis suggests that stimulus structure and previous experience with particular materials does influence the behaviours children produce.

The results of strategy search are also amenable to this type of analysis. At face-value, the data suggest that young children are capable of conducting highly sophisticated searches which bypass pictures which have already been consulted. This conclusion is somewhat problematic for a number of reasons. It contradicts the results of other studies which have found little evidence for such sophisticated search strategies (e.g. Drozdal and Flavell, 1975; Wellman et al, 1979), and also the results of Experiments II and III which show young children are

poor at keeping track of previous correct solutions. Two
pieces of evidence suggest that children's search patterns
may not be the result of complex eliminative strategies.
Firstly, the use of the eliminative search strategy is
limited to the sequential question condition, and secondly
the strategy itself may be explained by a simple heuristic.
The heuristic is to turn over the card to the right of
the one just searched. The behaviour looks even less
like a complex inferential strategy if we bear in mind
that left-to-right exposure is the norm when adults read
stories with children. These speculations combined with
the finding that children in the random condition showed
far more left-to-right than right-to-left searches,
strongly suggest that left-to-right search is an over-
learnt behaviour for the materials used in this study.
It just happens to be appropriate and effective in achie-
ving recall, when questions respect this ordering.[14] The
findings that young children may consult pictures without
understanding how they can help memory, and older children
employ "strategies" which are highly dependent on the
nature of the task materials, suggests that behaviours may
be highly influenced by the subjects' previous experience
with the task. It may be that subjects' actions are more
the result of overlearnt routines with certain materials
than intentional plans designed to benefit memory. In

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[14] This should not be taken to indicate that there is
no evidence for "cognitive" strategies which rely on
inferencing. In fact, the existence of such strategies
is demonstrated in the random question condition, in
which direct search frequency was above chance.

this respect the results are consistent with the specu-
lations of Ryan et al (1970) and Gordon and Flavell (1977)
about cuing behaviours. These experimenters suggest
children may often use cues appropriately, in a manner
which facilitates memory, but without any understanding of
how this comes about.

6.4 General Conclusions

The two experiments in this chapter apparently indicate
that young children are capable of employing highly
sophisticated memory strategies when familiar materials
such as stories are used. Thus, Experiment X suggests
that preschoolers will readily consult a picture in order
to disambiguate text, and that 3-year-olds are as able
to do this as older preschoolers. Experiment XI offered
two examples of precocity: 3-year-olds are as likely to
use picture cues to answer questions about text as 5-year-
olds; and all groups show some ability to avoid the search
of redundant pictures. There are a number of reasons to
suggest these may not be intentional strategies, however.
Firstly, the behaviours are highly-dependent on the pre-
sence of particular stimulus-structures. Thus, children's
use of pictures to help understand text (Experiment X) is
disrupted by having the pictures placed face-down in
front of them, rather than immediately visible. (Experiment
XI). If children were employing some form of deliberate
cueing strategy, the visibility of the cues should make
little difference to their usage.* The stimulus-dependent

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* Although as I have already noted, the children may not
have realised they were supposed to use cues.

nature of "strategic" behaviours is also shown by the fact that the "efficient" search strategy of Experiment XI is only evoked when sequential questions are used. Finally it was found that 3-year-olds in Experiment XI would turn over pictures when questioned about text, but had no idea of how exactly to use these pictures. In all three cases, it seems that what we are describing are overlearnt behaviours which are appropriate to the materials in question, which are not intentional plans to benefit memory, but which just happen to have memory pay-offs.

There are some theoretical implications which can be drawn from these studies. The first is that recent accounts of memory which stress the preschooler's ability to employ intentional strategies (e.g. Wellman, 1977a) may overestimate deliberate memory abilities in this age range. Secondly the finding that not all "strategic looking" behaviours are intentional may explain how some strategies come to enter the child's repertoire. A possible mechanism by which this is achieved may be that under memory instructions young children produce behaviours
                    are
which/not directed to memory goals. These behaviours are overlearnt and dependent on the child's normal activities in the task in question. If the behaviours happen to benefit memory and the children detect this, or they are given feedback, the behaviour may enter the repertoire as an intentional strategy.

CHAPTER 7   CONCLUSIONS

7.1 Introduction

In this concluding chapter I wish to focus upon three
different sets of issues. The first two directly concern
the data. Two reviews of memory development, (Flavell,
1971 and Brown, 1975) offer descriptions of the pre-
schooler as being largely incapable of deliberate memori-
sing largely as a result of deficits in metamemory. They
argue that increases in children's knowledge of their
own memory processes is largely responsible for the rapid
development of strategic memory skills in the early school
years. In contrast, Wellman (1977a) reviewed a number
of experiments which demonstrate the ability of pre-
schoolers to use intentional strategies, and conducted
further studies that demonstrated some metamemory know-
ledge in this age group (Wellman, 1977b, 1978). Since
the majority of the experiments I conducted have studied
preschoolers, it should be possible to determine which
is the more accurate depiction of the memory skills of
this age group.

The second problem addressed is that of change. It will
be argued, in contrast to Brown (1975, 1978) and Flavell
(1971), that memory development is not the result of
changes in metamemory. In fact, I shall argue that

exactly the opposite view is the case, and that metamemory development is itself the result of the development of memory strategies.

Finally, I shall discuss how the views offered here reflect on a number of recent controversies in developmental psychology. I shall discuss the issue of context-specificity, and offer a number of reasons why behaviours do not generalise across situations. I shall then look at competence in preschoolers, and the characterisation of adult memory and focus on the general issue of change in memory skills. In conclusion, I investigate the role of the environment and suggest it offers some insights into the above problems.

7.2 Memory in preschoolers

In his 1971 article 'What is memory development the development of?', Flavell concluded that "deliberate memorizing looks like a clear instance of planful, intentional, goal-directed, future-oriented behaviour, and such behaviour is hardly the stock-in-trade of the typical 4-year-old".(p. 276) This view is endorsed by Brown (1975) who argues that "the young child does not seem to realize that he needs to memorize".(p. 112) In direct contrast to this Wellman (1977a) reviews five studies which clearly indicate the use of intentional memory strategies. In addition he found that preschoolers had some idea of the importance of certain memory variables such as the number of items or length

of study time (Wellman, 1977b, 1978). It is clearly of
some importance to establish the exact nature of pre-
school memory and metamemory because, as Gelman (1978) has
argued for cognitive development, this has clear impli-
cations for our model of development.

On the face of it, we have in this thesis a number of experiments which
suggest a high degree of sophistication with deliberate
memory strategies. Thus, children as young as 3 years
will make use of cues which enable them to infer the
identity of animals they cannot see. They will also
readily consult a picture placed in front of them while
they are listening to a story. Again this behaviour results
in improvements in memory. If picture cues are placed
face-down in front of the children they are a little less
willing to consult them, but they do so after some promp-
ting by the experimenter.[*] In addition, the older chil-
dren show highly efficient search behaviours; they directly
consult the relevant picture, without redundant search
of previous locations.

A similar picture seems to emerge from the monitoring
studies. Although children cannot accurately assess the
absolute level of their performance, they can detect
changes in their performance on the spatial location task.
By the age of five, they also demonstrate some ability
to monitor the state of their understanding, and predict
memory for text. The transfer tasks also suggest that,
if strategy-use results in large performance changes, this

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[*] This need for prompting may arise from children's failure
to realise that they were meant to consult cues.

influences the generalisation of the strategy, which implies
that children as young as three can detect such effects.

This picture of the preschooler with a large and flexible
range of strategic and monitoring skills is extremely
misleading, because if we consider the "strategic"
behaviours in more detail, it becomes clear that many of
them do not deserve such a description. If a behaviour is
to be classified as intentional, it is clear that it
should be directed towards the achievement of some goal.
If we consider the monitoring data for the experiments
it becomes clear that strategy use was independent of its
effect on performance.

Considering first the spatial location task, four pieces
of evidence suggest that looking at cues was unrelated to
the goal of remembering. Firstly, children who estimated
that they were performing at ceiling without cues, still
looked at the cues when they were provided, as much as
children who estimated lower levels. (Experiments V and VI).
The overestimaters should not have used cues because there
was no need for them to do so. Similarly in Experiment VI
children did not seem to modify their behaviour in accord-
ance with memory goals. Thus there was no evidence that
children who perceived cue use as improving performance
were more likely to maintain cue use, or that those per-
ceiving a decrease in performance dropped the behaviour.
Finally, in Experiment VI children continued to use array
cues despite the fact that they did not influence

performance. An additional piece of evidence that cue
use was certainly not strategic is that some children
looked at the cues without making the inference. Now
some of these were in the youngest group, so it might
be argued that they were unable to make the inference.
However as inferencing was at ceiling for the older
groups, this argument cannot be made for those groups.
Cue use in the story comprehension task also looks
suspiciously involuntary. Despite the avid attention
paid to the picture, children in the two younger groups
were unable to establish that it affected performance, and
only five of the older children could explain this.

Another reason for arguing that/behaviours may not be
                                    such
intentional is /   they are "stimulus-driven". One mani-
            that
festation of this might be that the behaviour depends
critically on a particular stimulus configuration, any
modification to which changes the behaviour. So, we might
argue that if children were intentionally studying the
picture in Experiment X(one cue text comprehension) · accor-
ding to the strategy of using pictures to improve memory
for text, we should not expect a minor modification
(placing the cards face-down)*to influence use of the
strategy.[15] For the younger children, in Experiment XI
(7 Pictures cues and Text), behaviour also looks "stimulus

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15 This finding cannot be attributed to any peculiar
    feature of this experiment. The same result is
    reported by Ritter et al (1973) using a different
    procedure and materials.

*   As I have explained earlier, however, there are problems
    with making inferences from this failure to spontaneously
    consult face-down pictures.

driven". The children will readily turn over one or two pictures at the experimenter's suggestion, but go no further in using the pictures to answer his question. Finally the search behaviours shown by the children in this experiment are also highly dependent on the structure of the stimulus. The "direct search" strategy under sequential questioning also seemed highly related to stereotypical activities when young children look at books. This is not to say that all the children were producing the behaviour without attention to memory goals, merely that left-to-right search is a high probability response when adults ask children questions about stories in picture books. In fact, some children may discover the strategy by such a means. They may produce the behaviour on prompting from the experimenter, and find that the pictures enable them to answer the questions. This 'accidental discovery' route may provide an important means by which new behaviours enter the strategic memory repertoire.

In conclusion therefore, although Wellman has evidence for some clear examples of strategy use in very young children, the results of the present studies suggest that many 'strategic-looking' behaviours may not be intentional plans invoked to mediate memory. This argument is strengthened by recent reviews of organisational factors in memory by Ornstein and Corsale (1979) and Lange (1978) in which they argue that observations of clustering in young children are not strategic but the involuntary

effect of the child's semantic system. Likewise Gordon
and Flavell (1977) and Ritter (1976) argue that cue use
in young children has rather more of the characteristics
of stimulus-response behaviour than intentional strategy
use.

7.3 What develops?

If it is indeed the case that much of the behaviour of
preschool children in memory situations is involuntary,
we must explain how it is that such behaviours come to
be used as deliberate memory strategies. It was argued
that cue use (in the spatial location task in particular)
looked to be largely independent of memory performance.
How then do young children learn to associate their
behaviour with memory goals?

It is argued that two mechanisms may be responsible for
this: feedback and self-monitoring. Both are means by
which children become aware of the implications of their
behaviour for memory. In the case of feedback, others
such as peers, parents or teachers give them information
about the results of the behaviours they have just pro-
duced. It is clear that if we are to understand the
importance of a process such as feedback in the development
of memory or other cognitive skills, we must study its
role in the natural environment. In addition, as Heisel
and Ritter (1981) and Ringel and Springer (1980) have
shown, there may be different types of feedback. Younger

children may not only require information about changes in their performance, but may also need this information to be specifically attributed to the behaviours they have produced. Experiment IX demonstrates that information about the effect of picture cueing on performance does significantly influence transfer of this strategy.

Another mechanism by which children may become aware of the effects of their behaviours is by self-monitoring. Spontaneous checking of memory performance may lead them to attribute changes in performance to these behaviours. Of course, the effectiveness of such a mechanism depends crucially upon the monitoring skills of the young children and also upon the size and detectability of the changes which result from the use of experimenter-induced behaviours. One reason why behaviours may not generalise to serve the memory function is that young children are unable to detect the effects that they have upon performance. Experiments V and VI show that pre-schoolers are not able to make accurate absolute judgements about the level of their performance on the spatial memory task. In addition such changes were relatively small (one or two items), and may not have been detectable. The importance of making performance change detectable was shown in Experiment VIII in which cueing behaviours which resulted in large improvements in performance were more likely to lead to strategy transfer than less effective cueing strategies. One other factor which seems to influence detectability of induced strategy use is the interval

between the assessment (no strategy) session and the
instruction (induced strategy) session. Young children may
not be able to make a comparison of performance if the inter-
val between non-use and use is long in duration.* It is
argued that the discrepancy between Experiment VII and the
Kennedy and Miller (1976) and Keeney et al (1967) studies may
be due to such memory factors. It is also possible that the
size of the change in performance following induced strategy
use also influences children's interpretations of what is
responsible for such change. If strategy effects are small,
they may be attributed by the children to other factors such
as practice.

It is clear that a number of factors interact to influence the
detection of the effects of induced and involuntary behaviours.
Appeal to such factors may explain the absence of transfer in
other experiments where the subjects are older children who are
capable of accurate monitoring (e.g. Rosner, 1971).

It has been argued that young children's production of certain
behaviours in memory situations suggests these behaviours are
not intentional strategies invoked to benefit memory. These
behaviours may be produced for two reasons: either adults
instruct children to produce them, or children invoke them for
some reason other than to remember better. These I shall call
instructed and involuntary behaviours respectively. It is
also argued that two mechanisms, feedback and self-monitoring
may be responsible for the conversion of both types of be-
haviours into memory strategies. Instruction may be one
setting in which teachers induce certain behaviours and

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*This factor was suggested by a comparison of the results of
Experiment VII with Keeney et al (1967) and Kennedy and
Miller (1976), it was not experimentally determined.

provide feedback about the effects of such behaviours on memory. The question of how involuntary behaviours develop is more problematic. Monitoring is not likely to be the mechanism of change for two reasons. Firstly, for monitoring to be effective, there has to be a change in behaviour, in order that children can monitor the effects of behaviour change on memory performance. In most situations where children do produce such involuntary behaviours, there is no such behaviour change. A second reason why monitoring may not provide a good explanation of strategy development is that monitoring is not accurate in young children, although, as Experiments V and VI show, they are not totally insensitive to the level of their own performance. Feedback is also problematic as an explanation of strategy development from involuntary behaviours because adults may not always be present to provide it.

The above account suggests how involuntary behaviours already in the repertoire but serving other ends, and instructed strategies might come to serve the memory function. It leaves a number of other factors unexplained, such as the origins of involuntary behaviours, the later development of intentional strategy use, and improvements in monitoring skills. I shall now try to answer these questions.

The glib answer to the problem of the development of involuntary behaviours is that they are activities (or cognitive structures) which have developed in other areas of cognition and language. Thus the skills of looking at pictures while comprehending text, and also searching

pictures in story sequence, are learnt during the
child's considerable experience of listening to stories.[16]

Similarly, inferencing may be crucial in the development
of perception (Bryant, 1974) and language (Macnamara,
1972) and hence have developed in these areas. Experiment
IV however, shows that the particular type of inference
required in the spatial memory task may not have fully
developed in the early preschool years. This may be one
reason why use of the inferencing strategy increases
during the preschool period. Chi (1978) has demonstrated
that 5-year-olds are much slower to name objects than
adults. It may be that changes in underlying skills such
as naming and sequencing of names are responsible for
the emergence of the rehearsal strategy. Indeed research
on the development of rehearsal by Kingsley and Hagen
(1969) and by Ornstein and his colleagues (e.g. Ornstein
and Naus, 1978) suggests that rehearsal skills are const-
rained by the speed of naming. Thus Kingsley and Hagen
report that 5-year-olds were unable to rehearse items in
sets of two or three "despite understanding in principle
what was required of them". (p.45) Ornstein and Naus found that
adults were unable to rehearse items in sets of more than
five. Similarly it may be that older children's greater
facility with category structure, as documented by Rosinski
et al (1975) enables them to apply this knowledge in the
sort of category-sort strategy reported by Moely et al(1969).

16 There is a deeper argument that the very structures
   which underlie the comprehension of stories are
   derived from the structure of everyday episodes.

If memory development does depend on developments in other areas of cognition, we might expect that subjects with no knowledge of those areas would have few available strategies. This was substantially what Chi (1978) found. Subjects who were highly competent at chess-playing were much better at remembering chess positions than subjects with little chess ability. In summary then, developments elsewhere in cognition or language produce either activities (Experiments X and XI), or cognitive structures (Rosinski et al, 1975) which are then utilised for memory goals. The argument bears a similarity to the cognition hypothesis advanced by Cromer (1974) to explain language development, which concluded that although some sequences in language development could be explained by changes in the cognitive system this could not account for all such sequences. In particular, the development of certain aspects of syntax seems to be the result of changes internal to the domain of language.

Similarly, changes in cognition, language and social activities do not appear to be sufficient to explain all of memory development. The model proposes that strategies are limited to behaviours which are produced either because they are what the child normally does in that situation (e.g. name objects, look at pictures with stories) or because the experimenter suggests them. These become strategies once the child becomes (or is made) aware of their positive effect on memory performance. (cf. McShane's 1979, 1980 theory of the development of naming). However

this model cannot explain what many people consider to be the essential feature of adult memory - its creativity. (e.g. Reitman, 1970). The model can only explain generalisation - how behaviours already in the repertoire can become part of the memory system. According to Reitman, adults are not limited in this way, but can invent 'new' behaviours to meet situational demands. How is this freedom from involuntary or elicited behaviours brought about? According to Flavell (1971) and Brown (1978) it is the result of the development of knowledge about memory. Knowledge about memory variables, limitations, processes and situations enables the adult to generate an appropriate strategy to meet a particular situation. I wish to make two points about metamemory: the first concerns its existence and the second its relationship to memory behaviour. No-one would deny the mass of evidence indicating that people are in possession of a wide range of facts about memory, and that this body of knowledge undergoes large increases with age. Any theory of memory or cognitive development must therefore offer some explanation of this. What may be the case, however, is that its role in explaining memory has been overestimated. Although this matter will be dealt with in more detail later I shall briefly discuss the metamemory-memory relationship, before returning to the subject of how metamemory itself develops.

It has already been argued that one feature of adult memory is the ability to invent 'new' strategies to meet the

demands of a novel memory task. If we examine what is
generally implied in this account, we find that the
routine generated to solve the novel problem is a modi-
fication of a routine used elsewhere in cognition to
solve a different problem. This suggests that 'novel'
behaviours crucially depend on developments elsewhere in
the cognitive system. It may be that part of the adults'
proposed ability to generate more novel problem solutions
than the child can be explained by the fact that adults
have more routines available. In conclusion, part of the
flexibility and ability to modify strategies to meet new
demands, which is commonly attributed to metamemory may
be explained by increase in the number of cognitive
routines available, elsewhere in the child's repertoire.
To give an example, children show an increasing tendency
with age, to cluster together items of the same taxonomic
category in recall (Ornstein and Corsale, 1979). It is
unclear how much of this is due to changes in the child's
conceptual system and how much to the intentional insti-
gation of a category-structured retrieval plan. My
point is not that metamemory and intentional strategy use
is unimportant in memory, merely that some of the develop-
ments explained by appeals to metamemory may be the results
of developments elsewhere in the system.

All this does nothing towards explaining how metamemory
('the body of knowledge') itself might develop. It is
possible, however, that the model offered for the

development of early strategies may shed some light on this. It was argued that involuntary or induced behaviours influence memory and that the child becomes aware of this. This awareness is probably induced by feedback, as monitoring is unlikely to be very efficient in very young children, although on simple searches it may be obvious whether or not a behaviour is successful. By one means or another, then, young children become aware that the things they do have implications for memory. If children come to realise that this applies over a variety of contexts, then they may form the rule that behaviours influence memory. This is the concept of strategy which underlies all other developments in metamemory. Extensions to this knowledge may follow from the realisation that different behaviours have different effects on memory which may lead the child to an awareness of the structure of strategies.[17] It may well be possible that metamemory does influence strategy use in older subjects under certain circumstances, but such influence has yet to be demonstrated. In the present discussion I wish merely to point out that the concept of metamemory may not be necessary to explain many of the phenomena for which it has been invoked, and also that the origins of metamemory may be in involuntary routines.

Finally there is the question of the development of monitoring. It is clear that there is no single cognitive

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[17] All this knowledge may not be conscious, and may only be accessed when specific questions are asked which probe it.

entity which represents monitoring, because it can consist
of a whole range of different skills ranging from the
simple detection of the result of an action (an ability
in no way unique to man) to the complex multi-factor
interpretations of ones own behaviour which are a feature
of adult social cognition. Since this is the case there
is no one age at which 'the ability' to monitor will
emerge. Thus, the child's ability or monitoring skill,
will depend on the information-processing demands of the
particular situation. Thus, in the spatial location task,
accurate monitoring required children to compare the
responses they had generated with the actual animals
situated under each cup. This requires both retention
(of the names) and comparison skills. In addition the
experimenter asked the children to make a decision about
each location. This is clearly more demanding than the
global approximations which were necessary in Experiment
X.

Given the important role assigned to the development of
monitoring in this account, it might be argued that we
have not solved the problems of memory development, but
resituated them in a new construct. This is not the case
for we have some idea of the processes underlying moni-
toring. In addition, it has been clearly demonstrated
that the information from monitoring (or procedures which
avoid the necessity for monitoring) do influence strategy
selection. Also there are a number of factors which we
can manipulate to investigate its effectiveness.

7.4 Relevance of these results for recent issues in developmental psychology

7.4.1 Context-specificity

One of the features of Piaget's theory of cognitive development, which has given rise to an enormous amount of recent controversy is the assumption of the context-freeness of cognitive-structures. According to Piaget, once a structure enters the child's repertoire, it immediately generalises to all appropriate situations. There have been any number of experimental demonstrations that this is not the case (e.g. Donaldson, 1978), but more recently a number of models of development have built in the assumption of context-specificity. Thus Keil (1981) offers an account of development in which thought is domain-specific. A different approach has been adopted by Fischer (1980) who argues that specific environmental experiences determine the differential rates of development of different cognitive acquisitions.

The experiments conducted here provide evidence for the context-specificity of memory, but they also suggest that there are a number of different reasons underlying the failure of a routine to generalise across situations. These results suggest that memory, like cognition, is context-specific, but that accounts which attempt to offer a unitary explanations of context-specificity (e.g. Donaldson) are misleading.

The first type of context-specificity is the failure to evoke a behaviour or skill which is clearly 'in' the cognitive repertoire. Thus some children do not spontaneously rehearse (Experiment VII) or use pictures to cue the locations of objects (Experiments VIII and IX) and yet they can be induced to do so by minimal amounts of prompting or training. This sort of production deficit has been widely reported in the literature (e.g. Flavell, 1970) and the standard demonstration has been to show (a) the absence of a behaviour when the experimenter does not prompt it; and (b) its presence following instruction or prompting. The experiments reported here also include a different type of context-specificity which seems to be amenable to the same sort of analysis. In Experiment XI children did not consult pictures to answer questions about text, and yet they readily did so when listening to stories (Experiment X).* This also seems to be a type of production deficit, but one which is influenced by the structure of the experimental materials and not by experimenter intervention. These results are similar to the findings of Cole et al (1971a) and Moely and Shapiro (1971) who demonstrated that using blocked presentation of taxonomically related items in lists (i.e. all items from the same category are presented together) induced recall patterns which reflected category structure. This was much reduced when presentation order randomised category items. The influence of the structure of the materials is also demonstrated in Experiment XI where use of the direct search strategy was

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* I have already noted the problems with this conclusion.

influenced by question order and its relation to story structure.

Another example of the failure to evoke a behaviour 'in' the repertoire occurs in the transfer experiments (Experiments VIII and IX). The children who fail to transfer are obviously capable of producing the behaviour in the training session, but do not do so in the new situation. One factor which seems to influence strategy evocation in transfer seems to be the effectiveness of the behaviour. Thus, if children are given information about the efficiency of a given behaviour (Experiment IX) or the behaviour is more efficient and they can detect this (Experiment VIII) they are more likely to generalise it.

Yet another factor which seems to influence context-specificity is age. Thus, older children seem to have fewer production deficits (Flavell, 1970), or are more likely to transfer strategies (Experiment VIII). This has generally been attributed to the intentional operation of memory, in which developments in metamemory enable children to 'consider their thoughts as cognitive objects' and hence apply them across a variety of situations. This explanation may not be entirely necessary how-ever if we allow that behaviours (or strategies) generalise across more situations with age. This may be related to the underlying development of the behaviour. Thus, young children lack the ability to name quickly

and to sequence items - it is therefore hardly surprising that their rehearsal skills are limited. Similarly Esposito (1975) has demonstrated that the overlearning of a response facilitates positive transfer.

A completely different reason for context-specificity is evidenced in Experiments I, II and III. Children seem to produce the inferential skill in Experiments II and III despite its absence in Experiment I. Such differences are not limited to the youngest group, who have deficits in the inferencing skill (Experiment IV), but also occur in the two older groups. The reason for the failure to inference in these groups would seem to lie in deficits in auxiliary skills: children are unable to keep track of the objects at previous locations, and in consequence lack the information neces-sary for the inference. Similarly, some children did not look at the monitoring cues and were unable to make the inferences until the experimenter indicated the cues.

Thus four factors seem to influence the context-specificity of memory skills, these being the stimulus environment, information about skill effectiveness, age, and deficits in auxiliary skills. I shall now attempt to relate this to other research on cognitive and language development.

The notion that features of the stimulus environment influence the skills produced has been advanced by both Bruner (1966) and Donaldson (1978). These authors both

argue that cognitive skills first emerge in a privileged set of contexts and gradually generalise until their usage reflects that of adults. In neither case is it clear whether skills are thought to be innate - i.e. if we could find the 'right context' such skills would be in evidence in neonates. If not, then the theories should state how change occurs. If either of these arguments is to provide the basis of a principled account of cognitive development it is clear that they must offer (1) an analysis of situations to enable us to predict whether or not they are privileged and (2) an account of the generalisation process which enables behaviours to be evoked under the appropriate circumstances. I shall be more concerned here with the analysis of situations offered by the two accounts, the problem of developmental change will be discussed in a later section. Bruner's argument seems to be that cognitive skills will emerge much earlier if we manipulate the experimental context to avoid them invoking the wrong set of rules. Bruner offers support for his position by the demonstration that liquid conservation responses are generated by young children when one feature of the environment is manipulated. This involves the removal of 'perceptual seduction' which is achieved by conducting the transfer of liquid behind a screen. However, Bruner gives no analysis of a dimension of 'perceptual seductivity'.

The same can be said for Donaldson's synthesis. In contrast to Bruner, she does however offer some suggestions

about the features of the situations in which we might
find early emerging cognitive skills. Donaldson argues
that if we manipulate the structure of the situations in
order that they "make human sense" (p. 24) or that the
"motives and intentions of the characters are entirely
comprehensible, even to a child of three" (p. 24), then
performance increases. Additionally she argues that
children and adults pay different attention to language
"the difference between child and adult... lies in the
amount of weight that is given to sheer linguistic
form" (p. 63). Unfortunately, although these suggestions
do have some plausibility they are not tied to a princi-
pled analysis. Thus, it is not possible to arrange
situations along the dimension of "human sense" in
order to predict which cues will best induce precocious
skills.

The present set of experiments suggests that at least
two factors are crucial in determining what skills
emerge in different situations; the amount of prompting
given by the experimenter and the structure of the mater-
ials used. The experiments quite clearly show a decrease
with age in the amount of prompting required to elicit
a skill, which is not immediately evoked. What determines
whether behaviours are 'immediately evoked' however?
The crucial factor here would seem to be what children
would normally do in the situation when there is no
memory demand. For this it is clearly necessary that
we analyse children's behaviours in the natural environment.

From such an analysis it might be possible to offer
reasons for some of the sequences reported here. This
clearly also relates to the question of the structure
of the materials. This structure can only be defined
relative to the everyday cognitions and actions of the
child. Thus, we have the finding that children do not
look at face-down pictures to answer questions about
text, but will do so when the pictures are presented
along with the text. If we look to ecology we find that
children have little experience of face-down consulta-
tion, but frequently listen to stories and look at
pictures. Thus, there are differences in structure between
the two situations, with structure being defined relative
to the child's normal activities. Similarly more chil-
dren produce a 'direct search' strategy in the sequential
question procedure of Experiment XI.because it is an
activity more closely related to their normal picture
search strategy than is random search. This type of
analysis can be extended beyond children's overlearnt
activities to their internal constructs. Thus we may
argue that children have a set of concepts derived from
their experience with the natural environment (e.g. scripts,
story grammars, and prototypes) and that stimuli which
are 'well-formed' relative to these constructs will
induce appropriate memory skill earlier than those stim-
uli which are less 'well-formed'. Thus Corsale (1978)
has demonstrated that lists of words containing category
prototypes induce category sorting in 8-year-olds whereas
lists of less salient category members do not do so.

Similarly Mandler (1979) reviews a number of experiments suggesting similar results for story grammars, and room scripts.

Other recent research in cognitive development suggests the influence of the ecology of the situation and the structure of the materials. Thus Rosch et al (1976) found children were able to sort basic-level categories several years before they were able to do so with super-ordinate categories. The influence of what children normally do with materials or how they act in particular situations is also evidenced by studies of communication (Shatz, 1978) and semantic development (Clark, 1973b; Trehub and Abramovich, 1978).

All this is to say that ecology is important, and that if the skill we wish to study does occur in the natural environment, then it will first emerge in those situations which most closely model the natural environment. While this type of analysis is useful for comparing and sequencing ecological versus non-ecological versions of the same situation, it is clearly inadequate for compari-sons of very different situations, or for behaviours which do not occur naturally. Thus cumulative rehearsal (saying items in sets of three) and generating bizarre images are not naturally occurring behaviours and an ecological analysis would not tell us much about them.

The notion that children may fail to produce a routine

in their repertoire because they lack auxiliary skills,
is also to be found elsewhere in developmental psychology.
Thus, Bryant and Trabasso (1971) argue that children
fail the Piagetian inference task because they lack the
skills to encode the premise information. When children
are trained so that such information is overlearned, we
find they are able to make transitive inferences.
Siegler (1978) has offered a similar argument for deficits
in children's early understandings of the principle of
moments. Deficits in auxiliary skills may not only
occur in encoding, children may well be capable of gene-
rating some skill, but be unable to reveal this because
they lack adequate response skills. Many recent studies
have demonstrated that we have severely underestimated
the skills of infants because we have demanded criterial
behaviours not in the repertoire. A similar argument
has been made by Brainerd (1973) concerning the use of
verbal protocols as evidence for conservation abilities.

What generalisation may we draw from all these studies?
Firstly, it seems that whether or not a particular skill
emerges in a given situation is a complex interaction
between the task demands, and the skill itself and in
some cases the provision of information about strategy
effectiveness. One immediate implication of this is that
there seems to be no 'one age' at which a particular
skill emerges, and so the task of the developmental
psychologist becomes the analysis of the exact form of
the skill which does emerge, and also the amount of

support which the environment provides for the behaviour.
As I have already argued, there are a number of ways
in which the environment can provide this type of
support. At the stimulus end, these can include promp-
ting or placing the skill in the context in which it
is normally used. The environment might also avoid the
necessity of involving auxiliary skills, by itself
providing the/information necessary for the skill (e.g.
Experiments II and III). In addition, it may provide
information about skill effectiveness (e.g. Experiments
VII and VIII) which render monitoring unnecessary. One
way of viewing all these findings is to conclude that
as children grow older they become less and less depen-
dent upon this sort of environmental support.

7.4.2 Competence in preschoolers

A second major problem for Piagetian theory in recent
years has been the demonstration of precocious logical
skills. Such demonstrations offer a serious difficulty
for the theory; although the late emergence of skills
can be "explained" by appeal to notions such as hori-
zontal decalage, the finding that preschool thought is
in some respects comparable to that . of adults under-
mines one of the central assumptions of Piagetian theory.

The suggestion that thought is similar in adults and
children exactly contradicts a fundamental tenet of the
theory that thought undergoes structural changes,

and that the thought processes of adults and children are qualitatively different.

Given the importance of the issue, what is the status of the evidence for precocious preschool thought? Certainly claims about early competence have been made in a number of different domains, e.g. number development (Gelman and Gallistel, 1978), perspective-taking (Borke, 1977; Shatz and Gelman, 1973), quantity conservation (McGarrigle and Donaldson, 1975), concept formation (Rosch, Mervis, Gray, Johnson and Boyes-Braem, 1976), class inclusion (Markman and Siebert, 1976) and scientific concepts (Siegler, 1978). This research has led several reviewers (e.g. Keil, 1981; Nelson, 1977) to conclude that thought processes are fundamentally similar throughout development.

However attempts to replicate such work suggest that such claims may be unjustified, and in some cases, simple rules have been discovered which will explain precocious 'logical' behaviours. Thus, Shatz (1978) has argued that simple context-derived rules will explain the apparently complex communicative skills of very young children. McShane and Morrison (in press) have also argued that responses which would seem to require advanced knowledge of liquid quantity relations are explicable by a simple perceptual rule. Similar arguments have also been advanced by Trabasso, Isen, Dolecki, McLanahan, Riley and Tucker (1978) for class inclusion and Breslow (1981) for transitive inferences.

The same sorts of issues have also arisen in recent
studies of memory development. Early claims (Flavell,
1970) and Brown (1975) of the preschooler's incompetence
at generating intentional strategies for remembering,
and even their inability to recognise the need for
memory, have been falsified by numerous demonstrations
of intentional strategy use (Wellman et al, 1975; Yussen,
1974; Yussen et al, 1975). However the present set of
studies suggest that in some cases, apparently strategic
behaviours may not be the result of intentional memory
plans. This is also supported by the results of studies
by Ritter (1978) and Gordon and Flavell (1977).

If we accept for the moment that the demonstrations of
preschool precocity are not all the result of false
positive errors, then we are left with the conclusion
that preschoolers are capable, in some situations, of
great logical feats, but these skills do not emerge
in Piagetian tests. We may therefore characterise the
abilities of the preschooler as being highly context-
dependent.

7.4.3   The nature of developmental change

As Gelman and Gallistel (1978) so cogently argue, it
is crucial that we understand the nature of thought in
preschoolers if we are to understand and model the pro-
cess of change in development. Knowledge of the starting-
point will clearly influence both how we conceptualise

later developments, and will profoundly influence the mechanisms of transition we propose.

To this end, it is important that we correctly characterise the nature of memory in the later stages of development. I have just noted that memory seems to be highly context-specific in preschoolers. If it turns out to be the case that memory also happens to be context-specific in adults then our mechanism of change will have to be much less radical than if memory becomes decontextualised.

It is necessary first therefore that we characterise the nature of memory in adults. Flavell (1971) and Brown (1978) offer us accounts of adult memory which seem to be derived from the suggestions of Reitman (1970). A major characteristic of adult memorisers (according to these accounts) is the problem-solving nature of their skills. Adults are described as being better able to modify strategies to meet particular memory demands, or to invent new strategies if none are available. This is explained by the development of a central executive system (Brown, 1977, 1978) which has access to a large body of knowledge about memory and available cognitive routines. This system selects routines to meet partic-ular demands, monitors their effectiveness and modifies them if necessary. The knowledge of important memory variables and of available routines enables routines to be freed from their original context, and employed for other functions in the cognitive system. This knowledge

of available routines should result in the generalisation
of routines across a variety of contexts.

How accurate a picture of adult memory is this, however?
There are a number of reasons for believing that adult
memory may be rather less creative, adaptive and context-
free than the above account claims. In a summary of
recent developments in the levels-of-processing liter-
ature, Jenkins (1979) offers a convincing case that adult
memory is highly context- specific.

> The memory pheonmena that we see depend on
> what kinds of subjects we study, what kinds of
> acquisition conditions we provide, what kinds
> of materials we choose to work with, and what
> kinds of criterial measures we obtain. Further-
> more, the dependencies themselves are complex;
> the variables interact vigorously with one
> another (p. 431).

In addition we can find evidence that adult memory is
prone to the same sorts of deficits as the immature memory
system. Thus Rohwer, Raines, Eoff and Wagner (1977), found
that most 17-year-olds had a production deficit for the
use of anelaboration strategy in learning word pairs.
Similarly Bower (1970) reports enormous improvements in
memory when college students were instructed in the method
of loci. Finally, a study by Chi (1978) suggests that
context-specific knowledge rather than age is crucial in
determining performance in remembering chess positions.
She reports few examples of adults inventing strategies
or adapting them from elsewhere in the cognitive system.
It appears that even in adults, strategies may be limited
in their domain of application.

This suggests two conclusions: that adult memory may be much more similar to memory in children; and secondly that metamemory may play much less of a role in adult memory than has previously been claimed. This is not to imply that metamemory itself does not change with age, but that such changes do not directly affect the memory system.

If it is the case that preschool and adult memory are similar, this has important implications for an account of developmental change. The large differences described by Flavell (1970, 1971) and Brown (1975, 1978) provide major problems for any such account, because they imply a major change in the nature of the memory system. It is clear that such a discontinuity is much more difficult to explain than the small differences suggested in the present account. It has already been argued that one mechanism by which memory may develop is by 'borrowing' behaviours from other parts of the cognitive system, or by instruction. External feedback and monitoring may explain how these routines become connected with memory goals. This account provides an explanation as to how intentional memory may first emerge, and it can be extended to cover adaptivity and generalisation. Intent-ional memory may first emerge from the accidental or involuntary evocation of a routine, and the child becoming aware of this either by reinforcement or by monitoring. The account can also explain how strategies become more general. As children grow older the number of routines in their repertoire will increase, as will the number of

occasions on which routines are related to memory. It has also been argued that the rate at which routines enter the memory repertoire may well be influenced by developments in the ability to self-monitor. As this develops, children will become increasingly sensitive to the effects of their behaviour. The problem of how strategies become better adapted to memory goals, may be the result of this increase in the number of available strategies. The metamemory-based account suggests this adaptiveness is the result of the subjects ability to modify a strategy to meet particular goals. It may be, however, that older subjects simply have more strategies and are able to meet these demands by evoking another strategy rather than by modifying the one previously in use. A final quality mentioned by Brown and De Loache (1978) in their description of memory in the expert is creativity. Even given the problems of defining such a term, there does not seem to be a vast amount of evidence to suggest this characteristic in adult memory. In cases in which it does occur it seems to be dependent on vast knowledge of an area which allows the generalisation argument suggested earlier, as an alternative to appeals to metamemory.

It could be argued that the present account does not allow for the development of novel memory strategies, but strategies need not originate only from elsewhere in cognition - it is likely that many are introduced through instruction in schools.

What is the role of metamemory in all of this? As I
have already said, the increase in metamemory is a
developmental phenomenon which remains to be explained.
I have argued that the initial development of metamemory
may be the result of feedback on early strategy usage.
Metamemory was originally invoked, however, to explain the
differences in memory between adults and children (Flavell,
1970; Brown, 1975). As I have now argued that much of
memory in both adults and children does not have the
knowledge-driven characteristics of this account, its
importance as an explanatory construct is much reduced.
In addition, most of the studies attempting to demonstrate
the relationship between metamemory and memory have
failed to do so (see Chapter 3), the exceptions being
studies in which children were given information about
strategy effectiveness which are built into the account
offered here. All this suggests there are severe problems
with the metamemory-driven model of memory. This is not
to say that memory never has the intentional problem-
solving character described in the early accounts, and
that knowledge of memory does not influence performance,
but that models of memory which appeal to metamemory are
inadequate to explain the data. In view of this it is
suggested that we attempt to explain the development of
memory skills without appeal to such a construct.

This account has a number of implications for general
models of development, and mechanisms of change in such
models. Firstly it is important that we correctly

characterise not only the initial state of the system
(as Gelman, 1978 argues) but that we arrive at an accurate
description of the skills of the adult. There are some
parallels between the discussion of memory development
above, and recent findings in cognitive development. In
her summary of empirical research on Piaget's theory,
Boden (1979) concludes that

> Recent experimental research has shown Piaget
> to be wrong on many points, such as the inability
> of children at a given age to carry out certain
> types of 'more advanced' thinking.....And adults,
> by contrast, are considerably less logical in
> much of their reasoning than Piaget's theory
> would lead one to expect. (p. 152)

It was also argued that the differences between child and
adult skills will greatly influence the mechanism of
change. If adult and child abilities are much more
closely related and both context-specific then it is
clear that any mechanism we propose will be itself specific,
and need not be enormously powerful, as the changes to
be explained are quantitative rather than qualitative in
nature.

There are parallels between other theories of development and
the account of the development of intentional memory, and
the mechanism by which routines come to serve the goal of
memory. A number of other theories suggest that a major
feature of development is the increased access to cog-
nitive routines, and the use of these routines to serve
new functions (e.g. Fodor, 1972; Rozin, 1976). Other
theories have argued that existing routines are used in
a qualitatively different way, following the development
of reflectivity which enables the child to use the routines

in a logical "decontextualised" manner. (e.g. Donaldson,
1978; Vygotsky, 1962; 1978). If these are to serve as
adequate accounts of development they must specify: (1) the
reasons for the original constraints on routines; and
(2) the mechanism by which increased access is made
possible. In addition some of these theories allow for
the creation of 'new' routines. If this is the case,
how is the creation of new routines possible, and what
contribution does this make to development?

If we deal first with the question of initial constraints
we find that none of the theories provide a principled
explanation. Fodor's account is no more than a series
of suggestions about possible domains of early competence,
no reason is given as to why these are favoured. Ro^{z}in
(1976) goes somewhat further in suggesting that early
skills may be constrained by genetic factors. Thus chil-
dren develop first in those domains which are important
for their early environment. This line of reasoning also
seems to underlie the suggestions of Donaldson (1978)
that thought is initially predominantly "social", but
as has already been suggested (p.300) she has not proposed
criteria by which "social" situations may be isolated.
Similarly Vygotsky provides little in the way of descri-
ption of early thought.

The theories are similarly flawed in their explanations
of increased access. Rozin and Fodor offer no account of
how this might occur. Both Vygotsky and Donaldson

suggest that children's increased ability to analyse
the structure of early thought is responsible for their
increased control over its different functions. This
change is attributed in both cases to the development of
a conventional sign system. Thus Donaldson suggests that
the onset of reflectivity is determined by the develop-
ment of the skills of reading and writing, and Vygotsky
argues that thought is modified by the internalisation of
spoken language. While there is evidence that literacy
influences thought, this is often confounded by other
variables such as the use of a cash economy or collective
farming, (Scribner and Cole, 1973), and the account does
leave unspecified precisely how this change is brought
about. There have also been a number of attempts to
test the hypothesis that the internalisation of speech is
responsible for a modification in processes of thought.
The results of these studies have largely suggested that
language and thought functions develop in isolation
(Jarvis, 1963; Wilder, 1968; Miller, Shelton and Flavell,
1970). There is an additional problem for the theories of
Donaldson and Vygotsky. A number of recent volumes on
adult cognition (e.g. Claxton, 1981; Johnson-Laird and
Wason, 1977) have suggested that adult thought, like
memory, may well be context-specific. If this is the
case, then the theories may well be mischaracterising
the nature of adult thought, and misrepresenting the
means by which increased access is made possible.

The theories are also silent on the issue of novel

behaviours. Although Fodor and Rozin seem to allow the new routines may emerge, they do not explain how they emerge, nor how frequently behaviours enter the repertoire in this manner. It is not clear where Donaldson or Vygotsky stand on this issue.

The theory of memory development proposed here would seem to have some advantages over the these theories. Although it is yet not possible to specify exactly the constraints on early memory skills, it is argued that strategies emerge from overlearnt routines in the child's everyday activities, and a mechanism is provided by which these routines come to serve memory goals. There is also evidence from other areas of cognition that a mechanism such as social feedback can bring about change. (Doise et al, 1975; McShane, 1979; 1980; McShane and Whittaker, in press; Russell, 1982). The notion that early strategies are routines developed elsewhere in the cognitive system and are initially evoked in an involuntary manner has also been suggested by Lange (1978), Paris (1978a) and Brown and De Loache (1978), but none of these accounts suggest the mechanism by which involuntary behaviours come to serve memory functions.

7.4 Memory and the Environment

Ecology and Research in Memory I wish finally to point out the ways in which our present models of memory fail to take into account the influence of the environment. I shall not discuss recent ecological theories of development

(e.g. Wilcox and Katz, 1981), for as they are formulated
they are not much different from the more traditional
cognitive approach (McShane and Whittaker, 1982). I
shall firstly discuss differences between the types
of memory problems people encounter in everyday life,
and the sorts of remembering they have been asked to
carry out in laboratory studies. I shall then illustrate
                                            in
the more immediate influence of the environment/inducing
memory related behaviours, and in modifying the use of
such behaviours.

The types of problems which occur in the natural environ-
ment seem very different from those we study in the
laboratory.. In the early 70's there were a number of
attacks on the ecological validity of memory experiments
(e.g. Jenkins, 1974) but these largely resulted in
researchers modifying the stimuli they used. Thus, instead
of having subjects remember word lists, the task was
changed to remembering stories or taxonomically organ-
ised lists. There are a number of ways in which such
studies still do not approximate to everyday life.
Firstly the task demands, in particular the need for
verbatim recall, do not model the demands of the natural
environment. In addition, when faced with demands such
as those of the laboratory task, most subjects would
naturally respond by producing strategies, which avoid
verbatim remembering. One such strategy might be to
use external aids, such as note-taking or writing down
verbatim or tape-recording the story. We do not attempt

complex internal mnemonics when attempting to remember
what to buy at the shops, we simply sit down and write
a list. In addition there are a number of conventional
memory aids available which avoid the necessity of
remembering, such as books or computer files.

All this suggests that the goals of memory, and the means
available for achieving those goals may be radically
different in laboratory and naturalistic situations.
Given recent statements about the context-specificity
of memory skills, it is difficult to see what laboratory
studies can tell us about remembering in natural
contexts. It has been argued, in defence of laboratory
studies, that they tap the same sort of skills as the
school situation demands. Standard examinations such
as 'O' and 'A' levels do require the production of
large amounts of information in the absence of
memory aids, such as notes or books. However the
situation differs from the laboratory in that verbatim
reproduction of information is not demanded, nor did
learning all take place 'in the head'. In everyday
life, the encoding skills we most often require are the
skills of organising information in external storage
systems in such a way that it can be easily accessed,
e.g. by setting up filing systems, by taking notes, by
photo-copying, or writing diary entries. The retrieval
skills are those of accessing the desired information
from these external sources. Access and storage do
require cognitive processes, but they are of a different
order from those described in traditional memory

studies.

Ecology also has profound influences on young children's memory development. Thus while they will have to remember certain things e.g. their way around their immediate environment, few memory demands are placed upon them, because other people do all their remembering for them. Thus, they will seldom be asked to find their way around novel environments, because they will generally be accompanied by adults.. If they lose anything (toys, books, clothes) the chances are that an adult will be available to find the lost object. Thus, when Kreutzer et al (1975) asked 5-year-olds how they would remember a friend's birthday party, the majority of those who suggested a strategy said they would ask someone else to remind them.

What then is the status of the present set of experiments in the light of such criticism? The experiments do appear to be naturalistic in a number of ways. Firstly, they involve the consultation of external information sources (pictures monitoring and array cues). In addition, an adult provides some structuring of activity, by suggesting particular actions, or by providing feedback. The activities the child is asked to carry out are in most cases familiar ones, e.g. remembering stories, being asked questions about stories, and there were no demands for verbatim recall.

Models of memory and the environment

In addition to the environment influencing the types of problems we select for study, it is important that it is incorporated as a variable in any theory of memory.

Environment as stimulus

It has already been argued that task instructions, the materials and the amount of prompting are all factors in the stimulus environment which influence the accessing of a routine.   Any predictive account of memory must incorporate their interaction, and also allow for the fact that these influences of the different stimulus components may change with age.[18]

Environment as mechanism for change

Finally Experiments VIII and IX suggest that the feedback which the environment provides may be crucial in structuring the area of application of a particular routine. However, we have not established that this mechanism is actually in operation in the natural environment, although it seems likely that such feedback will be provided in the school setting. In order to assess the importance of this factor, we must study the environment of the child to establish if and when such reinforcement

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[18] E.g. Donaldson (1978) has argued that the influence of the language component of tasks may change with age.

is provided.

Environment as the basis of strategies

Experiments X and XI suggest that the origins of some strategies may lie in routines from the child's everyday activities. An alternative way in which strategies may have their origins in the environment is by teaching.

The environment may also provide strategies by its influence at a level deeper than the child's everyday activities.. The use of taxonomic organisation in remembering word lists can be seen as the application of category knowledge to the domain of memory.. However, it has been argued, e.g. Rosch (1977) that categorical organisation has its origins in the structure of the environment. A similar argument has been advanced for both scripts and story grammars (e.g. Mandler, 1979).

Finally, the environment itself may provide search strategies for children, for example, by children asking adults to find objects for them. Perhaps one of the best examples of the role of the environment in affording information to the young child emerged during one of the cueing experiments:

> Policeman (to child): "Who's hiding in this house, then?"
>
> Child: "I don't know, let's ask the pig, shall we?"

TABLE 1: Distribution of scores on the first trial

	Number of children obtaining score of:				
Age	0	1	2	3	4
3;0 - 3;9	3	4	3	4	0
3;10 - 4;6	4	5	6	2	5
4;7 - 5;2	0	1	6	4	4

TABLE 2: Distribution of scores on second trial

	Number of children obtaining score of:				
Age	0	1	2	3	4
3;0 - 3;9	3	7	2	2	0
3;10 - 4;6	6	5	3	4	4
4;7 - 5;2	1	4	6	2	2

TABLE 3: Number of children making use of monitoring
cues

	Number of children		
Age	Neither trial	One trial	Both trials
3;0 - 3;9	2	8	6
3;10 - 4;6	4	5	15
4;7 - 5;3	4	7	16

TABLE 4: Number of children making use of array cues

	Number of Children		
Age	Neither trial	One trial	Both trials
3;0 - 3;9	2	8	6
3;10 - 4;6	4	5	15
4;7 - 5;3	4	7	16

TABLE 5: Percentage of correct responses at each serial position

		Serial Position			
Age	Experimental Condition	1	2	3	4
3;0 - 3;9	Cues	38	25	47	72
	No Cues	36	17	25	20
3;10 - 4;6	Cues	44	46	60	97
	No Cues	37	39	30	39
4;7 - 5;3	Cues	41	44	56	100
	No Cues	55	50	38	48

TABLE 6: Number of children using monitoring cues

	Number of children		
Age	Neither trial	One trial	Both trials
3;0 - 3;9	2	2	5
3;10 - 4;6	1	1	12
4;7 - 5;3	0	1	11

TABLE 7: Number of children using array cues

	Number of children		
Age	Neither trial	One trial	Both trials
3;0 - 3;9	4	3	2
3;10 - 4;6	3	2	4
4;7 - 5;3	6	5	4

TABLE 8: Percentage of correct responses at each serial position

	Cue	Serial Position			
Age	Type	1	2	3	4
3;0 - 3;9	Monitoring	56	33	50	67
	Array	34	28	44	56
3;10 - 4;6	Monitoring	39	57	60	93
	Array	28	39	28	39
4;7 - 5-3	Monitoring	47	43	62	98
	Array	47	43	40	33

TABLE 9: Percentage of correct responses at each serial position as a function of cue type

	Serial Position			
Cue Type	1	2	3	4
No Cues	43	35	31	35
Array Cues	38	37	37	42
Monitoring Cues	41	38	54	90
Monitoring and Array Cues	44	47	56	82

TABLE 10: Summary table for analysis of variance

Source	DF1/	DF2	F	P Value	Mean Square	Sum of Sq
MA	3/	184	12.3729	0.0000	0.0003	26.6409
GP	2/	184	4.4217	0.0133	3.1735	6.3471
MA GP	6/	184	1.4200	0.2090	1.0192	6.1149
SE	3/	552	18.7361	0.0000	7.6340	22.9043
MA SE	9/	552	6.3113	0.0000	2.5710	23.1461
GP SE	6/	552	1.8047	0.0960	0.7354	4.4125
MA GP SE	18/	552	0.7372	0.7734	0.3004	5.4071
MA GP SS	184				0.7177	132.0605
MA GP SS SE	552				0.4075	224.9345

Key

MA are the four cue conditions

GP are the three groups

SE are the four serial positions

SS are the 196 subjects

TABLE 11: Percentage of children making inferences and
giving justifications

	Percentage giving:	
Age	Inference only	Inference with justification
3;0 - 3;9	73	50
3;10 - 4;6	93	71
4;7 - 5;3	100	91

TABLE 12: The relationship between children's assessments
of memory performance and their actual memory
performance

| | Percent correct | |
Age	Mean assessments	Mean performance
3;0 - 3;9	85	43
3;10 - 4;6	66	45
4;7 - 5;3	74	50

TABLE 13: Number of children using particular cues
expressed as a function of their post-diction
ability

| | Number of children using | | | |
Post-diction Ability	No Cues	Monitoring Cues	Array Cues	Monitoring & Array Cues
Accurate	1	20	3	12
Inaccurate	5	5	1	8

TABLE 14: The relationship between children's assessments
of their memory performance under various cuing
conditions and their actual level of performance

Age		No Cues	Monitoring Cues	Array Cues
3;0 - 3;9	Assessment	88	90	86
	Performance	37	53	40
3;10 - 4;6	Assessment	71	81	73
	Performance	48	63	33
4;7 - 5;3	Assessment	62	72	60
	Performance	35	60	36

Percent Correct

TABLE 15: Number of children maintaining a cuing strategy
as a function of its perceived effectiveness

	Improvement	No change	Deterioration
Maintenance	15	2	10
No maintenance	4	0	0

Perceived effectiveness

TABLE 16: The mean number of pictures correctly recalled
on Blocks 1 and 2 by the different groups

Experimental Group	Block 1	Block 2
Producers	9.61	9.55
Non-producers-feedback	8.70	9.30
Non-producers-no-feedback	8.88	8.41

Mean number correct

TABLE 17: Percentage of correct responses on the no-
strategy pretrials, for the 7- and 3-item groups

	Number of items	
Age	Seven	Three
3;0 - 3;9	23	52
3;10 - 4;6	25	72
4;7 - 5;3	42	82

TABLE 18: Number of children requiring explicit prompts
to induce the strategy on pretrials after
training

	Number of children	
Age	Prompt	No Prompt
3;0 - 3;9	7	13
3;10 - 4;6	4	16
4;7 - 5;3	2	18

TABLE 19: Number of cues used by children in the 7- and
3-item groups, on the near transfer task when
no prompts were given

	Mean number of cues	
Age	7 items	3 items
3;0 - 3;9	3.22	1.51
3;10 - 4;6	4.63	3.96
4;7 - 5;3	4.82	3.52

TABLE 20: Number of prompts required to induce strategy
use on prompted near transfer task

Age	Mean number of prompts	
	7 items	3 items
3;0 - 3;9	1.58	2.24
3;10 - 4;6	0.38	1.23
4;7 - 5;3	0.10	0.75

TABLE 21: Mean number of prompts required to elicit
strategy use in far transfer tasks

Age	Mean number of prompts	
	7 items	3 items
3;0 - 3;9	3.90	3.61
3;10 - 4;6	3.92	4.11
4;7 - 5;3	4.03	4.02

TABLE 22: Mean number of correct responses on far
transfer questions

Age	Mean number correct	
	7 items	3 items
3;0 - 3;9	0.91	0.82
3;10 - 4;6	0.54	1.08
4;7 - 5;3	1.54	1.14

TABLE 23: Mean number of cues used and prompts required
to induce use of strategy in the near transfer
task

	Mean Number	
	Cues Used	Prompts Required
No evaluative information	2.02	2.08
Evaluative information	4.40	0.92

TABLE 24: Number of correct responses given to memory
questions

	Condition	
Age	Pictures	No Pictures
3;0 - 3;9	5.34	3.00
3;10 - 4;6	5.58	3.92
4;7 - 5;3	9.07	6.81

TABLE 25: Mean time children spend studying the pictures

Age	Looking Time (seconds)
3;0 - 3;9	23.52
3;10 - 4;6	20.14
4;7 - 5;3	22.02

TABLE 26: Percentage of children correctly answering each type of monitoring question

	Question type		
Age	Prediction	Post-diction	Comprehension
3;0 - 3;9	50	50	33
3;10 - 4;6	42	50	33
4;7 - 5;3	92	67	67

TABLE 27: Mean prompt score required to induce picture consultation[a]

Age	Number of Prompts
3;0 - 3;9	6.00
3;10 - 4;6	7.12
4;7 - 5;3	5.46

a Maximum number of possible prompts is 48.

TABLE 28 : Mean number of prompts required to direct the strategy

	Question Order	
Age	Serial	Random
3;0 - 3;9	3.82	4.35
3;10 - 4;6	2.43	4.07
4;7 - 5;3	1.67	2.01

TABLE 29: Mean number of cards searched

	Question Order	
Age	Serial	Random
3;0 - 3;9	9.96	11.64
3;10 - 4;6	9.85	12.06
4;7 - 5;3	7.12	9.81

TABLE 30: Frequency of direct searches

Mean Age	Question Type	Number of direct searches					
		0	1	2	3	4	5
3;5	Serial	1	1	4	3	2	1
	Random	2	4	3	3	0	0
4;2	Serial	1	1	2	0	7	1
	Random	1	5	4	2	0	0
4;10	Serial	0	2	0	0	6	4
	Random	2	2	6	2	0	0

APPENDIX I Predicted distribution of scores if children

employ an inferential strategy

Number of locations remembered	Number of correct responses	probability
4[a]	4	1.00
3	4	1.00
2	4	0.50
2	3	0.00
2	2	0.50
1	4	0.16
1	3	0.00
1	2	0.50
1	1	0.33
0	4	0.04
0	3	0.00
0	2	0.21
0	1	0.33
0	0	0.42

The actual distribution of scores will depend upon what
the children directly remember, but it is important to
note that strategy should never result in scores of three
items correct.

a Strictly speaking, there is no need to make inferences
when all locations can be remembed by direct memory.

APPENDIX II   Stories used in Experiment X

Story A - <u>Mary and Fido</u>

One rainy day, Mary decided to take Fido for a walk - so
she went out and found he was stuck in the door.

'Come out' she said.

'I can't' he said 'I'm stuck'.

So she put a rope round his neck and pulled - but she
couldn't pull him out.

'I know', she said. 'drop your bone'.

So he dropped it and he came straight out, and had a
big drink from his bowl.

<u>Questions</u>

1. At the beginning of the story what did Mary want to do
    with Fido?

    -> Walk.

2. What was the weather like?

    -> Raining.

3. Why couldn't Fido come out?

    -> He was stuck.

4. Where was Fido stuck?

    -> In the door.

5. How did Mary try and get Fido out first of all?

    -> Rope around neck and pulled him.

6. What happened when Mary pulled Fido with the rope?

    -> He still didn't come out.

7. What did Mary tell Fido to do next?

    -> Drop his bone.

8. What happened when Fido dropped his bone?

    -> He came straight out.

9. What did Fido do straight after he came out?

    -> Drank from his bowl.

10. What sort of an animal was Fido?

    -> A dog.

Story B - Jenny and her Mother

Jenny had just finished her cornflakes when her Mummy
called out,

    'Hurry up, or you'll be late. It's nearly nine o'clock.'

    Jenny rushed round. She looked under the table but
she couldn't find what she was looking for.

    Then her Mummy came in.

    'I've found them', she said 'Your schoolbag is under
your coat and your ball's behind you.'

Questions

1. At the beginning of the story, what had Jenny just
    finished doing?

    -> Eating cornflakes.

2. What did Jenny's Mummy shout at the beginning of the story?

    -> You're late, it's nearly 9 o'clock.

3.   What did Jenny do after her Mummy shouted she would
     be late?

     -> Rushed round looking for her things.

4.& 5. What was Jenny looking for?

     -> Ball and Schoolbag.

6.   Where did Jenny look for the ball and schoolbag?

     -> Under the table.

7.   Who found the ball and the schoolbag?

     -> Her Mummy.

8.& 9. Where were the ball and schoolbag?

     -> Behind her, under her coat.

10. Where was Jenny going?

     -> School.

APPENDIX III   Stories used in Experiment XI

Story A - George the Owl has an Idea

George the Owl was always having clever ideas. One night
he was in bed when he realised exactly why people have
legs. "People have legs so they can walk" he thought to
himself. Now George thought this idea was very important.
He thought he ought to tell all the animals. He decided
he would make a speech in the market square to say why
people have legs. Soon everyone heard that George would
make a speech. Lucy the Lamb went to see Percy who was
standing on the green fence. "George is going to make
a speech" said Lucy the Lamb to Percy. "He's going to
tell us why people have legs." The animals agreed that
George would make his speech in the market square.
George went to see the square but it was very dirty. "What
can I do?", he said to Mandy the Mouse. "I can't speak
in a dirty square." "I'll clean it up!" said Mandy the
Mouse. So Mandy cleaned the market square. At last, the
day of George's speech arrived. Everyone came to the
market square. George stood up and they were all quiet
as he began to speak. He began to tell them about why
people have legs. Some of the animals were so interested
in what George had to say that they wrote it all down.
Others just sat and listened. At last George explained
why people have legs. "It's so that they can walk", he

said. Some of the animals laughed when they heard this. "Isn't George funny?" they said to each other "he makes a big speech about something we already know. We already know that people have legs so they can walk."

When George finished his speech he said "Now I've brought drinks for everyone". So everyone went and had a drink except for George who was thinking up his next brilliant idea.

Questions

1. Lucy the Lamb heard about George's idea. She went and talked to Percy about it. What sort of an animal was Percy?

2. Mandy the Mouse offered to clean the market square because it was dirty. What colour was Mandy's jumper?

3. George stood up in the market square and made his speech. What did he hold in his hand when he made the speech?

4. Some of the animals were very interested in what George had to say. Some of them wrote it all down. Which animals wrote down everything George said?

5. After George's speech everyone had something to drink. What did all the animals have to drink?

Story B - Mick the Duck has an Adventure

Mick was a big white duck who lived on a farm. Mick was
happy on the farm until one day he heard about the magic
stone. He was talking to Rufus the Dog. Rufus told
him about the magic stone which would grant you any wish
you wanted. Mick was very excited. "I'm going to find
the magic stone so I can have all the things I want" he
said to Rufus the Dog. So Mick began his search for the
magic stone. First he went to the big tree. "Have you
seen the magic stone?" he said to the animals who lived
in the big tree. "No, we haven't", they said, "but we'll
tell you if we see it.". Next he decided to swim up
the river to the little village, to look for the stone.
He got to the village and an old lady threw him a crust
of bread. "Have you seen the magic stone?" he asked
the old lady, but she hadn't seen it either. "Bye, bye,
old lady", said Mick. Mick swam past the village but
round the corner there were five nasty ducks. "Go away"
they quacked, "this is our river. You don't belong here!"
cried these nasty ducks. So Mick had to turn back
because he didn't belong on that river. By now, Mick was
very tired with swimming, so he got out of the river to
walk. But he hadn't walked more than ten waddles when
he saw a big black thing in his way. He tried to squeeze
past it, but it was no use. The big black thing jumped
and grabbed him by the neck. Just then Rufus the Dog
arrived. Rufus was very cross. "Put Mick down" he
barked fiercely. Rufus took Mick home and Mick never

left home again to look for the magic stone.

Questions

1. Where were Rufus and Mick standing when Rufus the dog told Mick about the magic stone?

2. Mick the Duck went to the big tree to talk to the animals who lived there. Which animals lived in the big tree?

3. An old lady threw Mick a crust of bread to eat. What was the old lady carrying on her arm?

4. Mick got chased by some nasty ducks. What colour were the nasty ducks, who told Mick he didn't belong in the river?

5. Mick got out of the river to walk because he was tired, but a big black thing blocked his way. What was the big black thing?

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APPENDIX IV   Pictures used in Experiments

X and XI

Experiment X

a.   Mary and Fido

b.   Jenny and her mother

Experiment XI

c-e   Mick the Duck has an adventure

f-h   Ernest the Owl has an idea

(a)

SMACK

1.

2.

4.

(d)

5.

370

6.

(e)

(f)

(g)

(5)

6
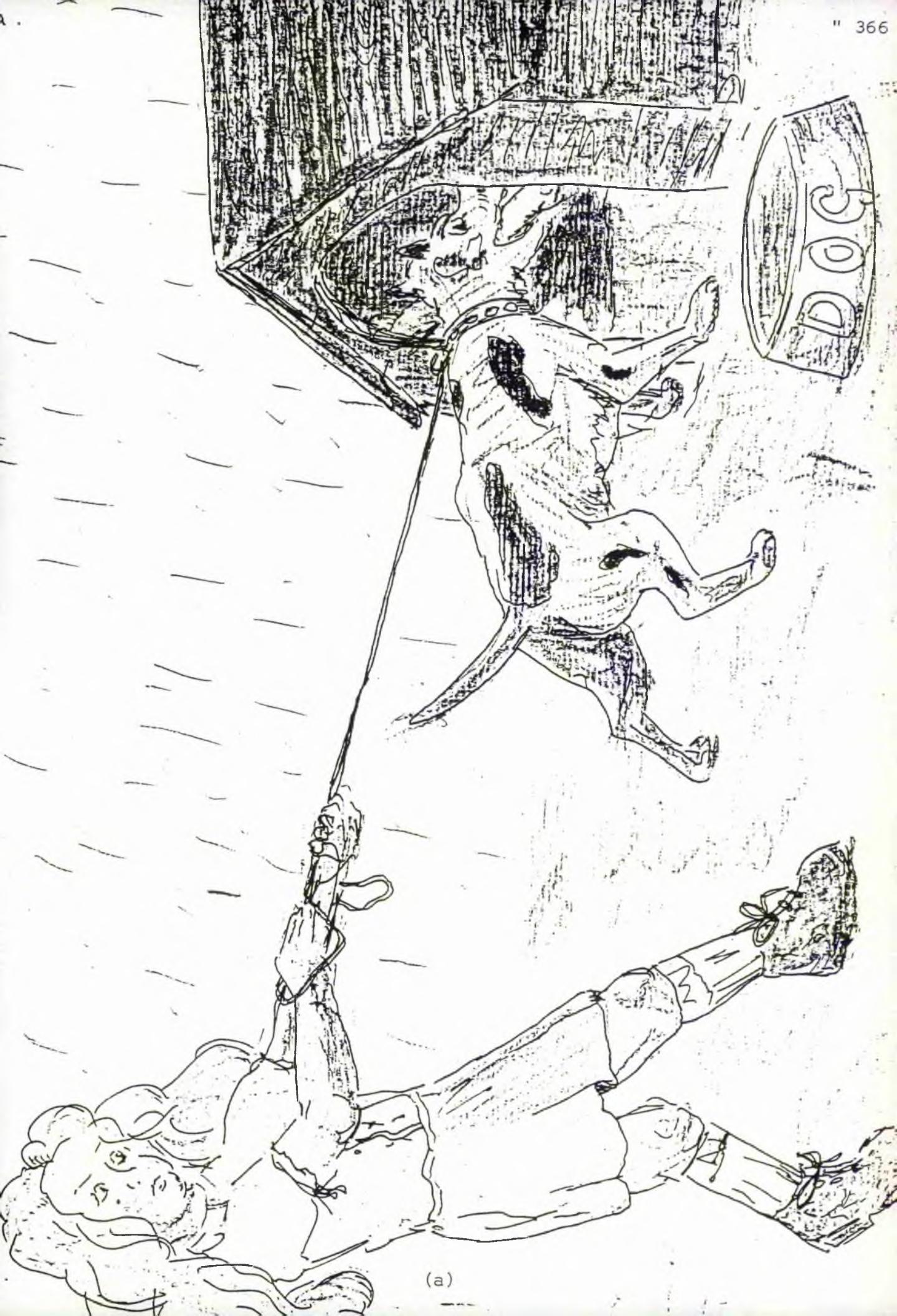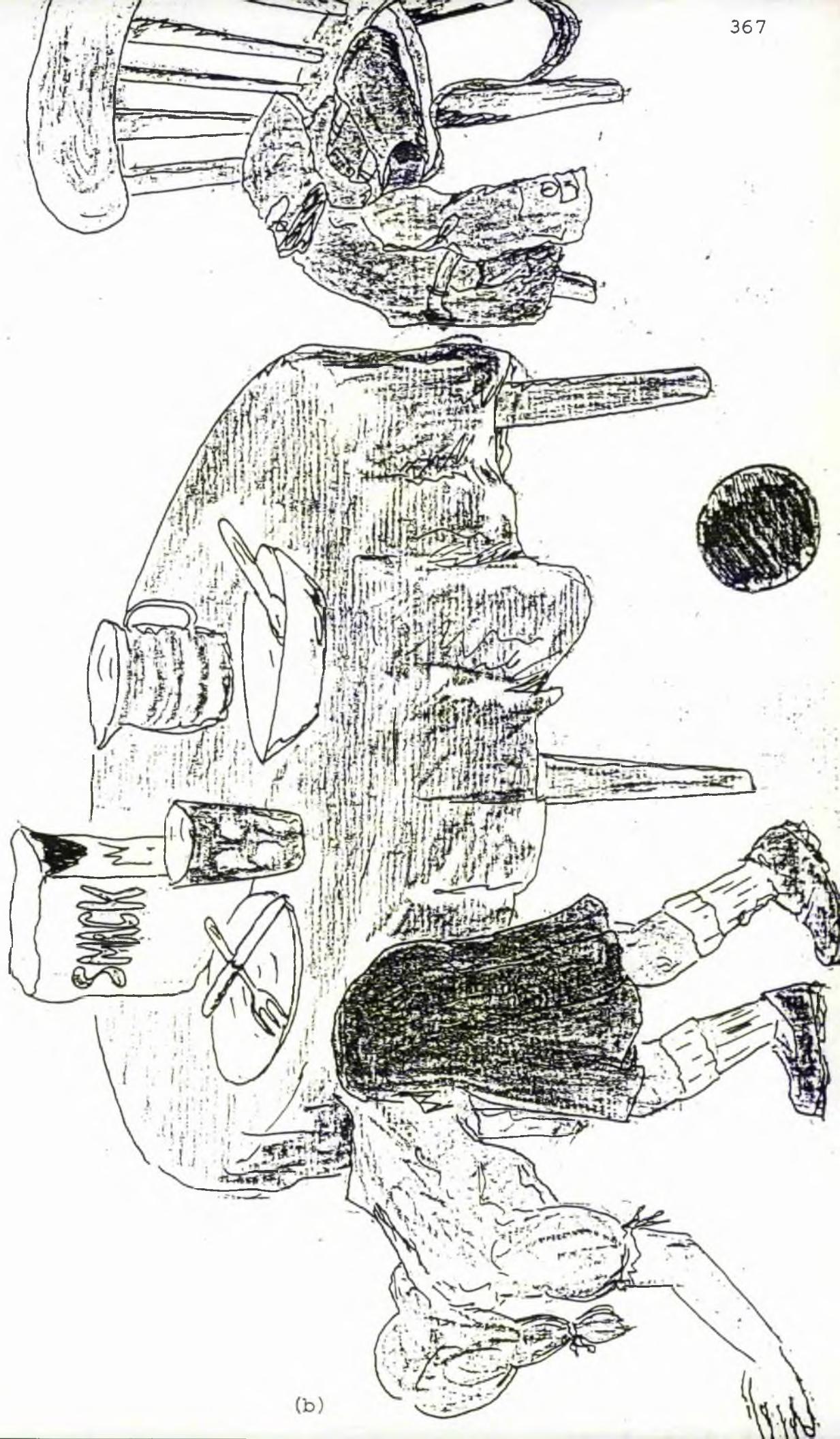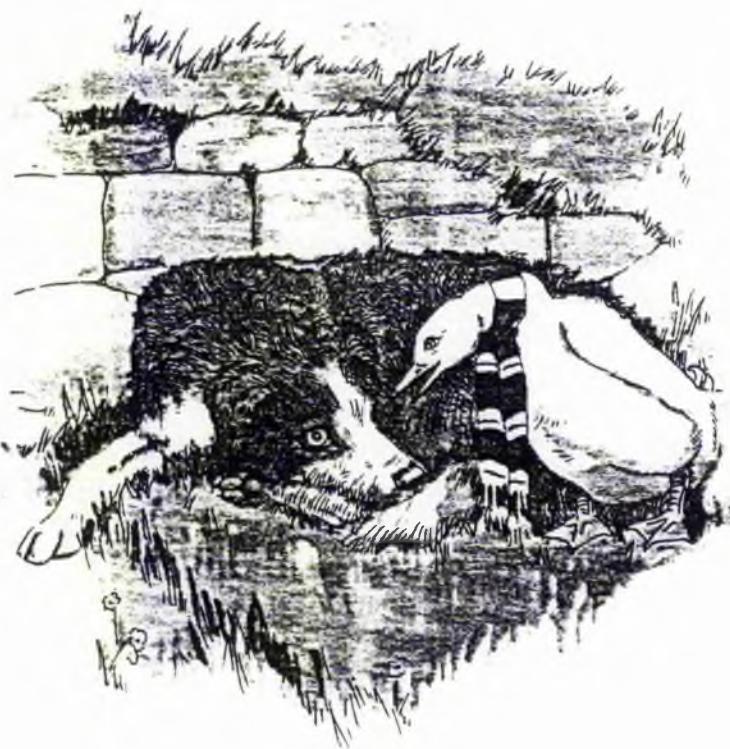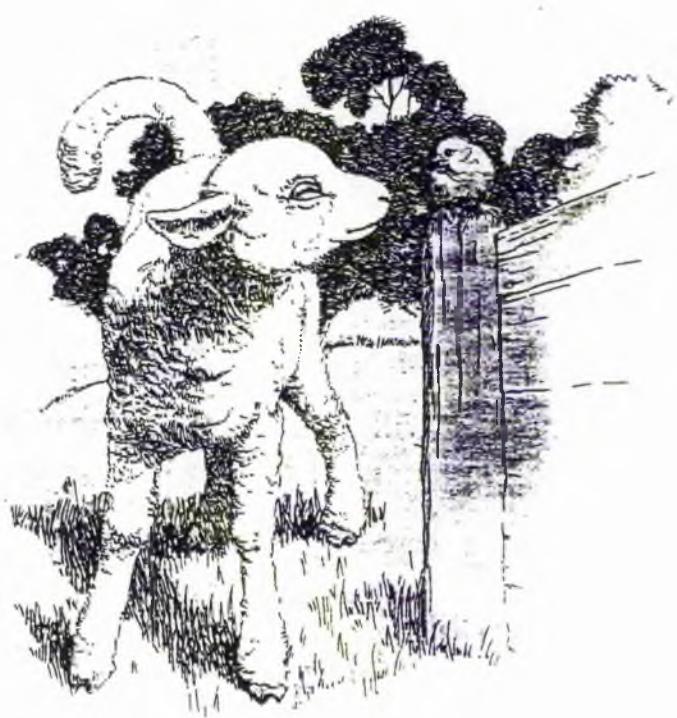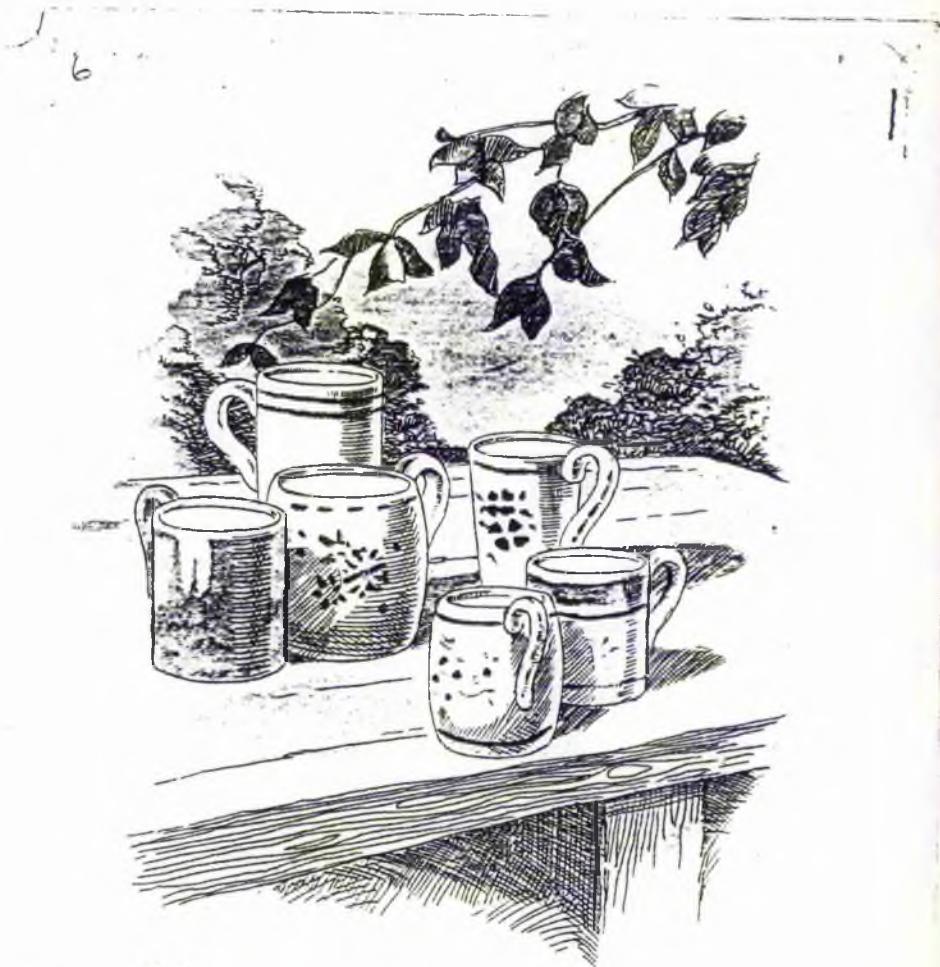
(h)

APPENDIX V   Experimental Apparatus

Fig.1   Apparatus for Experiments I-VI

Fig. 2, Fig.3   Apparatus for Experiments VIII & IX

CHILD
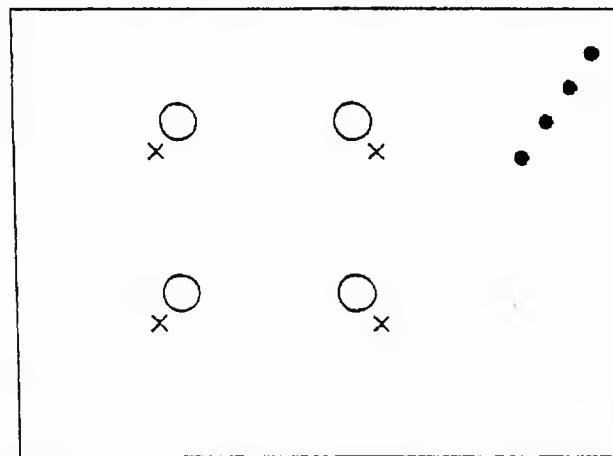
EXPERIMENTER

○ Locations of four cups
× Position of monitoring cues
● Position of array cues

Fig. 1.

Fig.2.

Child

Experimenter

Fig.3.

Q$_1$

Q$_2$

Q$_3$

Q$_4$
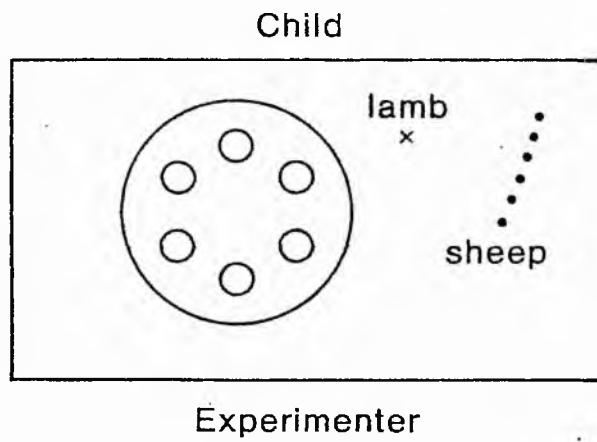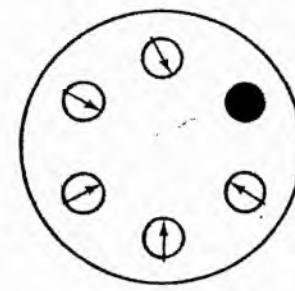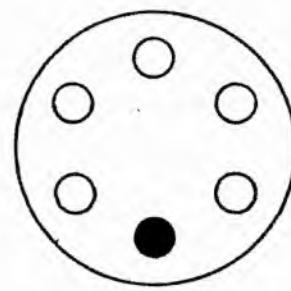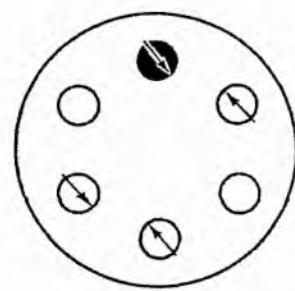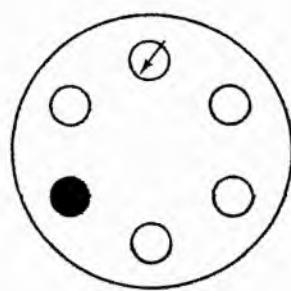
● Baited cup   → Direction of sheep