Introduction

Categories and concepts – basic building blocks of knowledge and hence a central part of cognition.

To recognise something as a 'thing' that has been experienced before two basic cognitive processes have been involved.

i) The storage of some sort of memory/experience

ii) The comparison of a later experience with the original memory and registering their similarity

In other words, we maintain an internal, mental structure that maps to a corresponding external structure in the outside world. It gives humans a real advantage in being able to recognise new things as class members of previous experiences, allowing rapid, appropriate and effective responses to them. At the heart of our psychological make-up; life would be impossible if everything had to be worked out from scratch each time we encountered something.

Animals – reaction to possible predators is a genetically programmed form of category. Humans are more complex, therefore also need to be able to generate new classes and corresponding behaviour – 'how is this mental structure achieved?' is a key developmental question.

Definitions:

Mandler – category covers two distinct ideas:

Perceptual categorisation – e.g. objects like doors have visible features – colour, texture, shape …

Conceptual categorisation – e.g. what a door 'is' – keeps out the cold, opens and shuts, keeps things safe

Concepts are human-generated, bound to our culture – e.g. door handle vs rope handle – we can identify a rope handle even though it's not perceptually like a door handle.

Book 3 Chapter 1 – Early Category Representations and Concepts

Do 3 & 4 month old infants categorise?

Specialised techniques used to investigate, as infants can't speak! Lab techniques reduce stimuli to simple forms – e.g. dot patterns, b&w photographs; stimuli presentation is standardised; allows responses from multiple infants to be studied.

Familiarisation / Novelty Preference method shows 3&4 month olds can categorise and do so in similar ways to adults; confirmed across many different stimuli types.

Fantz – infants prefer to look at novel things. Shown by familiarising infants to a picture; then shown alongside a novel stimulus; the novel one is preferred.

Can do this with categories of objects – e.g. cats vs dogs.

Method can be criticised – perhaps one set of stimuli is more interesting (eliminate by using a control group); may not be easy for infants to distinguish between cats and dogs – perhaps a dog is seen as a novel form of cat – i.e. cats and dogs not perceived as being separate categories. Can check for this by just showing different cats and checking the infant's responses.

<u>How categories are formed</u>

Younger & Gottlieb – dot pattern experiment with 108 infants aged 3,5 & 7 months. Familiarisation with 'good', 'intermediate' and 'poor' forms of dot patterns. Test pair shown including a prototype (undistorted) form of dots just shown alongside a prototype of another form. Results show that for all forms and all age groups (except 3 m.o. with the intermediate form) all prefer the novel prototype. Better than chance for 'good' for for 3 m.o.; 'good' and intermediate' for 5 m.o. and in all cases for 7 m.o. The older the infant, the better they were at extracting the prototype from the distorted exemplars.

The implication is that infants form category representations from distorted prototypes and then treat the undistorted prototype as being familiar.

<u>How categories are stored in memory</u>

Two possibilities – every single exemplar is stored (exemplar memory); or prototype abstraction occurs – i.e. an average of all the exemplars of a category.

Younger & Gottlieb – as the previous dot pattern experiment, but this time a previously seen distorted exemplar presented alongside the prototype of the familiar category. If storing an average of exemplars, the average should look most like the undistorted prototype – therefore, the already seen exemplar should be of more interest if prototype abstraction is occurring; or less so if exemplar memory is being used.

Results inconclusive – both types of memory seem to be used; it depends on the experimental conditions as to which sort is favoured – e.g. if there is no delay between familiarisation and test exemplar memory is used; if there is a delay, prototype abstraction used – same results as adults => young infants have sophisticated categorisation abilities.

Quinn and Eimas used richer stimuli – cats as familiarisation; preference shown for birds, dogs, horses, tigers. Horses shown as familiarisation; cats, giraffes and zebras elicit novelty preference.

<u>How infants organise their categories</u>

Adults understand hierarchical category structures –

e.g. Furniture = global/superordinate category
Chair = basic/intermediate category
Garden chair = specific/subordinate category

Behl-Chadha - experiment to see if infants could categorise furniture. 3&4 m.o. shown 12 realistic pictures of different types of chair. The shown chairs alongside non-chairs - preference shown for non-chairs. Same results with couches - good evidence that infants understand within the 'furniture' superordinate category that basic categories such as chairs and couches exist.

Behl-Chadha - similar findings for animals and mammal / non-mammalian animals.

Taken together, provides strong evidence that nested categories can be formed by infants as in adults - and evidence they can form categories on the basis of experience - e.g. furniture - as this couldn't have been provided by evolution.

<u>How infants categorise spatial relations</u>

Quinn - dot in different positions above a horizontal bar. Novelty preference shown for a dot below a horizontal bar when paired with one of the familiarisation stimuli of dot above.

Provides evidence that infants have the basic cognitive capabilities to form complex representations of the physical world - e.g. under/above. They have this ability before they learn to speak.

The information used to form cat. representations

<u>Cues</u>

A signal that initiates a sequence of behaviours or response. Any sensory modality - vision, sound, touch etc.

Experiments have looked at what cues are present when a category is formed; and what happens when the cues are absent - for example, dogs vs cats.

Quinn and Eimas - hybrid animals experiment showed infants focus on just a subset of cues - e.g. the head of dogs or cats is a more important cue than the body.

<u>Cues in the natural environment</u>

Real animals are 3D and they move around - therefore static 2D experiments can be criticised methodologically.

Mandler et al – Sequential touching procedure - 14m.o. infants presented with a category contrasted selection of toys – e.g. four with wheels, four with legs and the serial order in which the child touches the toys is recorded – categorisation inferred if they touch a majority of objects from one category before another.

Butterworth used this - found 14-22 month old children could categorise animals from vehicles. When legs removed from animal toys, no categorisation took place. Supports the idea infants use specific features to make contrasts between global categories of objects.

Arterberry & Bornstein reported 3,6 and 9 m.o. could categorise on <u>movement</u> of animals vs vehicles when shown light point displays of the exemplars.

How Infant categories develop into mature concepts

Clear evidence is that infants do have the capability to categorise objects. Two competing theories as to how initial categories develop into 'concepts'.

<u>Single Process Model</u>

Category representations develop gradually as they are able to include more information – "quantitative enrichment" (e.g. **Quinn and Eimas, Madole and Oakes**).

So the global category "animal" develops in sophistication as more animals are encountered over time. For a basic category such as "horse", a perceptual category representation is built first, supplemented by more abstract information ("eats hay", "carries loads") later.

In this model, language serves as an additional perceptual input that enriches the category definitions. Language is eventually used to describe the categories - e.g. "all birds lay eggs". **Quinn & Eimas** describe this process of enrichment as a perceptual learning model.

Support is also provided through connectionist computer models to some extent - category representations can be formed on perceptual feature or arbitrary labels.

<u>Dual Process Model</u>

Mandler argues that early in development, infants start to use an approach to categorisation based on more abstract attributes - "seeing is not the same as thinking".

Category representations based on perceptual features are simply <u>*perceptual schemas*</u> - they don't hold the meaning of something.

Mandler argues a second process that is distinct from the formation of perceptual schemas operates. This process analyses features and links them to changing information - e.g. motion, sound, function. This leads to the formation of <u>*image schemas*</u>, which preceed the creation of mature concepts. For example, they contain information on if an object is a 'self-starter' - an attribute that has to be inferred as they can't be directly seen.

Karmiloff-Smith introduces a concept known as 'representational re-description'.

Knowledge moves from being implicit & procedural to explicit and 'though/talked about'. Children gain new abilities as initially something they can <u>do</u> without being able to reflect on it, which when practised and applied becomes an 'object of thought' - a different form of mental representation - declarative knowledge. Knowing → Understanding

Experimental evidence has not yet conclusively determined which model (or if both) are correct.

How different levels of categories emerge

Levels of representation

Studies have attempted to answer the question if categories are acquired global -> basic -> specific or the other way round. Techniques such as *sequential touching* and *object examination* have been used to attempt to answer this question. On balance, the weight of evidence is that 'global -> basic -> specific' is the most likely route. (**Mandler, Quinn** etc…)

[Object examination: Used for studying category representation in 6m.o.+. Relies on the idea that infants lose interest in objects of the same category. Gove object to infant, allow exam for a fixed period. Repeat with members of same category. Introduce novel exemplar from a novel category, measure the amount of active examination that then takes place. If it is greater, can conclude categorisation is taking place (subject to usual controls).]

Single process explanation of this is given by **Quinn** and others - infants learn global categories first, differentiate to basic level. Observation supported by connectionist computer models.

Spatial relations

Adaption by **Quinn et al** of the above/below line experiment - using four different shapes above line in the familiarisation phase. If a fifth symbol is shown above and below the line in the test, then 3&4m.o. infants divide attention equally => they don't have an abstract category representation of 'above' and 'below' at this age. (**Deloache et al** have shown this categorisation is done by children > 2½ y.o. by other means). Follow up by **Quinn et al** showed 6-7m.o. infants did prefer the novel spatial relation. Supports the idea that initial category representations of spatial relationships are tied to the object; but become independent of object as development occurs.

Tim Holyoake 2009, http://www.tenpencepiece.net/

Developmental trend towards abstraction

Seen in both object and spatial categorisation systems.

Objects - early categorisation on perceptual, then more abstract knowledge; Spatial - early categorisation tied to object, then becomes independent.

Categorisation therefore developmentally useful - a basis for future cognitive growth.

Category possession vs category formation

Categorising non-human animals

Category formation may be being formed 'bottom-up' (as an experiment progresses) or 'top-down' (using categories they already possessed). The age of infants is likely to be important in determining which strategy is used - older infants have more prior experience to draw on so may be more able to use a 'top-down' approach.

Quinn at al conducted one study that indicated a novelty preference for a dog over a novel cat in one group, but a second group did not show a preference for a cat over a novel dog. Suggests 'dog' was broad enough to include 'cat'. Subsequent studies suggest this asymmetry only occurred because the dog stimuli were more variable/interesting that the cat stimuli.

Shows that non-human animal categories are flexible and fluid, determined more by experimental conditions than prior experience ('bottom-up' processing is occurring).

Categorising humans

Quinn & Eimas - no novel category preference for cats or horses over humans observed and no spontaneous preference for humans over non-humans. => Infants cannot tell the difference between humans, cats and horses! A very surprising conclusion. However …

Humans and non-human animals

Later experiment showed infants did categorise humans, but it was broad categorisation that included cats, horses and fish, but excluded cars. Therefore it seems that humans are classified differently - maybe by the storing of individual exemplars as opposed to an averaged prototype.

A further experiment showed infants preferred a novel human over a familiar human but not a novel cat over a novel human.

The data supports the idea of exemplar based representation of humans and that the human category includes many other animals; whereas other animal categories exclude humans.

Categorising and early language development

Gopnik & Meltzoff - investigated links between categorisation and language use. Longitudinal study of 12 children every three weeks between 15-20 months. Found a sequence of development occurring when infants given objects from two different categories, that progressed from the infants doing things with the objects that related to their category; through touching all member of one set before examining the other items; to eventually grouping like objects together. Language skills, means-ends test and object permanence also studied.

Significant correlation only between language skills and categorisation ability (weaker correlation between object permanence and language). Lack of correlation between language and other tests indicates there is something specific about the vocabulary spurt and categorisation skills - not just a general increase in cognitive competence.

Children who categorised well were the same children able to use names for objects - a deeper connection between categorisation competence and vocabulary spurt. Causal direction cannot be determined from this experiment.