

SESSION THREE – THE PRACTICAL TEACHING OF 'SORTING'

Preface

Clearly there is much scope for clarification and development of the idea of sorting itself.

As with matching, visual sorting has been used in these papers as the exemplar, very little attention being given to haptic, acoustic or olfactory sorting.

There is also plenty of room for recognising and defining its importance and place in mathematics, language development, etc. and for describing techniques and materials which have already been devised for teaching.

For example – what is the relationship between 'sorting' and 'matching' and at what stage of development do they come to be truly differentiated?

Our object is to create a set of conditions within which the child is exposed to adequate potential experience when in an optimally receptive learning mood.

I have already referred to the means by which we attempt to ensure that the child is not distracted by irrelevant social factors and is free both from social over-demand on his understanding and any reinforcement of his defensive behaviours, whether justified or not.

Within this asocial atmosphere (conditions of minimal handicap) we are required to cause the child to create suitable potential experience and, by concentrating his attention appropriately, to convert some of this potential experience to actual realised and stored experience likely to influence his future behaviours.

Let us assume for practical purposes that every perception is associated with pleasure (whether or not it is also associated with unpleasure) and the more actively the child engages in the perceiving the greater the amount of pleasure experience (whether or not this is associated with bodily movement).

The more effort the child puts into an activity the greater the chances of his learning as a result, for effortful play not only increases the available potential experience but also tends to focus the attention as well as creating a satisfactory emotional climate for learning.

Now if 'retardation' can be thought of as *doing too little, within too narrow a range, with too little variation* and too little *variety of materials*, it is clear that we can satisfy all requirements by promoting *prolonged periods of concentrated effortful activity* covering *wide ranges* of type and in which emphasis is placed on *variation*, form, direction and rhythm, circumstances etc. as well as on *variety* of materials.

In order to impose some order on our discussion of the practical teaching of our chosen area – 'sorting' activities – we shall need to divide up the child's

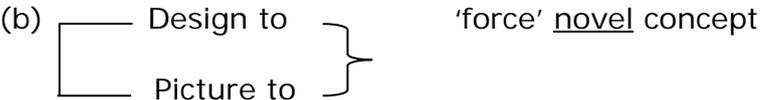
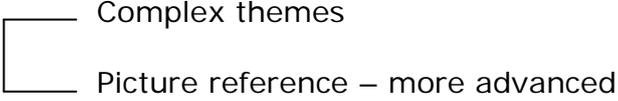
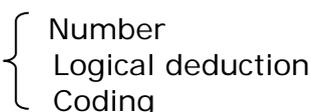
developmental history into a succession of roughly defined stages in which each stage (i.e. from that time on) is characterised by those aspects which are most relevant to sorting. Hence, as one would expect, the early stages are more general, the later ones rather more specialised to the particular learning 'tool'.

The accompanying diagram should help us in this respect. (Fig.1). The divisions are entirely artificial and have no meaning other than that of indicating a sort of chronological order:

'Sorting' activities Figure 1

	0	months
Increasing quantity and refinement of movement Cooperations between limbs Focusing of interest	6	months
Earliest reaching, securing, using and disposing	12	months
Early continuant behaviours	18	months
Rapid gain of experience of materials Recognition of similarities	24	months
Early continuant separating of identicals	27	months
Fairly consistent separation of identicals Early similarity separation	30	months
Fairly consistent separation of easily- distinguishable similarities	33	months
Early separation of graphic patterns	36	months
Early picture references. Early variants, distractions	42	months
Parts, distributions etc. More advanced picture reference	48	months
Immediate change of sorting criteria	60	months
Simultaneous criteria	60+	months
"Intersection"	72	months
"Union"/ "complement"	84	months

'Sorting' activities Figure 2

Period 1	Ignore at this stage – too involved
Period 2	Continuant + Experience
Period 3	Pre-sorting – Early separation leading to competent separation
Period 4	(a) Intro to similarity + 'feeding' (b) Identity with initiating
Period 5	(a) Development of similarity (b) Large number of identities and 'easy' similars with initiation (c) Intro to plain shapes
Period 6	Intro to pictures – graphic design – picture reference
Period 7	(a) Pict vague impression/parts/complements (b)  'force' <u>novel</u> concept (c) Sequence of separations according to shape, size, colour etc.
Period 8	 Complex themes Picture reference – more advanced
Period 9	Analogy
Period 10	Intersection, union, complement \longleftrightarrow  Number Logical deduction Coding

It would take far too long to outline development within the first year of life and so for practical purposes I intend starting at about a fifteen months level by which time the child has normally learned to be able to transfer a small number of small, not too 'interesting', objects one at a time into a nearby vessel. At this time of course the child does nothing even vaguely resembling 'sorting' but he is developing behaviours which are its immediate predecessors, as well as the foundation for it.

From a practical point of view it is (i) the child's capacity for transferring things consecutively from one place to another under any circumstances and (ii) his increasing experience of form, substance, texture, size, weight, colour, etc. (which leads to his recognising increasingly complex patterns) which must be encouraged and exercised by the teacher during this period. Eventually of course it is to be hoped that the 'sorting' tool will become an entirely mental exercise abstracted from the physical distribution of objects or pictures; however in the early stages during the second, and to some extent the third year, the child must learn to master every possible aspect of picking up and deliberate placing of objects and materials so as to be able to relegate this 'carrier phase' of the skill to a low level of consciousness, so releasing most of his attention for scanning the potential 'targets' (that is – 'target' sets) and for decision making. The importance of this groundwork tends to be grossly underestimated by teachers.

Returning to practical teaching: let us assume, so as to simplify the discussion, that the child is seated at a low table of ample proportions, the teacher is behind and slightly to one side. A target receptacle is immediately in front of the child.

Objects are 'fed' (put down) one at a time in front of the child who picks each one up and puts it into the target vessel. The following main variations on this theme are possible:

- 1 Increasing rate of delivery
- 2 Changing nature of objects
- 3 Varying angle and point of delivery relative to the child, including off the table, e.g. floor, chair, etc and (a) nearer or further away (b) at various angles of direction (c) various orientations (d) moving direction of movement
- 4 Changing nature of target, e.g. jar, dish, cup, can, box, etc.
- 5 Varying positions (a), (b), (c), (d), of target (see 3)
- 6 Increase of number of objects delivered
- 7 Larger number of objects in the 'pool', (positions as 3 above), close together or widely spread

Practising in these various ways the child comes to be proficient in *persisting* with relatively large numbers of things over relatively long periods of time, in disposing satisfactorily of elements in the face of obstacles and distractions, and to be able and willing to search his surroundings, both for an object for transferring and for a target vessel. That is to say he becomes 'competent' in transferring objects at the early pre-sorting stage.

Meanwhile the variation in materials used, often in quantities of identical or similar forms (usually supplemented on other occasions, by the introduction of pairs of identical or similar objects [see pre-matching activities] and the use of the 'obstructions' and other continuant and persistence games) will be helping to increase the child's experience and discrimination of appearances, properties and behaviours.

Once the child is fairly proficient in transferring things to a target vessel he may be given practice in using more than one target. This can arise smoothly from the moving of the target as mentioned earlier, so that one of two is removed from the field and replaced by the other in a different spot. Then both can be allowed to remain but separated, the child being directed (by any and all means available) to which target he is to use at any moment. The child's capacity for being always ready and able to be guided (re-directed) to a new target is a useful sign for his teacher in deciding on the introduction of:

Early separation work

Having reached such a state of competence the child may now be exercised in the separation of elements into distinct sets. Two sets are sufficient to begin with, the members of each set being virtually identical and as different in as many respects as possible from those of the other set e.g. red plastic spheres versus green metal cylinders, plain wooden clothes pegs versus metal bottle tops, etc.; however, our introduction to this stage assumes the child's ready and sufficient discrimination of and distinction between such elements so that if separation is the intention there is no room for 'originality' – hence at this stage where we are teaching the 'tool', there are possibilities for correct and erroneous placements (as opposed to real 'allocation-to-sets' where the appropriateness of a placement is entirely a matter of its seeming relatively more or less congruous to the child).

At first the elements may be delivered one at a time in some sort of random order, then several and eventually large numbers may be placed for the child to allocate. Whatever non-social means are necessary are used to ensure (i) fairly random selection of elements (ii) 'correct' placement or allotment, thus 'concentrating' the defining characteristics of the sets and (iii) variation in character and position and orientation of the elements to be separated, in the character and positions of the vessels holding the sets, and therefore in the *direction* and *sense* of allocation. In due course all the variations referred to earlier may be applied.

As the child begins to become fairly consistent in allocating the elements to the correct locations, dishes may be overtly transposed, erroneous placements made but corrected, and a third set added to the system. In due course all the variations outlined earlier may be used singly and in combination, and basic exercise - including increasing the number of sets and the total numbers of elements; imposing a need for some correcting by surreptitiously seeding a few wrongly placed elements; and causing the child to initiate some of the sets by leaving appropriate but empty dishes - should be continued during this phase.

By the time the child can separate a dozen and a half or so elements into three sets of identicals under a variety of differing types of conditions the time is ripe for the introduction of the separation of *similar*s.

At first, as with the separation of identicals, the first elements should be chosen for their close similarity. Then others may be carefully fed to extend the defining characteristics of the sets. For example glass marbles varying in colour and size versus room-door keys may be gradually expanded to include plastic balls and front door and car keys etc.; almonds and peach nuts vs. cockle shells may be extended to include plum and prune 'stones', limpet and certain other sea shells. Soon a third set may be added.

Gradually the child should be able to deal comfortably with large numbers of elements consisting of five or more sets each of identical or closely similar elements. At least when sets of 'identicals' are involved he should be practised in initiating each set and deciding for himself which or even how many receptacles should be used, from an excess.

Caution. Do not confuse teaching with testing. The object is not to determine whether the child *can* make the correct decision or '*knows*' where to put each element but to cause him to *almost* always 'correctly' allot the element *as if* he understood quite independently of whether or not he is fully aware of the appropriateness of his decision.

Object sorting into sets of similar or related elements can be steadily extended so that each of a significant proportion of allocations requires active decision following a moment or measure of uncertainty, by the careful feeding of suitable materials. For example (extending an earlier example) the set of cockle and limpet shells may be extended to include whelks and winkles and thereafter snail shells, and subsequently mussels which have a different texture and colour or to marble or granite having a stoniness or calcareousness in common with the shells. Once heavy stones have been admitted to the set other only distantly related materials, such as an amorphous lump of lead, may be allocated. Or following the 'keys' set, a length of wire, metal springs, wood screws, copper pipe etc. may be admitted, by stages.

As the experience of deliberately allocating in a manner free, as far as the child is aware, from the approval/disapproval and critical appraisal of others is consolidated it becomes less necessary for the teacher to choose the objects or materials so carefully for it is not necessary for the child to explain or defend his decisions and there is no particular end point; however, as has been intimated earlier particular features, qualities, properties etc. may be outlined, indicated or pinpointed by 'causing' a concentration of significant features in contrast with an averaging out of the 'noise', or aspects considered at that time *by the teacher* to be irrelevant. This technique underlies and is the basis of at least some aspects of classification especially when coupled with re-partitioning and 'union' (involving re-separating the same elements but using different set definitions). Subsequently such forms, patterns and relationships brought to the child's attention may be verbally labelled in discussion.

Use of graphic patterns and pictures

In some ways, it will be easiest and most convenient to make use of graphic patterns to illustrate further discussion as the earliest techniques of these can be introduced conveniently at this stage.

As a preliminary exercise cardboard, plastic etc., shapes (e.g. equilateral triangles, squares and circles) in one colour or two colours (i.e. one for each face), may be usefully separated.

As the child becomes more practised other shapes (e.g. pentagon or hexagon and oblong) might be added and in due course variation in size, colour and form can be introduced; however, such changes should initially be introduced one at a time before mixing, with the whole process occupying some months of fundamental experience.



Meanwhile a useful set of constraints in the form of sorting-set trays can be introduced and the original uniform shapes separated on to the squares of these. Then the shapes if suitably sized may be mounted on plain card squares so that the shape must be seen against a plain background. Besides helping to wean the child towards graphic designs, these cards have the advantage of being susceptible to inversion and shuffling which makes the imposition of the rule that the child picks up each element at random and then makes his decision, much more practicable.

As soon as the child is coping with the stuck-on cardboard shapes, gummed paper or drawn figures can be substituted. At first these should be uniformly monochrome, variations in uniformity, shade and colour being introduced slowly as the child's competence increases.

The use of plane figures (e.g. triangle, circle, square, star, cross etc.) with the gradual introduction of variations and distortions allows the child to practise attending to one main characteristic etc. at a time whilst deliberately ignoring or relegating to relative insignificance certain other obvious features. As this capacity for recognising several characteristics simultaneously but attending predominantly to one or other (later to two or more in parallel) matures, the child becomes potentially able to allocate freely – although he usually tends to strike a balance between assiduously following a defined course of action despite distraction and a receptiveness towards supplementary or cross-current or contrary patterns (and readiness to be influenced by these when this seems appropriate).

In general it is often easiest to combine the '*set-expansion*' and '*concentrating*' (averaging-out or pointing up) aspects by seeding the set locations with fairly bald examples (stripped of as much irrelevancy as possible) together with one or two further examples of the property, characteristics, principle etc. as they come from a shuffled pack, so allowing a range of allocations and re-allocations before finally, with or without outside help, the child comes to distribute the limited number of elements according to the pre-set constraints and criteria; however, seeding with only fairly 'way out' examples of the theme can produce the most valuable and enjoyable set expansions.

This applies both to graphic design and picture reference sorting, indeed at first, as might be expected, it may be very difficult to know how the child is handling his materials from this point of view. In the early stages he usually seems to be variously influenced from moment to moment.¹

Early groups of sets that I have found useful, once graphic sorting has been established, combine variants on shapes such as circles, triangles and crosses with human faces drawn in the same monochrome, or consist of sets of patterns, which like the faces of the last group, may be treated as variant designs or common themes or as representative examples of everyday things e.g. fish, cobwebs and clock faces.

Meanwhile pictures deliberately intended to be simple illustrations of everyday objects may be given sufficient geometric form or content or just enough family colour resemblance to cause the child who does not see them as representing objects to still tend to allocate them finally to the appropriate groupings².

As the child's competence increases it becomes possible to deliberately exercise a variety of developing mental operations still without his necessarily being aware of the nature of these. For example, a family of sets may have roundness, rectangle-ness and triangle-ness, as their defining features, but may be represented by isolated circle, square and triangle; or by these embedded in a distracting background; or by segments such as arc, right angle and acute angle from which the whole may be deduced in the imagination; or by pictures of objects having these main forms, such as a wheel, box or bell tent etc. The set may be introduced as the stark principle (from the teacher's point of view) or the examples may be allowed to 'average out' and delineate the underlying principle or common characteristic. Even from this stage additional, relatively straightforward, sets (of e.g. common objects) may be used both to induce feelings of security (related to familiarity and ease of allocation) in the child as well as to confuse the issue at times so as to make allocations which must subsequently be changed, more likely.

In the field of picture reference various kinds of representations ranging from photographic resemblances, through simple line drawings to vaguely reminiscent patterns may be utilised to illustrate fairly simple sets such as mammals versus people versus flowers versus houses, or birds versus wheeled vehicles versus fruit versus fishes, etc. Whilst slightly more complex ideas such as tools versus clothes versus transportation may be introduced using clearly formed pictures at this stage.

¹ In passing it might be noted that among children with delayed development those whose understanding is closely associated with social and verbal skills tend to be relatively speaking more at home with picture reference ideas whilst the more remote, undersocial and verbally vulnerable children find the task easier when the guiding principle is embedded in the image itself. This in no means implies, as is so often assumed, that the remote child is incapable of the sorts of thinking which allow classifications on the strength of say 'birdness' or 'transportation' but simply that many such classifications are arbitrary and conventional and commonly mediated through verbal language which although facilitating such associations does not necessarily promote real understanding of the concept labelled. Furthermore 'sorting' is an excellent way of inducing such concepts in the remote child's thinking, when required.

² With some otherwise fairly advanced remote children, as well as routinely with many more vulnerable ones, it may be necessary to use some technique to ensure that they do perceive pictures as representing objects etc. This may be done by mixed object and graphic sorting.

At this time too, as alluded to earlier, the use of consecutive separations of cardboard or plastic cut-outs according to colour and shape (later, size, thickness and texture) practises the child's capacity for single-minded attending to one set of mutually exclusive properties in the face of others, presently irrelevant but which had been significant during a previous/prior separation³.

In addition to the free association of simple allocation to sets which becomes more and more effective and to which the maturing child can apply his own system of constraints, the mixed game can involve more subtle and abstract criteria.

To summarise

'Partition sorting', to distinguish the kinds of sorting which we have been discussing from 'intersection sorting', which will be briefly referred to directly, consists in the allocation of elements to a limited number of sets - each element being allotted according to its evidencing some feature in common with the other members of the set to which it is allocated, so that in practice it is put where it looks as if it fits best.

The addition (under these conditions) of new elements to a set will either *accentuate* what properties or characteristics are held in common by the members of the set or will *modify the defining characteristics* of the set. As such a change *usually* entails an increase in the range of characteristics subsumed by the set, I usually refer to this as expansion of the set or simply as 'expansion of sets'.

In case one, the teacher may deliberately arrange the materials so as to delineate some particular property, and so for example draw the child's attention to such as, being novel from the child's point of view, cannot be satisfactorily indicated in any other way and, of course, without the aid (or restriction) of language.

Case two is a major way in which the mind can be led to notice relationships between things, materials, patterns, properties, behaviours, etc, and in ever-widening ways.

- Either (1) allocation leads ever onwards extending the mental associations in a virtually unpredictable manner or
- (2) the constitution of certain constraints imposed on the (system of) elements leads to the child's recognising the reason for his eventual choice or form of allocation i.e. he is forced eventually to recognise the defining characteristics of the sets.

³ Of course the child who is allowed to facilitate such an exercise by deliberate verbal labelling such as 'it's a triangle' or 'it's red' will not benefit so much from such an exercise.

His conscious division of the whole 'universe' of available elements into subsets according to the defining characteristics of the component sets is known as classification.

Finally the defining characteristics derived from 'partition-sorting' may be arranged differently so as to provide another extremely valuable group of teaching tools

Communication

The child's very learning to recognise the nature of the task whatever its guise is already an important example of fundamental communication; however, the concentrating and focussing of attention on a characteristic, property, association, relationship or behaviour can be the basis of the injunctive, indicative and predicative functions in communications between individuals. The child's developing capacity for deriving a general principle from a host of examples and his transfer, exploitation and extrapolation from such principles may be exercised conveniently and effectively, in those children who reach a sufficiently advanced stage of 'allocation' and 'concentration' (fifth year onwards approximately), through 'sorting' and its links with other learning 'tools'.

For example the step from 'similarity' to 'analogy' is fairly straightforward: amassing sets of similar elements, or of elements which are similar in some respect or other to the more specialised use of sets of elements which may be thought of as having been treated in some common manner, thus rendering them as analogous, might be pursued to the stage where A is to AX as B is to BX etc. In practice small sets of perhaps four members may be supplemented by simple similarity (analogy) sets.

Meanwhile by arranging the sets in linear fashion and setting them at right angles to one another it is possible to pinpoint the properties common to any two sets (intersection), to illustrate the contents of the two sets combined (union), to indicate those elements which contain characteristics not to be found or do not contain characteristics which are to be found in other members of the combined sets (exclusion), or to show the effects of one property or characteristic, etc. on another under various operational conditions such as addition, subtraction, multiplication and division (complement).

It is easy to see the relationships between these aspects of sorting and the mathematics of sets, as well as that of numerical arithmetic.

GEOFFREY WALDON
1976