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English version of a more reasonable size (1000 words)!

### **Sketch on Piaget (1896-1980)**

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Given the abundant literature on Piaget's life and work (e.g. Montangero, 2001), we concentrate here on crucial aspects of his theory on cognitive development that too often have been misinterpreted.

- Piaget introduced a structuralist and constructivist approach to developmental psychology. His major contribution is to interpret children's behaviour in terms of structures and transformations. Structures are conceived as transformational systems; and transformations as actions modifying the object's positions or its dimensions. For example the numerical invariance of a collection of objects is considered as resulting from the combined effect of transformations such as adding or subtracting objects.
- Piaget states that an action can be physically or mentally produced. Actions that are mentally produced (so-called "internalised actions") are judgements related to actions and their results on the object's positions and/or dimensions. Structures are the co-ordination of a set of object's positions or dimensions and actions (*or as the co-ordination between actions and object's positions or dimensions*)
- Co-ordination may for example entails the relationship or connections between a set of displacements of an object (such as to be put inside, or placed under or behind another one) and its various localisations (to be contained, recovered, hidden); or the co-ordination of a set of transformations of a collection of objects (such as spacing and regrouping) and its numerical invariance (in spite of the variations of its size).
- Finally, at the core of Piaget's theory, there is the idea of the construction of new structures as "*a passing going from a simpler to a more complex structure, in an endless*

*regression*” (Piaget 1968/1970, p.54/62). Piaget views these changes (“passing”) take place by means of adaptive processes such as abstractions and reconstructions

These ideas remain relevant today, some supported by current research in cognitive neurosciences. For example, the “canonical” cells from the pre-motor cortex discovered by Rizzolatti (Rizzolatti et al., 1997) are activated both by the perception of a given object (a cup) and by the usual action (grasping) applied to that object. Another example is the distinction introduced by Ungerleider and Mishkin (1982) between two broad streams of projections of visual pathways: *a ventral* and *a dorsal stream*. The former plays a critical role in the *identification* and recognition of objects, the latter mediates the *localisation* of those same objects. A successful integration of the two streams. has been recently considered at the origin of adaptive goal directed behaviour To me these new perspectives sound very close to Piaget’s ideas.

We shall now illustrate the constructivist aspect of Piaget's theory, taking as an example the development of object permanence, inseparable from the structuration of space in terms of displacements, in order to specify how its (their) construction(s) is(are) only possible if starting from previous structures related to the same type of problems (Piaget, 1968/1970). This construction takes place during the first eighteen months of life; object permanence is the constant (the “invariant”) testifying the achievement of a new structure called the group of displacements (a mathematical structure). For Piaget object permanence demonstrates, on the one hand, the capacity to conceive the existence of the object without perceiving it directly, and on the other hand, the capacity to *coordinate* a given set of possible object locations and displacements, or to *relate* various locations of an object to a set of possible displacements (as stated by Poincaré)

In the standard tasks, the infant has to look for an object hidden under or behind another one. Infants’ difficulties to solve the tasks are not related to object disappearance as such, i.e. to the loss of visual contact with the object (e.g. the experiments with transparent covers). Rather, one should consider the concept of object permanence as the invariant in the organisation of successive displacements and locations taken by the object or by the subject himself. Infants progressively overcome the difficulties related to this type of situations. They are misled by the tasks before mastering their various difficulties. They try for example to reach for the object in the direction of its initial location when in fact it has been displaced to a different location, or they search for it at the location where previously found

According to Piaget, these progressive changes in infant behaviour are made possible by the previously constituted structures enabling the infant to solve similar problems of object permanence at other levels of organisation. Looking at the reflex behaviour of the neonate for evidence of these primitive structures, Piaget considered that various reflex schemes (defined as a coordinated set of perceptions and movements) could realise simple forms of permanence, qualified as “practical” (Piaget 1937/1955, p.182/210). For instance, the rooting reflex is a behaviour that allows the newborn to capture the mothers' breast, in other words to maintain its practical permanence. In a similar way, oculomotor reflexes can be defined as the capacity to keep the permanence of visual contact with a moving object (visual tracking and capture). It is a form of coordination between object displacements and eye-head rotations. A more complex structure called "pre-reaching" has been described in which infants are not only capable of visually tracking a moving object, but also have the propensity to extend their arm toward the object. This complex behaviour integrates ocular and manual activities and allows us to define the kind of primitive structures that are potentially responsible, in Piaget's conception, for the construction of a new structure. Now we have considered two levels of object permanence dealing with mental organization (structuring) of space in terms of displacements, as proposed by Piaget. Changes from one level to another are realised by abstractive and reconstructive processes. The new structure does not result from a simple re-description or generalisation of the previous one, but instead from “a convergent reconstruction with overtaking (*dépassement*)” or “reflective abstraction” (Piaget, 1967/1971, p.366, 376 / 320, 329). Thus we can understand that recent discoveries related to the complexity of primary structures do not necessarily contradict Piaget's constructivist theory. In conclusion, Piaget's view on cognitive development is characterised by the construction of new structures that are based on previous ones. However, recent progress in infancy research show that these primary structures are more sophisticated than initially thought by Piaget. These sophisticated primary structures foreshadow future structures without entirely predetermining them.

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