

AN OVERVIEW OF Bruner and Piaget—Cognitive Constructivists

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INTRODUCTION

This review will briefly look at the theories of Jean Piaget and Jerome Bruner and visit how these two theorists thought about *cognition* (*cognition* refers to thinking and memory processes) and *cognitive development* (*cognitive development* refers to long-term changes in these processes.)

Both Piaget and Bruner were interested in cognitive development. [6] Both developed their own cognitive theories of development—

Cognitive theory is a somewhat complex idea and proposes that development in human beings is a function of an interaction with their environment and personal experiences (Meece, 1997). However, cognitive theorists place emphasis on things that are not so tangible. West, Farmer, & Wolff (1991, p. 5), clarify this by saying that “cognitive theorists emphasize internal processes and knowledge representations which are impossible to observe directly, but which are inferred. [2]

Piaget is best known for his *cognitive stage theory*, in which he maintains that children and youth gradually become able to think logically and scientifically in distinct stages. And this through two processes called accommodation and assimilation, and subsequent equilibration which interplay to construct mental representations of objects and experiences. These mental models of the world are then created and held in mental schema. Piaget, because of his background in Psychology, refers to development, not learning per se. [17]

Bruner is best known for his *spiral curriculum*, for his emphasis on revisiting learning, on discovery learning and for his belief that language, not only encoded and mediated language, but that it allowed cognition to reach higher levels (making possible the generation of new propositions).

Both Piaget and Bruner believed that learning is constructed actively; it is contextualized; the perceived context feeds into processes of constructing knowledge rather than acquiring it. Bruner and Piaget are considered to be the chief theorists among the *cognitive constructivists*. [19]

In order to distinguish between Piaget and Bruner it is very helpful to lay hold of two classifications—that is, one of *psychological constructivism* and one of *social constructivism*. [16] Piaget represents the former, in that he believed in changes in thinking resulting from individual experiences (psychological constructivism) whereas Bruner represents that latter since he builds on the Socratic tradition of learning through dialogue, positing that learning requires a social framework for interpreting experiences (social constructivism). [13] [19] [21]

INTRODUCTION TO PIAGET

Jean Piaget (9 August 1896 – 16 September 1980) was a Swiss biologist. Piaget can be categorized as belonging to the category of psychological constructivism — a process of learning through mentally organising and reorganising new information and experiences — new experiences are related to older, well understood, meaningful organisations.

PROCESSES, STAGES AND SCHEMAS

An interplay of cognitive processes

Piaget's theory worked on this principle of cognitive equilibrium (from the interplay of assimilation and accommodation processes) which balances prior information with new input. [16] [Piaget's theory of cognitive development](#) and [epistemological](#) view are together called "[genetic epistemology](#)". [23] (Also, See Appendix A).

Piaget saw cognitive development as a series of progressions or stages

He saw cognitive development as occurring in a "series of four distinct stages characterized by increasingly sophisticated and abstract levels of thought. These stages always occur in the same order, and each builds on what was learned in the previous stage (Bruner, 1966)" [1] Each stage takes on a more mature perspective on reality. This changes how children view the world and assimilate new information. [22]

Schemas

Progression operates in stages from the physical sensorimotor experience of the child, resulting in learned action-schemes, to schemas which facilitate increasingly abstract mental operations. [9]

Helpful others

Whilst Piaget did not emphasise strongly, the aspect of constructivism which takes place when one learns with the influence of others, he did recognize the importance of helpful others and called the process "support" or "assistance social transmission" [16]

Please find more on Piaget's Epigenetic Theory which led to the above three aspects (schemas, stages and processes) in Appendix A, below.

INTRODUCTION TO BRUNER

The American psychologist, Jerome Bruner (October 1, 1915 – June 5, 2016), became a leading figure in 'cognitive' psychology in the 1950's. Whilst both Piaget and Bruner believed in the importance of children exploring and discovering by themselves, he saw the adult and more knowledgeable peers as having an important role of broadening the child's perception and facilitating a greater learning capacity. [5] He believed in fact that a child could learn anything at any age as long as it was demonstrated in a suitable way, as long as there was appropriate guidance and resources. He called such support *instructional scaffolding*. In this, knowledge should be linked to existing cognition, building upon through continuous revisitation of concepts. [13] [22]

BRUNER'S ADDITION TO CONSTRUCTIVIST LEARNING

Bruner added to the foundation of constructive learning theory that was established by Piaget, in these ways:

He brought forward ideas regarding

- a) **modes of representation**
- b) **the importance of teaching and learning "optimal structure"**
- c) **the spiral curriculum**
- d) **discovery learning**, which is learning through acts of discovery in order to rearrange and transform what is learned "in such a way that one is enabled to go beyond the evidence so reassembled to additional new insights (J. S. Bruner, 1961, p. 22)". [9]

BRUNER EMPHASISED HOW CULTURE SHAPES THE MIND

Bruner criticised Piaget for his lack of attention to the social context. In *The Culture of Education*, Bruner (1996) shows how culture (layers of culture and subcultures which embody a set of values, skills, and way of life [18]) impacts on cognitive development:

"culture shapes the mind... it provides us with the toolkit by which we construct not only our worlds but our very conception of our selves and our powers" [1]

An example of the toolkit is the language commonly used in a particular cultural context. [18]

BRUNER'S CONSTRUCTIVIST THEORY

Bruner puts forward and distinguishes three systems of processing information by which human beings construct models of their world: through *action*, through *imagery*, and through *language*.

Bruner's [constructivist theory](#) suggests it is effective when faced with new material to follow a progression from enactive to iconic to symbolic representation; this holds true even for adult learners. [5] Bruner (1966) was concerned with how knowledge is represented and organized

through different modes of thinking (or representation). In his research on the cognitive development of children, Jerome Bruner proposed three modes of representation:

Enactive representation (action-based)

Iconic representation (image-based)

Symbolic representation (language-based) [\[5\]](#)

Please find more on Bruner's Constructivist Theory in Appendix B, below.

CONTRASTING PIAGET'S THEORY TO BRUNER'S THEORY

BRUNER COMPARED TO PIAGET

An important **difference** between Bruner and Piaget is that Bruner's modes suggest a co-existence. Certainly, one mode may dominate over another, but Bruner makes clear that what determines the level of intellectual development is:

the extent to which the child has been given appropriate instruction together with practice or experience. So - the right way of presentation and the right explanation will enable a child to grasp a concept usually only understood by an adult. His theory stresses the role of education and the adult. [5]

PIAGET DEVELOPED A THEORY AROUND FOUR STAGES. BRUNER'S THEORY WAS BUILT AROUND THREE STAGES

There is not quite a one-to-one correlation in stages, but we can try to compare these stages against one another:

BRUNER'S STAGES	PIAGET'S STAGES
<p>The enactive mode (first eighteen months) here, the child's activities are predominantly related to motor nerves. [1]</p> <p>Also described as action based information or muscle memory, e.g. a baby remembering the action of shaking a rattle. [3]</p>	<p>sensorimotor stage (0-2)</p> <p>information comes through sensory inputs and movement. Infants learn to control their own bodies. Some language abilities are developed. "During this stage a child achieves a sense of object constancy, in other words, the knowledge that objects go on existing even when they cannot be seen." [1]</p>
<p>The iconic mode (1-6) "information is stored visually in the form of images (a mental picture in the mind's eye). For some, this is conscious; others say they don't experience it. This may explain why, when we are learning a new subject, it is often helpful to have diagrams or illustrations to accompany verbal information." [3]</p>	<p>preoperational stage (2-7)</p> <p>"Memory and imagination are developing but by adult standards, is often illogical and self-centered." [1]</p>
<p>The symbolic mode (7 and upwards)</p> <p>information is stored in the form of a code or symbol, such as language.</p> <p>"This is the most adaptable form of representation, for actions & images have a fixed relation to that which they represent.</p>	<p>concrete operational stage (7-10)</p> <p>Children "begin to deal with abstract concepts while logical, rational and operational thinking also develops (mental actions that are reversible). Egocentric thoughts diminish. A child will begin to understand other people's perspectives and</p>

<p>Dog is a symbolic representation of a single class. Symbols are flexible in that they can be manipulated, ordered, classified etc., so the user isn't constrained by actions or images. In the symbolic stage, knowledge is stored primarily as words, mathematical symbols, or in other symbol systems." [3]</p> <p>In this final stage- the symbolic mode (from about six or seven years and onwards) the child expresses self in the form of words. He/she will also have a mental sense of time and distance. [1]</p> <p>"A symbolic system represents things by design features that include remoteness and arbitrariness. A word neither points directly to its referent here and now, nor does it resemble it as a picture"[9]</p>	<p>views and will build on past experiences" [1]</p>
	<p>formal operational stage (12 -15) Children have "increased independence for thinking through problems and situations and taking decisions based on these and they will begin to reason logically, systematically and hypothetically. A formal operational child is capable of meta-cognition, in other words, thinking about thinking." [1]</p>

SIMILARITIES BETWEEN BRUNER AND PIAGET

Bruner, like Piaget, believed children have an innate capacity to learn language, are naturally curious, and that cognitive abilities develop over time and through active interaction. [1]

Although both Bruner and Piaget emphasized the social context as being important for cognitive development, [10] Bruner was more firmly placed within the framework, often referred to as social *constructivism* or *sociocultural theory* [1] [8], whereas Piaget's orientation was towards individual thinking. [16]

DIFFERENCES BETWEEN BRUNER AND PIAGET

Like Piaget, Bruner said that children have an innate capacity and that cognitive abilities develop through active interaction. However, unlike Piaget, Bruner argued that social factors, particularly language, were important for cognitive growth.

Stage disagreement

According to Piaget's, cognitive development occurs in a series of *four distinct stages*. These are characterised by increasingly sophisticated and abstract levels of thought. These stages always occur in the same order, and each builds on what was learned in the previous stage. [1]

Bruner, however, meant that these stages were *not necessarily age-dependent, or invariant*. Bruner contended that any subject can be taught effectively to *any child at any stage of development*, that "there is no unique sequence for all learners, and the optimum in any particular case will depend upon a variety of factors, including past learning, stage of development (Bruner, 1966)" [1]. This is the foundation for the idea of a *spiral curriculum*. In *the spiral curriculum*, subjects are revisited again and again. This builds not only knowledge, but depth and a continuous fine-tuning and re-orienting of focus, as greater clarity is gained, each time upon revisiting. [1]

Bruner doesn't see the different stages of cognitive development as representing different separate modes of thought

Bruner disagreed with Piaget that symbolic encoding displaced earlier modes of mental representation.

Although Bruner proposes stages of cognitive development, he doesn't see them as representing different separate modes of thought at different points of development (like Piaget). Instead, he sees a gradual development of cognitive skills and techniques into more integrated "adult" cognitive techniques. Bruner views **symbolic representation** as crucial for cognitive development, and since language is our primary means of symbolizing the world, he attaches great importance to language in determining cognitive development. [5]

Social factors

Bruner meant that *social factors* (particularly interactions between a learner and others who are more knowledgeable or experienced) impacted cognitive growth, and that this cognitive growth could be facilitated especially through language. This is underpinned by the concept of *instructional scaffolding*. Instructional scaffolding is tailored support given to a student by an instructor.

Bruner brought forward the concept of *scaffolding* in the late 1950s - where small children's language acquisition improved through scaffolded dialogue with parents. [15] This learning framework is often referred to as *social constructivism* or *sociocultural theory* [1]

In contrast to Bruner who meant that learning was a continuous process, Piaget meant that learning occurs in distinct, age related stages:

Jean Piaget states that there are "four invariant stages of cognitive development that are age related" (Merriam & Caffarella, 1999, p. 139). According to the authors, Piaget contends that normal children will reach the final stage of development, which is the stage of formal operations, between the age of twelve and fifteen. [25]

Bruner furthermore, posited that not only was learning *not* confined to and cocooned by distinct age determinate, procedural stages, that were the same across the board, but that "different processes were used by learners in problem solving, that these vary from person to person" [19] And so, in Bruner, we see not only an enlarged room for acknowledging the dispersion of variance there can be in cognitive development among age groupings, but also, between persons.

Bruner emphasized the *re-visitation* of concepts, and believed progression through cognitive ability was not stage determinant and linked to specific ages, but rather could progress exceptionally well in even small children. In contrast to Piaget, who believed one should wait for the child to be ready, Bruner contested that

"a learner (even of a very young age) is capable of learning any material so long as the instruction is organized appropriately" [20]

These similarities and differences are reflected in the chart below.

BRUNER AGREES WITH PIAGET	BRUNER DISAGREES WITH PIAGET
1. Children are PRE-ADAPTED to learning	1. Development is a CONTINUOUS PROCESS – not a series of stages
2. Children have a NATURAL CURIOSITY	2. The development of LANGUAGE is a cause not a consequence of cognitive development
3. Children’s COGNITIVE STRUCTURES develop over time	3. You can SPEED-UP cognitive development. You don’t have to wait for the child to be ready
4. Children are ACTIVE participants in the learning process	4. The involvement of ADULTS and MORE KNOWLEDGEABLE PEERS makes a big difference
5. Cognitive development entails the acquisition of SYMBOLS	5. Symbolic thought does NOT REPLACE EARLIER MODES OF REPRESENTATION

(Taken from McLeod, S. (2012).[3])

MORE RESOURCES DESCRIBING THE SIMILARITIES AND DIFFERENCES BETWEEN BRUNER AND PIAGET

THESE ARTICLES; RESEARCH PAPERS AND ESSAYS FOCUS IN ON COMPARING JEROME BRUNER TO JEAN PIAGET

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APPENDIX A: PIAGET'S THEORY OF COGNITIVE DEVELOPMENT

INTRODUCTION

Piaget's background in both Biology and Philosophy influenced his theories of cognitive development. He gave his general theoretical framework the name "genetic epistemology" because his interest was focused in on in how knowledge developed in human organisms [27].

Piaget's epigenetic ontogenesis perpetuates and fine-tunes the acts of knowing

Ontogenesis- a continuous process of assimilation and accommodation of the organism, is built around moments of disturbances and requests from the environment, to which the brain adapts, becoming renewed for new capacity to perceive again, new stimuli and expand its (the brain's) understanding of the world. This process is encapsulated in Piaget's core idea:

His core idea: it is possible for human beings to attain the necessary and universal knowledge due to the exchange processes of their organisms with the environment, which give rise to the epigenetic ontogenesis of their specific organic mental structures for the act of knowing [31]

Children, from infancy are "categorizing". Perception of constancy and variability are both required.

children's cognitive activities, are on the one hand aimed at building constancies and regularity on reality and, on the other, are interested in that which violates this same constancy and regularity. To use a metaphor, it is as if in the human mind there were a tendency to become bored or accustomed very soon to already known stimuli and therefore seek novelties that must, however, be chewed over and transformed into orders, categories and constancies. The two processes are inextricably linked because it is not possible to construct constancy and catch redundancies and repetitions without starting from variability. On the other hand, it is not possible to grasp variability, transgressions or differences without starting from constancy and repetition....when children construct conceptual hierarchies they build constancies that include variability. They understand that plants exist, that among these there are the ornamental flowers which include roses and primroses (similar to each other by being flowers) and all those that were not classified because they are not roses or primroses are still flowers. [11]

The goal of genetic epistemology – is to link knowledge to the model of its construction

Piaget invented this term and with it, has sought to explain the processes of cognitive development present in in four primary stages: the sensorimotor stage (birth to age 2), the pre-operational stage(2-7), the concrete operational (7-11), and the formal operational (11 years onward). [35]

Piaget's hypothesis (1952) was to assume that the organic brain functions as an expression of Classical Logic. Since Aristotle, it was understood as a set of *laws of thought*. Now, it is

understood, in general, just as a *language*. [31] Piaget's genetic epistemology is halfway between formal logic and dialectical logic [35]. Such logic was built into structures in the brain that Piaget termed "schemas".

According to Piaget, thought manifested through a series of different development stages. Each stage operates at a specific stage of differentiation that equate to the axioms of logic present at that level-

this logic is manifested first in actions, then at a relatively early stage in sensorimotor operations (in the specific mathematical sense of the word, as opposed to "actions" which are equivalent to relations but not yet mathematical operations), and finally in operations which express thoughts, conscious purposive activity. [35]

Piaget was a cognitive constructivist. The key point of cognitive constructivism, according to von Glaserfeld, is that:

there is no way of transferring knowledge every knower has to build it up for himself. The cognitive organism is first and foremost an organizer who interprets experience and, by interpretation, shapes it into a structural world. That goes for experiencing what we call sensory object and events, experiencing language and others; and it goes no less for experiencing oneself. (von Glaserfeld, 1982,p.612) [29]

There are three Aspects to Piaget's Cognitive Theory

Piaget's three general ideas behind the theory of genetic epistemology are as follows:

1) The **adaption of an organism to its environment during its growth, together with the interactions and autoregulations** which characterize the development of the "epigenetic system" (Epigenesis in its embryological sense is always determined both internally and externally)

2) The **adaption of intelligence in the course of the construction of its own structures**, which depends as much on progressive internal coordinations as on information acquired through experience.

3) The establishment of cognitive or, more generally, epistemological relations, which consist neither of a simple copy of external objects nor of a mere unfolding of structures preformed inside the subject, but rather **involve a set of structures progressively constructed by continuous interaction between the subject and the external world.** [30]

Piaget's theory of cognition involved schemas, stages and processes

Piaget developed a theory of cognition involving *schemas, development stages* and *processes*. He is credited as the first to create a cognitive development theory which included schemas.

The theory goes like this: New information is added or assimilated into existing schemas. Then cognitive dissonance occurs through new information which cannot be easily integrated. Schemas are then forced to either change or to accommodate this new information. [33]

More on this below:

-Schemas or cognitive structures (building blocks of knowledge)

The assumption is that we store these mental representations of what we perceive as schemas in the brain. Schemas can be patterns of behaviour, [24] they can also be organized units of knowledge for a subject or event. [33]

What we need to know is that these schemas are built up over past experiences and are accessed to guide current understanding or actions. [33].

As we get older these schemas become more numerous and more elaborate. But we are also born with schemas:

Piaget believed that newborn babies have a small number of innate schemas - even before they have had many opportunities to experience the world. These neonatal schemas are the cognitive structures underlying innate reflexes. These reflexes are genetically programmed into us.

For example, babies have a sucking reflex, which is triggered by something touching the baby's lips. A baby will suck a nipple, a comforter (dummy), or a person's finger. Piaget, therefore, assumed that the baby has a 'sucking schema.' ...Shaking a rattle would be the combination of two schemas, grasping and shaking [24]

Piaget (1952, p. 7) defined a schema as: "a cohesive, repeatable action sequence possessing component actions that are tightly interconnected and governed by a core meaning." [24] [36]

The number and complexity of the schemata that a person had learned, was what Piaget was referring to, when he talked about mental processes. A state of *equilibrium* is said to occur when existing schemas are capable of explaining the perceived information. [24]

Piaget emphasized the importance of schemas in cognitive development and described how they were developed or acquired. A schema can be defined as a set of linked mental representations of the world, which we use both to understand and to respond to situations.

Wadsworth (2004) maintained that that schemata (the plural of schema) could be thought of as 'index cards', that informed the person how to react to incoming stimuli. [24]

-Processes that form cognitive development:

These are *adaptation processes* that enable the transition from one stage to another. [37]

Piaget saw cognitive development as a process of adaptation to the world. The processes of **adaptation: assimilation and accommodation. These change cognitive structures.**

Assimilation: the interpretation of events in terms of existing cognitive structure i.e. using that existing schema to deal with a new object or situation

Accommodation: refers to changing the cognitive structure to make sense of the environment This happens when the existing schema (knowledge) is not adequate enough to deal with with a new object or situation, and needs to be changed. [37] [27]

In fact, such a stance on cognitive development, shows the constant effort to develop or acquire new schemas:

“Cognitive development consists of a constant effort to adapt to the environment in terms of assimilation and accommodation. In this sense, Piaget’s theory is similar in nature to other constructivist perspectives of learning (e.g., constructivism, social development theory).” [27].

Piaget termed the force, responsible for moving this development along **equilibration**. And this process does not progress at a steady rate but rather in leaps and bounds, It operates by restoring balance through mastering new challenges (accommodation) .. *“Once the new information is acquired the process of assimilation with the new schema will continue until the next time we need to make an adjustment to it.”* [37]

-Stages of Cognitive Development

There are four development stages of cognition according to Piaget. These stages are:

- 1. Sensorimotor:** Birth to ages 18-24 months.), intelligence takes the form of motor actions
- 2. Preoperational:** Toddlerhood (18-24 months) through early childhood (age 7). Intelligence in the preoperation period (3-7 years) is intuitive in nature
- 3. Concrete operational:** Ages 7 to 11 years. The cognitive structure during the concrete operational stage is logical but depends upon concrete referents
- 4. Formal operational:** Adolescence to adulthood. Thinking involves abstractions [26] [27]

Piaget's Epigenetic Theory which led to the above three aspects (schemas, stages and processes)

“Three factors cause cognitive development – biological development which progresses in stages, interaction with the world of nature and objects, and interaction with others.” [26]

Ontogenetic Epigenesis is the process that describes a person's growing knowledge through empirical experience with their actions upon the environment to know the world. [31]

Paget's particular newness was to posit the existence of organic mental structures that had the propensity to form progressive structures as builds upon builds of logical fittings aligning with Classical Logic but structured through organic evolutions

In conclusion, the mental activities whose progressive structuring prepares the logical structures thus cover the entire development field (or ontogenetic evolution), which means that logic has its roots situated in a much deeper level than commonly imagined. In pursuing them, we are forced to go back so far that we may ask ourselves whether the integrations proper to the nervous mechanisms are not already an outline of logical fittings.” (...) This leads us to assume that the evolutionary process, which we have referred to, is isomorphic to an organic evolution (1954, p. 144/145; Synthèse). [31]

Knowing is brought about through active construction of knowledge as interactions between subject and object are stored in cognition

It is important to note although Piaget takes a constructivist stance, he does also admit to the existence of an independent reality, and focuses in on the perceiving and transforming activity of the perceiver. This mental *activity* in itself is very important:

human knowledge is essentially active. . . . *To know is to transform reality in order to understand how a certain state is brought about. . . .* knowing an object does not mean copying it—it means *acting* upon it. . . . *Knowing reality means constructing systems of transformations that correspond, more or less adequately, to reality. . . .* Knowledge . . . is a system of transformations that become progressively adequate. (p. 15, emphasis added) [28]

Cognitive activity of the perceiver/subject follows a logical system which determines behaviour i.e. the construction of systems of transformations, which comes about through interactions with objects, that passes through different stages of cognition.

There is an underlying logic that organizes thought structures, that is deeper than language

This idea of activity between subject and object as a central dynamic is central in this text - *Jean Piaget's Genetic Epistemology as a Theory of Knowledge Based on Epigenesis* . First of all, we learn here, if we trace back Piaget's realisations on cognition, there were several distinct points that he evolved his theory. One of these points was during his internship at the Binet/Simon

laboratory in which he, at the beginning, believed that language disclosed the logic of thought, but then he observed that this logic “is present, though underlying actions, organizing them and allowing for findings” [31]

What is even more interesting is Piaget’s finding that “children’s actions are not structured randomly but they obey true logical systems that determine their behavior without their being aware of them” [31]

Organic structures interestingly, are framed within operations in the environment. Knowledge is not acquired directly from the objects perceived, but rather, through the actions or the coordination of actions that the subject exerts over these objects

Piaget, then became interested in the transmission of acquired traits through inheritance. This study of *the inheritance of acquired traits* was conducted, through observing snails over many years. It was from this that Piaget developed a law of biology which, with regard to intelligence, caused him to lay claim to a “set of organic structures that are formed from within operations in the environment” [31] and this is echoed here in Piaget’s writing:

“Now, how can we not be surprised with the convergence between this biological law that seems general and the work of the forms, even the higher forms of intelligence, whose new constructions rest on information taken not from objects as such, but from actions or the coordination of actions that the subject exerts over objects, which is not the same thing at all, as we will insist later on (...).” [31]

Mental structures do something in addition to spurring to action. They REPRESENT

And so there is a dual dynamic, where both biology and interactions, spurred on by direction from this biology within the environment, to produce organic structures of intelligence. This spurring on to actions are “internalized as operations, but performed by mental structures with their capacity to represent” [31]

And so these mental structures have dynamic properties (operational, directional) and encoding properties (representation)

Furthermore, these mental structures, build upon one another, operating from a basis of dependency upon what has transpired, which determine its range of possibilities for expansion of knowledge. Furthermore, this set of structures is inherited by descendants

“It can be said that knowing is expanding the world of the subject who acts, always on the basis of their possibilities, programmed at first but then undergoes changes in function of exchanges with the environment and transmission of new knowledge to their descendants.” [31]

The stages of cognition and the non randomness of the establishment of relationships between subject and object, suggest a directional mechanism, that leads logic

If we trace how knowledge begins in an individual, we may like to start with the actions of a subject upon the environment to know the world. Tremendously interesting that this establishment of relationships between objects, “never at random, but always displaying the logic presented by Piaget when he observed the 9 boys from the Binet & Simon Laboratory,” [31]

More on the Transitions within the Stages of Cognitive Development

There is a transition of logical relations from unconscious to conscious and from non-verbalised to verbalized at ages 5-6

These observable and logical relations remain unconscious up to 5-6 years of age and then become conscious and verbalized, but still in actions with objects. [31]

At the stage when logical relationships pass consciousness and onto speech, they are represented by "*their image-making faculty, humans can think about them.* Piaget understands this movement as "reflechissante" (that means something that is reflected as an image at a higher level than that of the action that will allow for the rise of deduction.)" [31]

Piaget understands this movement as "reflechissante" (that means something that is reflected as an image at a higher level than that of the action that will allow for the rise of deduction.)" [31]

The concrete operational stage – here the organic construction of mental structures with capacities for abstraction and dialectic processes of organism perceiving the environment and actually these determine the future processes of adaptation (this is the *reflechissantes abstractions- the evolution of functioning mental structures that have already established logical relations, now establishing dialectic abstract capacities, that evolve into logical and mathematical relations independent of objects*) [31]

The moment Piaget understands as "reflechissante" - something that is reflected as an image at a higher level than that of the action that will allow for the rise of deduction

This is the moment when logical relationships pass consciousness and onto speech, and in this way: "Introjected and being represented by *their image-making faculty, humans can think about them.*" [31]

Once aware of these logical relationships, children are said to be in the concrete operational stage- a capacity whereby new organic mental structures specific to the act of knowing have been completed in the organism, and these determine the progress in adaptation.

Reasoning is dialectic

This new equilibrium level is transient because it simultaneously means brain progress that increases the capacity of the individual to perceive new stimuli in the environment, and new relations to be established therein, in a dialectic process: organism x environment, which will determine imbalances and rebalances. [31]

An example of observing the arrival of abstract thinking

"Thus we could observe Maria Gabriella, age 9, verbalizing the following 6 reasoning: (...) "*if there is only 'yes' and 'no', if I say **no** to 'no' I'm saying **yes**.*" (...) this thought occurred to Gabriella spontaneously, it is as if we were watching live the moment of arrival at abstract thinking." [31]

MORE ON REASON

Schemas and reasoning

These actions upon actions or actions, rather involve a set of structures progressively constructed by continuous interaction between the subject and the external world...i.e reason is seen as stemming from organic processes that lay foundations for further reasoning , this brings us into the idea of evolution of further complex structures, that deal with concepts.

Reason is an evolutionary process

“at some point in the dialectical process, by virtue of which the construction of Reason takes place, the exchange of the organism and the environment is no longer restricted to object as such, but involves concepts” [31]

On reasoning as being active/ operational: This constitutive mechanism that operates to regulate reason is more than observation, rather it is predicated upon an activity of mental operations, a coordinating, that can apparently go in two directions- the decomposition of a whole into its parts and the re-composition of these parts into a whole:

We thus have a new instance of the origin of knowledge lying neither in the object alone nor in the subject, but rather in an inextricable interaction between both of them, such that what is given physically is integrated in a logicomathematical structure involving the coordination of the subject's actions. The decomposition of a whole into its parts (invisible here) and the recomposition of these parts into a whole are in fact the result of logical or logicomathematical constructions and not only of physical experiments. The whole considered here is not a perceptual "Gestalt" (whose character is precisely that of nonadditive composition, as Kohler rightly insisted) but a sum (additive), and as such it is produced by operations and not by observations. [30]

Reasoning involves operations of transformations, displacements, connections, combinations, disassembly and re-assembly

This view of reason as being an operational, regulatory and coordinating, activity and more than just passive reception is echoed here: in which Piaget goes against the view that perception is just a *“set of perceptive recordings*. And of objects and the connections between them, he lays out, that if one were to hold an empiricist view, then the contents of intelligence would come from outside, and the coordinations that organize would only be the consequences of language and symbolic instruments. However, he states clearly that:

“this passive interpretation of the act of knowledge is in fact contradicted at all levels of development and, particularly, at the sensorimotor and prelinguistic levels of cognitive adaptation and intelligence. Actually, in order to know objects, the subject must act upon them, and therefore transform them: he must displace, connect, combine, take apart, and reassemble them.” [30]

Determinate Points in Piaget's life that Illuminated his Theory for him

Piaget had four decisive moments that clarified for him different aspects to his theory.

These were

1. during his career as a zoologist, he learned from the logician Paul Godet, how organic forms and structures of intelligence were linked.
2. then, Immanuel Kant's Philosophy prompted him to transpose Kant's theory into biology. Here we see a glimpse of his thinking about assimilation and accommodation: "the first discovery is that if we start with Le Dantec, on the duality of functions, named assimilation and imitation by him; whereas I would say assimilation and accommodation. Knowledge is not merely imitation as he believed in his empiricism, but, in fact, an assimilation to the structures of the subject and the organism. It was gently moving from Le Dantec on to an evolutionary Kantianism." (autobiographical text Piaget, 1960 p. 58/59, in [31])

Piaget posed that Mathematics and Physics are understandable to humans due to this very *epigenetic ontogenesis* of the logical mathematical thinking and those of intelligence.

Here we see how Piaget, sees knowledge as beginning with *actions* which in fact, according to him, have already been a consequence of an *endogenous process*, in the brain. Piaget differs from Kant who saw reason as abstract. For Piaget, it is organic. And most interestingly that, constructions of intellect are preceded by determinate previous structures, upon whose makeup, successive evolutions emerge.:

"His conviction that every moment of epigenetic evolution is necessary for the construction of the one that succeeds it, that is, every moment is *a priori condition* of the next moment" [31]

3. During Piaget's internship at the Binet and Simon Laboratory, he discovered a

logic underlying children's actions: inclusion, addition, multiplication of classes, fitting of transitive asymmetric relations etc., whose 10 model was Couturat's classical logic he had studied at a very young age. This logic, he realizes, foreshadowed a Logic of Classes and Relations and it was not a matter of abstractions or chimera. A second fundamental finding was that **the logic underlying a child's behavior evolves.**" [31]

4. The fourth decisive moment for the construction of Piaget's Theory of Knowledge was the research he conducted with the *lymnaea stagnalis*, from 1927 to 1965., in which Piaget studied *the inheritance of acquired traits*. [31]

APPENDIX B: BRUNER'S THEORY OF COGNITIVE DEVELOPMENT

INTRODUCTION

Bruner built on Vygotsky's social constructional theory, which, firstly, laid claim to the theory that cognitive development is linked to the construction of knowledge within a social context.

Bruner, like Vygotsky, asserted that higher mental functioning in the individual was emergent through social processes (culture) and that children could learn better with more skilled partners. Secondly, Bruner believed that the cognitive development of the child through the social and psychological processes, present in their environment, are fundamentally shaped by language (seen as a cultural tool).

Bruner further developed Vygotsky's social constructional theory which built upon 3 pillars that support higher mental functioning (culture, language, scaffolding)

Bruner believed that mental development was formed in three ways- through impacts from culture, language and through guidance by a mentor :

Bruner built on Vygotsky's social constructional theory from the 1930's which fell into three general claims; higher mental functioning in the individual emerged out of social processes (culture), secondly, social and psychological processes are fundamentally shaped by cultural tools (language) and lastly, the developmental method Zone of Proximal Development (ZPD). The ZPD is defined as the difference between problem-solving the child is capable of performing independently, and problem-solving capabilities with guidance or collaboration. [1]

To contrast to Piaget: "Piaget was primarily interested in invention, and Vygotsky was primarily interested in transmission" [14] However, Bruner built upon this with the idea that the child/ learner could build further concepts upon the original- further **thought inventions**, especially through language, that lifted the original propositions to higher levels:

Bruner was interested in how knowledge is represented and organized through different thinking modes and he posited that the learner could autonomously invent further concepts, categories and problem solving answers, effectively constructing their own knowledge

For Bruner, "important outcomes of learning include not just the concepts, categories, and problem-solving procedures invented previously by the culture, **but also the ability to "invent" these things for oneself**" [3]

Bruner's text, "The Process of Education" posited that students are active learners who construct their own knowledge. [3]

Bruner was interested in how knowledge is represented and organized through different thinking modes and he posited that the learner could autonomously and actively invent further concepts, categories and problem solving answers.

For Bruner, "important outcomes of learning include not just the concepts, categories, and problem-solving procedures invented previously by the culture, but also the ability to "invent" these things for oneself" [3]

Bruner saw learning as an active process- one which learners are able to form their own, new concepts, based on their current knowledge and on "the mental processes which offer the learner the ability to organize experiences and derive meaning from them". [7]. These are the "cognitive structures" that form the basis for constructing new concepts: "The learner, often a child, will take pieces of their past knowledge and experiences and organize them to make sense of what they know, then base further concepts and solve additional problems based upon a combination of what they already processed and what they think should be processed next." [7]

There are four scaffolding principles that drive constructivistic learning, according to Bruner

The four major principles of Bruner's theory on constructivism involve 1) a predilection toward learning. 2) that a grouping of knowledge is able to be constructed to best be understood by the learner., 3) effective manners for the teacher to present said material to the learner, and 4) the progression of rewards as well as punishments. [7]

For cognition to develop, Bruner emphasised two mental organising principles: recurrent features of the complexity of the perceived environment and how acts are organized into cognition in higher order object ensembles (integration)- as meta structures for the resolution of particular problems

"In Bruner's (1964) view, growth necessitates and is facilitated by manageable representation of "recurrent features" of the "complex environments in which [we] live" (p. 1)" [9]

It is fruitful, I think, to distinguish three systems of processing information by which human beings construct models of their world: through action, through imagery, and through language. A second concern is with integration, the means whereby acts are organized into higher-order ensembles, making possible the use of larger and larger units of information for the solution of particular problems. (J. S. Bruner, 1964, p. 1) [9]

Bruner's Discovery Learning

Bruner's chief tenet was that learners' construct their own knowledge and they do this by organising information into categories, using a coding system. "Bruner believe that the most effective way to develop a coding system is to discover it rather than being told it by the teacher." [3] The concept of discovery learning operates through students constructing their own knowledge for themselves. [3]

The main attributes of discovery learning

- i) exploring and problem solving, which stimulate learners to actively approach to creation,
- ii) acquisition and generalization of new knowledge instead of passively being exposed to lectures and practice,
- iii) taking responsibility for learning in terms of the ability of learners to choose their own learning pace,
- iv) building new knowledge from the existing.

The characteristics by which discovery learning differs from classical learning

These are

- i) active rather than passive learning
- ii) learning is process-oriented rather than content-oriented
- iii) “ failure is important, feedback is necessary, and understanding is deeper” [\[12\]](#)

Models that are based on discovery learning

These are examples of models based upon discovery learning: guided discovery, problem-based learning, simulation-based learning, case-based learning, and incidental learning. [\[19\]](#)

Coding of Concepts and Language as an Instrument for Cognitive Development

Coding of concepts begin to form hierarchical mental structures, whose formations, essentially hold more information, according to Bruner

Bruner believed that the learner, having built up these hierarchical mental representations, can speed up further learning:

in sharp contrast to the beliefs of [Piaget](#) and other stage theorists. Like [Bloom's Taxonomy](#), Bruner suggests a system of coding in which people form a [hierarchical](#) arrangement of related categories. Each successively higher level of categories becomes more specific, echoing [Benjamin Bloom's](#) understanding of knowledge acquisition as well as the related idea of [instructional scaffolding](#). [18]

This formed the belief that the cognitive development process could be sped up through the revisiting of concepts. The *spiral curriculum* is built on the foundation of revisiting concepts, each time, with a more expansive repertoire of foundational and linking concepts.

The Importance of Language for Bruner who saw language not only as a consequence but also as an encoding system directly influencing learning

Bruner argued that language, was not just a consequence of cognitive growth as Piaget determined it was, but rather it was an instrument for thought which caused further cognitive progression:

Bruner (1990) identifies event schemas, embodied in narratives, as basic organizers of both culture and cognition. [32] And so narrative framing, plays a central role in forming and organising concepts:

"It may well be that language provides a kind of temptation to form concepts of objects and events"[34]

Language can facilitate the coding of concepts, especially abstract concepts. Language's ability to encode meaning, allowing cognition to operate through it, can further, not only help with the organization of knowledge, but generate new propositions!

The flexibility offered in cognition through language can remove constraints otherwise present, such as being able to move away from only perceiving here and now:

"Language is important for the increased ability to deal with abstract concepts. Bruner argues that language can code stimuli and free an individual from the constraints of dealing only with appearances, to provide a more complex yet flexible cognition. The use of words can aid the development of the concepts they represent and can remove the

constraints of the “here & now” concept. Basically, he sees the infant as an intelligent & active problem solver from birth, with intellectual abilities basically similar to those of the mature adult. According to Bruner the child represents the world to himself in three different ways.” [3]

And about methods conducive to arriving at new understandings, the methods should allow for structuring knowledge in a way that “ should result in simplifying, generating new propositions, and increasing the manipulation of information.” [8]

And so a pliability around opportunities for rearranging the bricks of knowledge seems to be what is called for. Here, below we see this thought into the phrase “flexible cognition” The bricks are of course, represented in language:

Language is important for the increased ability to deal with abstract concepts. Bruner argues that language can code stimuli and free an individual from the constraints of dealing only with appearances, to provide a more complex yet flexible cognition. The use of words can aid the development of the concepts they represent and can remove the constraints of the “here & now” concept. Bruner views the infant as an intelligent & active problem solver from birth, with intellectual abilities basically similar to those of the mature adult [5]

The outcome of cognitive development is thinking and the ability to invent things for oneself. Cognitive growth involves interaction between human capabilities and culturally invented technologies that serve as amplifiers of the capabilities, even abstract notions such as “the way a culture categorizes phenomena, and language itself”

The outcome of cognitive development is thinking. The intelligent mind creates from experience "generic coding systems that permit one to go beyond the data to new and possibly fruitful predictions" (Bruner, 1957, p. 234). Thus, children, as they grow, must acquire a way of representing the "recurrent regularities" in their environment. So, to Bruner, important outcomes of learning include not just the concepts, categories, and problem-solving procedures invented previously by the culture, but also the ability to "invent" these things for oneself...

Cognitive growth involves an interaction between basic human capabilities and "culturally invented technologies that serve as amplifiers of these capabilities." These culturally invented technologies include not just obvious things such as computers and television, but also more abstract notions such as the way a culture categorizes phenomena, and language itself. Bruner would likely agree with Vygotsky that language serves to mediate between environmental stimuli and the individual's response. The aim of education should be to create autonomous learners (i.e., learning to learn). [5]

Educational implications of Bruner's Theory

Bruner saw the aim of education as being to create autonomous learners. He recommended following a progression from enactive to iconic to symbolic representation.

“Bruner's work also suggests that a learner even of a very young age is capable of learning any material so long as the instruction is organized appropriately, in sharp contrast to the beliefs of Piaget and other stage theorists.” [3]

The basic premise was that “ the intellectual activity of the child is no different in kind from the intellectual activity of a scientist, only different in degree (J. S. Bruner, 1960, p. 14), “ [9]

Bruner's Theory of Instruction

Bruner's theory, as laid out in *Toward a Theory of Instruction* (Bruner, J. 1966), states that a theory of instruction should contain four major pillars: (1) the predisposition towards learning, (2) the ways in which a body of knowledge can be structured so that it can be most readily grasped by the learner, (3) the most effective sequences in which to present material, and (4) the nature and pacing of rewards and punishments.[8]

Bruner believed that the larger goal should be kept in mind when learning and that learners become aware of the organization of content

“Bruner's theory suggests that the teachers be explicit regarding organization, help the learner to focus on the larger task at hand as well as the goals, instead of getting caught on minor details or frustrations” [7]

Teaching should be geared to the elucidation of fundamental ideas in whatever subject is being taught and this is what Bruner referred to as the learning structure. His focus was on the long term prize of advancing cognitively with more ease, as concepts become clarified, become related, they become distinctly placed within a pattern of concepts and one grasps the fundamental principles

“Bruner believed that “teaching should be geared to the teaching of fundamental ideas in whatever subject is being taught”[1] (J. S. Bruner, 1960, p. 18). He referred to this as learning structure, the learning of which “should not only take us somewhere; it should allow us later to go further more easily” (p. 17). Structure provides the framework for a given subject. To learn the structure of a subject is to understand it “in a way that permits many other things to be related to it meaningfully,” or “to learn how things are related” (p. 7). Bruner made four general claims in support of teaching fundamental structure as the primary and initial goal of a curriculum:

1. “Understanding fundamentals makes a subject more comprehensible” (p. 23).
2. “Unless detail is placed into a structured pattern, it is rapidly forgotten” (p. 24).

3. “An understanding of fundamental principles and ideas appears to be the main road to adequate ‘transfer of training’” (p. 25).

4. By constantly reexamining material taught in elementary and secondary schools for its fundamental character, one is able to narrow the gap between “advanced” knowledge and “elementary” knowledge (p. 26) .[9]

The following focuses in on the importance of structure in learning and the attributes belonging to the predisposition of the learner:

In *The Process of Education* (1960) Bruner published a set of views that grew out of a ten-day conference of thirty-five scientists, scholars, and educators, convened by the National Academy of Sciences through its Education Committee to discuss how education in science might be improved (pp. vii – xvi). The book is written around four themes (introduced in pp. 11-16):

1. The role of structure in learning – “The teaching and learning of structure, rather than simply the mastery of facts and techniques, is at the center of the problem of transfer” (p. 12)

2. Readiness for learning – “Our schools may be wasting precious years by postponing the teaching of many important subjects on the ground that they are too difficult...the foundations of any subject may be taught to anybody at any age in some form” (p. 12)

3. The nature of intuition – “The shrewd guess, the fertile hypothesis, the courageous leap to a tentative conclusion—these are the most valuable coin of the thinker at work, whatever his line of work” (pp. 13-14)

4. The desire to learn and how it may be stimulated – “Ideally, interest in the material to be learned is the best stimulus to learning, rather than such external goals as grades or later competitive advantage” (p. 14) [9]

Bruner’s Spiral Curriculum

The effective spiral curriculum is about starting from simple ideas and advancing through complexity, but consistently returning to the basic ideas and building these up into more complex forms

In summary, an effective spiral curriculum (J.S. Bruner, 1960)

1. Begins with the basic and simple ideas that underlie that which is more complex (pp. 12-13).
2. Emphasizes the intuitive grasp of ideas and the use of those basic ideas in the early teaching of any subject (p. 46).
3. Revisits the basic ideas repeatedly (p. 13).
4. Enables continual deepening of understanding by facilitating the use of basic ideas in progressively more complex forms (p. 13). [9]