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# **The Working Mind**

## **Meaning and Mental Attention in Human Development**

© 2021 Juan Pascual-Leone and Janice M. Johnson

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## Notes

### Preface

1. We place *Reality* and *Resistances* in capitals to emphasize that we are talking about actual Reality out there imposing on us its Resistances. This is different from modeling. We write *reality*, in lowercase, to signify any interpreted modeling.
2. What follows is translated and modified from Pascual-Leone (2015).

### Chapter 1

1. A situation is an immediate context, objective and subjective, where there are one or more persons, one or more objects, and physical or mental activity. When at least one person in the situation also has goals to pursue, then the situation contains a task.
2. Remarks on Piaget's work come with modifications from Pascual-Leone (2012a).
3. Not all Raven's items require consideration of all dimensions of variation. In simpler items just one or two distinct dimensions must be considered to triangulate the relational invariant features to be abstracted, which the missing lower-right section should also have. These simpler items are often (see table 3 of Unsworth & Engle, 2005) more strongly correlated with working memory tasks (Operation Span) because in Raven's they have less executive demand.

### Chapter 2

1. Mediation as a technical term has two distinct senses in psychology. It can mean external mediation, that is, the social interactions and psychosocial relations that a person has with others that support thinking or action. Vygotsky used the term in this manner. Alternatively mediation can be internal, that is, the cognitive or perceptual processes that in a working mind link (mediate between) the here-and-now situation (as represented) and the response—that is, thinking processes or action needed to cope with the task at hand. This second sense, favored by Hebb and others, is our intended meaning.

2. Stages are distinct developmental levels of processing in which mental schemes or schemas are processed by other schemes/schemas and by the brain's general-purpose resources. This processing is progressively more complex as hierarchically nested stages advance.
3. Infrastructure is a term engineers and economists use for functionally essential aspects of complex objects, relative to the praxis and function served by these objects.
4. This is an important point usually not appreciated. Contemporary researchers often wrongly interpret classic theoretical statements as consistent with contemporary views. For instance, Case (1985, p. 33) and Barrouillet and Gaillard (2011, p. 1) have interpreted Baldwin's (1894/1968) concept of a (mental) attention that increases developmentally, as if it were the same as Pascual-Leone's (1970) construct of mental attention. They fail to notice that Baldwin, like his contemporaries, thought of growth in the power or breadth of attention as the operative/motor "excess function" that develops as a consequence of neuronal coordinations, due to associative learning. Baldwin thought of mental attention as being a consequence (not a maturational cause) of higher learning and cognitive growth. That mental attention is cause, and not just consequence of learning, was first proposed by us (Pascual-Leone, 1970; Pascual-Leone & Smith, 1969).
5. Driven by both situation-specific motivations and Baldwin's excess function—which is analogous to Piaget's operative-assimilation roots of all knowing.
6. G. Miller (1956) ends his paper with a theoretical disclaimer: "Perhaps there is something deep and profound behind all these sevens [his maximum estimate of mental attention span], something just calling out for us to discover. But I suspect that it is only a pernicious, Pythagorean coincidence" (p. 96).
7. A minority of these preoperational children may also claim the contrary, that there is more in the sausage than in the ball, because it is longer. Thus, preoperational children do not mentally attend to both length and width of the object simultaneously, and fail to coordinate both dimensions.
8. There are many different examples of these vicariance structures. A familiar example corresponds to the concept of number. If we take for instance the number 7, we could say that 7 is the name for the grouping of covariances constituted by all arithmetic operations that preserve as functional invariant the number 7, i.e.,  $3+4=2+5=9-2=...$  Each of these operations can be interpreted as facets of the same arithmetic distal object 7.
9. Maturation, like the concept of development itself, has two different related meanings in psychology. One is *biogenetic*: maturation, in this biological sense (like development *in its narrow sense*, as Piaget emphasized) refers to changes largely caused by biogenetic unfolding. The other sense is *psychological*. It refers to mental or behavioral maturing/growth in individual ways of coping with situations; this is also the *broad sense* of development for Piaget. In the present text, unless stated otherwise, we mean the biogenetic sense of maturation.
10. These are action schemes boosted in their activation by affective schemes motivating them.

### Chapter 3

1. Benson-Hamstra used means and mean differences because our *M*-operator is not a latent variable but a *hidden variable*, that is, an organismic variable that is *codetermining* performance with other process variables like several sorts of learning (e.g., *LC*- and *LM*-operators), the neo-Gestaltist Field factor (*F*-operator), and so forth. This hidden variable maintains some nonlinear organismic interactions with other codetermining variables as they generate performance. Thus theory-predicted age-bound values of *M* cannot be found directly in performance. They can only be found indirectly, when quantitative relations among various mean performances are contrasted in items in which subjects' *M*-power minus the items' *M*-demand are systematically varied and compared.

2. Interrater reliability was assessed by having a second rater transcribe complete videotapes for two children in every age group. There was 86.6% agreement in assignment of semantic relation codes to the video transcriptions, and 91.7% agreement on the total score of the tasks. Differences were resolved by discussion between raters.

### Chapter 4

1. Note that *subjective* in the term *metasubjective* refers not just to psychological subjectivity but more broadly to adoption of a "from within" perspective to study the subject's own processes. There is no intended reference to psychological subjectivity, in the sense of private or relative to the subject, although this too can be studied metasubjectively. "Metasubjective" refers here to thinking and theorizing (metacognition) *from within* the perspective of a given subject-matter.

2. The terms *resemblance*, *likeness*, or *similarity* capture a key aspect of iconic codes for resistances. The old term *similarity* (*resemblance*) is ambiguous, as has been long noticed (from Aristotle to Watanabe—1969, see his "Theorem of the Ugly Duckling," p. 376). As Watanabe indicates, similarity refers to selective organismic biases in recognizing stipulated characteristics that are perhaps relevant for the individual's life (biases coming from evolution and/or experience). These characteristics emerge in praxis as recurrent resistances (recognized in the form of similarity relations) that constitute context-relative functional invariants.

3. *Semiotics*, which Peirce founded, is the logic of signs: the systematic analysis of patterns of interpretive behavior.

### Chapter 5

1. Piaget gives two complementary definitions. In 1957 he said (JPL's translation), "The scheme of an action with regard to a class of actions equivalent from the perspective of a subject, is the common structure that characterizes this equivalence" (Apostel et al., 1957, p. 46. Df. 7). A year later, he wrote: "schemes [are] the common structure of actions equivalent from the perspective of the subject (according to equivalence classes more or less large or narrow)" (Jonckheere, Mandelbrot & Piaget, 1958; p. 56, JPL's translation).

2. By *praxis* we mean conscious goal-directed activity addressed to the environment, to satisfy relatively *central* and *intrinsic* needs (direct *affective goals*).
3. For instance, imagine that walking in the forest we suddenly hear a loud sound-of-a-tree-falling (a figurative expectancy or sign) telling us that an actual tree just fell, and we must be guarded. This is because of a package of interrelated schemes we had previously internalized. This particular package gives us the causal texture of the forest environment, raising the question of whether wind or axe, or some other force caused the tree to fall.
4. Notice that *epireflection/epireflect* is a more encompassing function than Peirce's *iconic* (or *iconicity*). In our definition, epireflection can be obtained by either of two mutually compatible processes (see chapter 4): Peirce's iconic function and his indexical (i.e., associative learning) function. Either can inform (inject form into) a scheme or sign so that it reflects epistemically some relevant aspect(s) of the Real object or process at hand.
5. Updating is the executive process of changing the current content of working memory (WM, produced by mental-attentional centration) so as to drop now-irrelevant schemes and replace them with currently relevant ones; doing so without (this condition is important) changing the level or "grain" of descriptive analysis (e.g., to replace the previously heard two digits with the newly last-heard two digits). Shifting/switching is the executive function in which the content of WM is changed so that the level or "grain" of descriptive analysis is changed as well (i.e., shifted). An example of the latter is shifting attention from overall patterning to local details (e.g., from the overall face to an eye or the lips).
6. This hypothetical mechanism is clearly related to Hebb's (1949/1961) rule, expressed by the phrase "neurons that fire together wire together" (i.e., become coordinated within the same scheme).
7. This backward-and-forward analysis we use in task analysis is reminiscent of the classic method of geometry (Hintikka & Remes, 1974), as we discuss in chapter 8. A key difference of our method is that it investigates semantic-pragmatic situational *resistances* imposed by the task performance (its constraints). Our analysis does so by representing schemes that express these constraints. Further, auxiliary constructions in our method are not new figures, as in geometry constructions, but they are new schemes of various sorts that we posit and use to model the task at hand.
8. Notice that "expectancies," as used originally by Tolman and by many researchers today (implicit functional hypotheses), do not involve consciousness or conceptualization. In a footnote Tolman (1938, p. 163) said, "Let me emphasize again that an 'expectation' does not require words nor consciousness—that it is just a 'set' for a certain environmental object-sequence."
9. This is so because (with repeated *C* learning) high activation of all *C*-schemes tends to become equalized across schemes within the activated set, since they reach asymptotic levels.
10. The possibility for mental attention to effortfully interrupt or inhibit (*I*) task-irrelevant schemes can facilitate and make sharper *LM* learning.

11. This simple four-way categorization of cortical areas is useful to grasp basic differences in processing and so was used by early neuroscientists (e.g., Eccles, 1980; Luria, 1973), but it is no longer popular in neuroscience. It has been replaced by more complex and concretely refined local brain levels. We use the old categorization here because it helps to capture general functional relations between brain processes, cognitive development, and semiotics that more recent descriptions do not show as well because of their greater specificity.

## Chapter 6

1. A situation is a state of affairs in which there is an experiencing subject, object(s), and an external/internal context, in which some events and experiences (e.g., cognitions, feelings, emotions) occur to the subject.
2. An activated scheme is misleading when it is task-irrelevant and strongly competing with task-relevant schemes for application. In that case, the probability of subsequent application of task-relevant schemes is reduced, unless misleading schemes are actively suppressed (Pascual-Leone, 1969, 1989).
3. This formulation comes from Sherrington (1906) and was originally restricted to motor neurons (see also McFarland & Sibly, 1975).

## Chapter 7

1. From our perspective the input sources A and B could be understood as carrying information about figurative (object) schemes, operative (procedural) schemes, and/or adjunct-information schemes (parameters or expectancies).

## Chapter 8

1. Mereologic is the logical study of objects and their part-whole relations.
2. The task used for testing children in conservation of identity does not present a ball A, only a B ball that is transformed into a sausage in front of the child.
3. Notice that in figure 8.1 and formula (f1), the relation  $TB=B'$  is seen by the child as meaning that  $B=B'$ .
4. Such judgment  $A>B'$  occurs in children when the thickness of A appears more perceptually salient than the thinness of B'. When the thinness and length of B' are more salient, the child's judgment may instead be  $A<B'$ .

## Chapter 10

1. Mereologic (its adjective mereological) is a branch of logic founded by Lesniewski that studies part-whole relations, that is, the constitution of objects and their interrelations.

2. “Epistemic” etymologically refers to knowing; “ontic” and “ontological” refer to being, that is, Reality prior to its knowledge representation. Thus “epistemo-ontological” refers to a knowing that is truly grounded into (or true) to Reality.
3. This equilibration principle resembles other principles of general adaptation that dynamic system theories in computational rationality and neuroscience currently express (e.g., Gershman et al., 2015; Friston, 2010; Schönér, 2014).
4. Notice that we are here adopting the definition of schema currently found in cognitive science and neuroscience, which we think usually corresponds to complex schemes. Piaget had defined a schema as different from a scheme, standing for a configural representation or simplified image. We disregard such definition of schema and instead talk of figurative schemes/schemas versus operative schemes/schemas.
5. The saliency is caused, for instance, by the field— $F_s$  – perceptual-saliency factor, or by primacy or recency effects ( $C$ ,  $LC$  learning), affective factors ( $A$ ), and so on.

## Chapter 11

1. The logological mode generates a *linguistic* mode in the context of communication; as a communication tool at the service of logological processing. We omit separate reference to this important language mode and treat it as part of logological processes, although a refined study would have to separate them, because language has partly distinct but related brain expressions.
2. The learning and production of motor sequences involves a prefrontal circuit constituted (in monkeys) by F5; PreSMA; and SMA (supplementary motor area). These areas correspond, respectively, in humans to BA 44, 45; BA 9, 8; and BA 6 (Arbib, 2005; Leonard, 2003).
3. In Kant’s sense, transcendental means essentially categories or intuitive dimensions that refer not to actual experience but to processes of knowing making any experiences possible (such as, we say, innate neuroscience determinations), thus establishing possibilities and limits to experience.
4. There is also an “operative temporal” stream for producing (rather than perceiving or representing) sequences, which is located, as we mentioned earlier, in BA 44, 9, 8, 6 (e.g., Leonard, 2003).
5. Notice that to cognitively construct objects via experience one has to store temporal sequences of acts and actions in which these objects in fact intervene, so as to cognize them. Thus the identity of objects may be a by-product of this time or  $T$ -operator’s functioning.
6. This important book is available on ResearchGate: [https://www.researchgate.net/profile/Gyorgy\\_Buzsaki/publication/223130267\\_Rhythms\\_of\\_The\\_Brain/links/00b4952bb0ae609ac9000000/Rhythms-of-The-Brain.pdf](https://www.researchgate.net/profile/Gyorgy_Buzsaki/publication/223130267_Rhythms_of_The_Brain/links/00b4952bb0ae609ac9000000/Rhythms-of-The-Brain.pdf)
7. Fluents are schemes that reflect the experiential flow (Johnson et al., 1989).

8. We are grateful to Marie Arsalidou and Anton Alexandru, who separately sought out references on neurotransmitters and wrote relevant reports. Their review work has informed our neurotransmitters' model.

## Chapter 12

1. We received this quote about Bacon's "constructivist" bee from Dr. Muhammad Ali Khalidi, Department of Philosophy and Cognitive Science Program, York University.

2. Olivier Houdé was not a formal student of JPL; he attended seminars given by JPL in France and then adopted JPL's theory as his initial approach to research.



