The Working Mind

Meaning and Mental Attention in Human Development

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The Theory of Constructive Operators (TCO) is a process-qualitative causal model and, in method, might be compared with Darwin's theory of evolution. We address how our theory can be useful and discuss potential contributions to cognitive psychology, neuroscience, individual differences and cognitive styles, psychotherapy, and current notions of consciousness, self, and Will. We suggest that TCO may be helpful to human science and education because of its causal-organismic approach and methods of task analysis.

> Those who have treated of the sciences have been either empiricists or dogmatists. Empiricists, like ants, simply accumulate and use; Rationalists, like spiders, spin webs from themselves; the way of the bee is in between: it takes material from the flowers of the garden and the field; but it has the ability to convert and digest them.
>
> —Bacon, 1620/2004, XCV, p. 79[1]

> In summary, empiricism begins with the record of plain facts, science denounces this evidence to discover hidden laws. *There is no science but of that which is hidden.*
>
> —Bachelard, 1949/1975, p. 38; translation by JPL

> Come back, Piaget: Much (but not all) is forgiven.
>
> —Adey & Shayer, 1993, p. 29

The aim of this final chapter is to provide a rationale for the book and to summarize some of its key innovative ideas. First we address the approach to knowledge (epistemology) underlying our theory and methods. Most explanatory theories in psychology are empiricist or meta-empiricist. *Empiricist* theories are grounded in perception and aim to describe/analyze from an observer's (outside) perspective the phenomena relevant for the problems to be understood. *Meta-empiricist* theories are sophisticated versions of empiricism; they are mindful that the organism (in psychology) or nature (in physics) contains processes that interact in hidden ways to produce observable phenomena. This is the dominant approach in science. There is, however, a complementary, equally important approach, empirical rationalist *constructivism*.

Unlike empiricism the constructivist approach does not aim to describe phenomena from an observer's (outside) perspective. It accepts phenomena described by empiricism and meta-empiricism (including its own empirical-rationalist observations) and proceeds to investigate empirically-inferable hidden processes (in nature or in the organism), whose interactions may serve as organismic causes of the phenomenal manifestations. This alternative complementary approach is *constructivism*. The constructivist approach attempts to model hidden processes from within; this is what we have called a *metasubjective* perspective. It is complementary with, but radically distinct from, the meta-empiricist perspective. Empiricist or meta-empiricist theories tend to be local and descriptive, whereas constructivist ones are general and causal-organismic.

The two types are incommensurable in method and theory. We cannot present the one by using presentational methods of the other. For instance, one does not make constructivist theories clearer by first critically reviewing empiricist research (from an empiricist perspective) and then judging whether constructivism, in terms of empiricist standards, meets the empirical/theoretical constraints. Their respective methods are different: the old empiricist presumption that theories emerge by contrasting and comparing empiricist research data across situations is not valid for causal-organismic (or causal-nature) inferences. Constructivist theories demand other epistemological foundations in biology and evolution, to guide organismic-causal modeling. As with the theory of evolution, when it was first presented, constructivist theories must be argued using metatheoretical biological arguments and by interpreting many concrete and diverse examples that use the same constructivist organismic-causal model—as we have done repeatedly by way of metasubjective task analysis.

Copernicus may have been the first physicist to adopt a perspective from within nature's own processes—a metasubjective perspective, as we discussed in chapter 1. In biology the first scientist to adopt an explicit constructivist approach may have been Darwin. His theory and methods are empirical rationalist. His purpose is to understand hidden causal-organismic processes that enabled species of animals to evolve over the millennia from simple to complex and become more versatile and adapted. The hidden operators and principles in Darwin's evolution were inferred abductively (empirical rationalism), adopting a from-within-the-organism (metasubjective) perspective. Paraphrasing Stephen Jay Gould (2002), we can say that Darwin's theory has as metatheory a causal-organismic framework of three complementary processes in dialectical interaction (a dialectical trinity), which cause natural selection in evolution.

These three interacting constituents of natural selection are first, *overproduction of offspring* and the *agency* in these *organisms* that struggle “for their own personal advantages as expressed in differential reproductive success” (Gould, 2002, pp. 14–20). Second is spontaneous biogenetic *variation* of individual qualities and characteristics, which achieves *efficacy* “as the positive mechanism of evolutionary novelty” and can “create the fit” as well as “eliminate the unfit” by slow accumulation of useful variations across generations. Third is *hereditability*, which can ensure transmission of gains across generations, with a *scope* that explains the full diversity of continuous evolutionary change “through geological time.” According to Gould, these three causal-organismic dialectical factors produce, in their interaction, natural selection. Thus, Darwin’ theory is not empiricist but constructivist, and his empirical research aims to exhibit across species the anatomical and functional phenomena recurrent across individuals or species that support, in a constructivist manner (often through Peirce’s abductions), the causal-organismic functional framework just described.

In the Theory of Constructive Operators, a dialectical trinity of causal-organismic factors is found, somewhat analogous to what Gould (2002) described for Darwin’s theory. These three intertwined dialectical factors are first, *overproduction of schemes/structures* that internalize *resistances* from *Reality,* are self-propelling, and spontaneously seek *agency.* This is Piaget’s assimilation function. Because they actively adapt (Piaget’s accommodation) as experience accumulates, more and more schemes/schemas are formed adapting to distinct circumstances. Second is *variation of schemes promoted by other causal-organismic factors*, or innate constraints (Edelman, 1989, p. 185). In our theory, these constraints are hidden operators and organismic principles, which appear in the brain with evolution to ensure that enough schemes adapt with *efficacy* across expectable environments or milieux. Third, synthesis of all these effects produces a *functional totality* that unitizes individuals’ performance and follows a principle of Schemes’ Overdetermination. These dialectical factors codetermine together individuals’ functioning and their learning and development. These functional syntheses in the psychological organism are the counterpoint of natural selection in humans’ performance, development, and learning. Edelman (1987, 1989), with his theory of neural Darwinism, was first to formulate in neuroscience a related analogy between Darwin’s theory of evolution and the brain’s adaptive growth.

Notice that from this constructivist/evolutionary perspective, the various constructs here formulated as a dialectical trinity correspond epistemologically with Darwin’s core dialectical system and other dialectical systems of lower level. For instance, all schemes can be decomposed in self-propelling dialectical systems such as *<:rc: ec: fc:>*. That is, they are constituted by a releasing component, an effecting component, and a functional component, as described in chapter 5 of this book. However, every scheme can also be reduced to a more basic dialectical system, such as <:animal[needs]:milieu [resistances]:>. That is to say, the animal with its needs is in dialectical exchange with the surrounding milieu, which presents positive resistances that satisfy needs (by way of affordances), while the animal manages obstacles and encumbrances (i.e., negative resistances). It is in such a biologically basic system that functional emergence of new schemes appears.

The TCO model may be important for human science: it helps to explain developmental transitions from perception (proximal objects) to high cognition (complex distal objects); or from sensorimotor processing in infancy to symbolic processing in school-age children, adolescents, and adults. It also helps to integrate cognitive and affective/personal processes and integrate cognitive development with neuroscience. It provides a method of "from within" (metasubjective) process/task analysis of situated mentations. This method can produce *causal-organismic models* of mentation in tasks, which may be deeper than the qualitative methods of phenomenology, hermeneutics, descriptive process/task analysis, and so on. Our causal-organismic models yield quantitative (at times interval-scale) estimates of mental-processing task complexity and allow analysis of real-life mentation and experiences.

The TCO is a framework for causal modeling and for relating cognition, affect, interpersonal relations, individual differences, learned automatisms, mental-executive attention, problem solving, learning, intelligence, developmental growth, and so forth. It does so by deconstructing organismic processes into schemes, hidden operators, and organismic principles.

Because generic rules of organismic *schemes* are invariant across content domains and participants, the method can create process/task analytical models to compare across domains and across samples, as we demonstrated in infancy (chapter 3) and in research with school-aged children (chapter 7). Furthermore, our research may help clarify causal-organismic factors for psychometric intelligence versus developmental intelligence. Individual differences can also be modeled with our analyses.

Hidden operators are purely organismic specific regulations or resources that control development, learning, and application of schemes; *organismic principles* (such as simplicity, overdetermination, equilibration, and reflective abstraction) express rules (general regulations) for coordinating schemes and operators in specific situations.

Unlike many cognitive-science theories, the TCO is truly developmental. This aspect has real advantages: developmental constructivism could make cognitive theorizing better grounded when ontogenetic and cultural developments are incorporated and modeled. For any developmental-constructivist cognitive science, a complex cognitive (i.e., distal) object is a manifold of coordinated functional invariants (invariant across chosen situations and contexts) abstracted during meaningful goal-directed actions. Cognitive objects emerge as targets of our activities and so are called distal.

The TCO emphasizes that perception and cognition, although deeply intertwined, are different psychologically and neurologically. Consider a simple example common in both perception and art: line drawings provide essential methods for object representation. To explain and convey deeper meanings of good figurative-art drawings, we must assume that artists and observers (i.e., creative artists versus observing artists) have internalized functional models in their brains of some distal objects. Efficient generic syntheses performed by the brain (which causes representation of distal objects) are needed to explicate meaning of meaning, even in perception. Indeed, researchers may use line drawings as unambiguous stimuli. Thus, distal objects must exist as models in the brain abstracted from the Real. TCO can explain this reflective abstraction.

Scheme units adapt (accommodate and assimilate) to specific Reality constraints, the resistances. Schemes incorporate the good/positive resistances and attempt to accommodate (control) unsuitable ones. Accommodation to resistances (in order to assimilate them) helps schemes to internalize relevant aspects of Reality, allowing them to serve as mental tools for agency/praxis, as Vygotsky claimed (Pascual-Leone, 1996b). Without this postulate of Reality resistances, a general model could not explain how schemes may be useful in outer Reality.

TCO and Cognitive Psychology

The TCO can explain, process analytically, differences across age-bound developmental stages and between facilitating versus misleading processes (or situations). It also explains the necessary complementarity between automatic attention versus mental attention (Matt, the largely maturational constituent of working memory) and can deconstruct mental attention into its four key operators (Matt = <*E, M, I, F*>—see chapter 7). These operators, plus other necessary learning operators (*C, LC, LA, LM*—see chapter 5), can provide causal specific models (via process/task analysis) for the emergence of working memory, thus explicating this unclear but important construct. From the perspective of the TCO, working memory appears as a descriptive construct; it is just an estimate of mental attention after the accumulated effect of prior learning is added (schemes' repertoire, including executive schemes). In contrast, TCO gives an organismic account of how mental attention evolves, from infancy to old age, changing performance and producing, among others, the complex symbolic function (see chapters 3 and 4).

TCO also explicates differences and complementarity among various dialectical pairs of complex descriptive constructs: problem solving versus constructivist learning, or developmental/maturational intelligence versus adult psychometric intelligence, or levels of reflective abstraction versus maturational levels (epilevels)—the latter explicating proper stages of cognitive development. These constructs can in turn explain dialectical complementarity of perception versus learning versus cognition and of cognitive versus affective versus personal, psychosocial processes.

The TCO can help to integrate adult-experimental with developmental psychology, and cognitive with clinical/personality psychology. It can clarify motivation, organismic-measurement of developmental intelligence, and how babies psychologically evolve into adults. Referring to our neo-Piagetian work, Barrouillet and Gaillard (2011, p. 270) said, "Neo-Piagetian theories have the potential to account for most of the learning difficulties and developmental disorders by cumulating the strengths of the functionalist and the structuralist approaches." Some working-memory researchers now support maturational growth in mental-attention capacity (which they conflate with WM), as illustrated by Cowan's experiments in the last ten years (e.g., Cowan, 2016; Cowan, AuBuchon, Gilchris, Ricker, & Saults, 2011; Cowan, Ricker, Clark, Hinrichs, & Glass, 2015).

Limited mental-activation capacity is recognized in meta-empiricist psychology but often reduced to a maximum of four to five units. People may not always mobilize all their capacity, and so four to five may be mental-attentional units some people commonly use. However, these reduced capacity-estimates, claimed by researchers, may have a different reason: researchers do not recognize the total mental demand in a task, because they fail to count operative schemes or procedures needed to manipulate objects. Barrouillet and Gaillard (2011, p. 264) acknowledge our method: "This conception [the TCO's task analysis] consists in taking into account both the figurative and the operative aspects of the cognitive functions." Researchers on working memory have recognized this problem, which we first formulated (e.g., Pascual-Leone, 1978, 1984, 2000a; Pascual-Leone & Johnson, 2005, 2011; Pascual-Leone & Sparkman, 1980).

Reluctance in accepting fully our mental model and measures may be caused by the need to conduct task analyses and quantify mental attention. A task analysis "from within" requires change toward an empirical-rationalist (constructivist) perspective. Nonetheless, the broad impact of our task analytical method can be recognized (e.g., Arsalidou, Pascual-Leone, & Johnson, 2010; Arsalidou, Pawliw-Levac, Sadeghi, & Pascual-Leone, 2018; Burtis, 1982; Case & Okamoto, 1996; de Ribaupierre & Bailleux, 2000; Greenberg & Goldman, 2019; Morra, 2000; Niaz, 2006; Antonio Pascual-Leone, Greenberg, & Pascual-Leone, 2009, 2014; Tsaparlis, 1998).

TCO and Neuroscience

TCO constructs and methods provide a heuristic tool to study organismic-causal significance of brain networks. Much research on brain networks uses a variety of tasks to study elicited brain activity. These tasks are typically analyzed using only intuitive common sense, which often is inadequate. In contrast, our process/task analyses construct metasubjective (from within) models of subjects' semiotic activity in a task, and such models could semantic-pragmatically explicate task-related patterns of brain activity. Metasubjective models clarify meaning of activated circuits. These semiotic analyses are illustrated in chapter 11 and could advance research on the brain (e.g., Arsalidou & Pascual-Leone, 2016; Arsalidou et al., 2018; Guevara, Arsalidou, Pascual-Leone, & Stevens, 2019). TCO can help to interpret brain processes, differentiating those of cognition versus perception, versus affects or emotions, versus motivation (Arsalidou & Pascual-Leone, 2016; Arsalidou et al., 2018; Pascual-Leone, 1987, 1989, 1995; Pascual-Leone, Pascual-Leone, & Arsalidou, 2015).

A person's processing limitations in cognitive-complexity (within and across domains) can be investigated in neural networks. Also, because mental-endogenous attention (*M*-capacity in particular) is measurable across content domains (Pascual-Leone, 2019; Pascual-Leone & Johnson, 2011), units of *M*-measurement can be compared across brain areas and domains.

TCO and Individual Differences or Cognitive Styles

Adopting a causal-organismic constructivist perspective, TCO modeling pioneered a from-within process-analytical investigation of individual differences and cognitive styles. Such pioneering of a "new approach to individual differences" was recognized by Case and Edelstein (1993, p. 5), who wrote referring to our analyses of cognitive conflict and cognitive style (field-dependence-independence): "The nature of this cognitive conflict, Pascual-Leone asserted, is the same as the conflict elicited by Witkin's classic embedded figures test." Case and Edelstein (1993, pp. 5–6) concluded their comments as follows:

> Pascual-Leone was able to predict the pattern of individual differences across a remarkably broad variety of Piagetian and psychometric tasks (Pascual-Leone, 1969). In the general theoretical system that he evolved, what was seen as universal about development was its inexorable move toward greater complexity [of processing], as a result of biennial increases in mental power (*M* power). What was seen as individual about development was the particular situations to which different children were sensitive, and the particular styles or strategies that

they evolved for dealing with these situations. Field independence was just one of the styles Pascual-Leone studied. Others were *adaptive flexibility*… and *reflectivity*.

These authors appreciate our theoretical approach regarding individual differences (ID), which expresses differentials (functional specific differences) in various categories of organismic processes, yielding specific ID-formulas of metasubjective processes not emphasized in this book. The approach has had an impact on the (organismic) construal of ID variables, as illustrated by field-dependence-independence (ID cognitive style described by Witkin, e.g., Witkin & Goodenough, 1981; Witkin, Dyk, Faterson, Goodenough, & Karp, 1962). Messick (1994) explicitly sided with our conflict-analytical interpretation of FDI (Pascual-Leone, 1969, 1989), emphasizing that ID-cognitive styles were not competences or skills but dispositions (person-based unconscious probabilistic tendencies). That is, they are tendencies to adopt one of two contradictory perspectives: either pursuing *reflective cognitive restructuring* (which demands executive-driven mental attention) or reacting with *spontaneous field sensitivity* to salient aspects of experience (content-schemes sensitivity and the neo-Gestaltist field factor). As Messick (1994, p. 127) put it, echoing our TCO model, "Field independence as restructuring skill versus sensitivity to field effects." In field-independent (FI) persons, restructuring (driven by executive and mental-attentional processes) tends to be stronger; in field-dependent (FD) persons, the field-sensitivity factor (mediated by *C*- and *F*-driven processes) tends to dominate, controlling/reducing the restructuring factor (Pascual-Leone, 1989).

However, Messick (as well as Witkin & Goodenough, 1981, who also accepted our FDI formulation) points out that experimental psychologists tend to misconstrue cognitive style as a skill or competence (e.g., spatial ability). This miscontrual contradicts findings suggesting that FI and FD people are functionally different in their favored brain processes: FI people exhibit spontaneous propensity to favor use of the left hemisphere, whereas FD people have the propensity toward the right hemisphere (e.g., J. Levy, 1980, 1983). Goodman (1971) in Pascual-Leone's lab (see Witkin & Goodenough, 1981, who summarize these data) found that FD adults were much worse at disambiguating meaning of ambiguous sentences than were FI adults, thus establishing that FDI is not just a spatial structuring skill. This important finding was replicated by Lefever and Ehri (1976). Mindful of the need for causal-organismic ID research in psychology, Dr. Michael Shayer (Kings College, University of London, UK; personal communication to JPL, 2014) writes, "Another aspect of your work *should* have found its way into the education literature: that is the relation between field-dependence and your *M*-measures."

The impact of our cognitive-style TCO research, done in connection with Pascual-Leone's lab (e.g., Goode, Goddard, & Pascual-Leone, 2002; Johnson, Prior, & Artuso, 2000; Johnson & Rosano, 1993; Pascual-Leone, 1969, 1989) has been felt mostly in Europe and Latin America.

TCO and Education

Our metasubjective model of children, sensitive to individual and style differences, could be useful in education. It can help teachers to design plausible educational interventions that are different for distinct sorts of children or adults. Michael Shayer raised this issue in a personal communication (2014): "For me, in the educational intervention field, the key contribution of your work would be showing that cognitive demand of a learning task can be estimated without the backing of empirical testing of the students' success on it: that is, using an independent theory (and MTA)." By MTA Shayer means our metasubjective task analysis.

Some of TCO's influence on education and educational interventions was mediated by mentees of Pascual-Leone, such as Robbie Case (1985, 1992, 1998; Case & Okamoto, 1996), Anik de Ribaupierre (de Ribaupierre, Fagot, & Lecerf, 2011; de Ribaupierre & Lecerf, 2006; 2017) and Olivier Houdé[2] (1995; Houdé et al., 2011). Case and Edelstein (1993, p. 5) said, "The first step in this direction [i.e., specific structural analysis of individual differences relevant to Education] came from the work of Pascual-Leone (1969). In addition to carrying out more local process analyses of individual tasks, Pascual-Leone began to group the results of his analyses into broader categories."

A new line of work in science education influenced by the TCO was initiated by Niaz (1995, 2006; Niaz & Robinson, 1992; Tsaparlis, Kousathana, & Niaz, 1998), inspired by our theory and task-analytical method. Much research in science education has been directed to show relationships between science achievement and students' mental-attentional capacity, including analysis of logical-structures and their *M*-demand in science problems (e.g., Niaz, 1992; Stamovlasis & Tsaparlis, 2012; Tsaparlis, 1998; Tsaparlis, Kousathana, & Niaz, 1998). Tsarparlis and Angelopoulus (2000) have shown that there is a line of British research in science education initiated by Johnstone (Johnstone & Al-Naeme, 1991; Johnstone & El-Banna, 1986, 1989) that uses one of our *M*-measures. These authors have used our figural intersections task and have adopted (although with too much simplification and lack of explicitness) constructs similar to participants' *M*-capacity versus tasks' *M*-demand. Research in our own lab has investigated the role of *M*-capacity in children's understanding of multiplication (Agostino, Johnson, & Pascual-Leone, 2010; Pascual-Leone, Johnson, & Agostino, 2010) and use of genres in writing (Balioussis, Johnson, & Pascual-Leone, 2012).

TCO, Psychotherapy, and Emotional Change

Our work on understanding psychological processes has had an impact on psychotherapy research. Theories of clinical practice try to explain human emotional change, in terms of processes (therapeutic insight, self-knowledge, behavior therapy). Contributions to psychotherapy research initiated by Rice (1974) and greatly expanded by Greenberg, founder of emotion-focused therapy, use a dialectical-constructivist approach and methods inspired by us (Greenberg & Goldman, 2019; Greenberg & Pascual-Leone, 1995, 2001; Greenberg, Rice, & Elliott, 1993). This therapy relates to the TCO in its interpretation of affects, emotions, cognition, and method of task analysis.

To illustrate how TCO may contribute to ground theory in psychotherapy, consider Greenberg's key principle in therapy: "Changing emotion with emotion." We all have different modes/styles of experiencing and of mentation (the working mind). One is purely cognitive, another is personal (cognitive and affective)—the mode where emotions emerge. To have therapeutic effect, real human encounters (both experiential and existential) must engage actual schemes of original personal concrete experiences or problematic issues (the schemes of relevant affects and emotions re-enacted). To achieve such personal encounter, client and therapist should direct their mental attention (Matt=<*E, M, I, F*>; see chapters 7 and 10) toward a mode/style of processing embedded in personal and empathic re-experiencing, very different from cool associative remembering. These therapy-relevant intuitive personal schemes may initially be weak and need boosting with Matt to re-experience and synthesize new insights about old disturbing issues. New personal schemes formed in the human-relational (client and therapist) encounter may lead to better emotion control (via self-monitored overdetermination and reflective abstraction), and the soothing personal presence and relational modeling by the therapist could aid clients to use their attentional *M*- and *E*-power to reconstruct empathically the original emotion situation. "Changing emotion with emotion" is to rework original problem situations with open mental attention and a clear personal mind (Greenberg & Goldman, 2019). Our theory's working-mind modeling could also be useful to other psychotherapies. Despite different theories of change, all clinicians see clients with varied but related problems; metasubjective modeling of the therapy process could be useful to many sorts of therapy (e.g., Antonio Pascual-Leone et al., 2009, 2014).

TCO, Consciousness, and the Self

The TCO can contribute to understanding of consciousness as we know it, primary consciousness and self-consciousness. Paraphrasing the language of Edelman (Edelman, 1989; Edelman & Tononi, 2000) consciousness is caused by groups of highly activated and closely interconnected neurons (functionally integrated by many reentrant corticocortical and corticothalamic dual links) that, in each act of consciousness, produce a momentarily integrated *dynamic core* of activated informational processes (i.e., schemes), causing the conscious act. These core schemes are heterarchically organized with relatively high-level cofunctional neurons, which carry much information complexity (Edelman & Tononi, 2000). Similar conceptions of consciousness are found in other current neuroscientists and psychologists. Damasio (2012) and Dehaene (2014) agree with this view of Edelman, as we and many others do (Pascual-Leone, 2000a). On a first approximation (Pascual-Leone, 2000a), consciousness is the aptitude of an organism to have a distinct representation of some constituents of its own mentation (perception or cognition), feeling (affects and emotions), or willing (deliberate intentions). Damasio (2012, p. 167) has defined consciousness as "*a state of mind in which there is knowledge of one's own existence and the existence of surroundings*." Demetriou and Spanoudis (2018), using the term *cognizance*, have emphasized this intentional or causal (operative self-agency) aspect of consciousness.

Even in primary consciousness (where the self is only implicit) intentional and causal aspects can be found. In self-consciousness this is much more so. The self is always, implicitly or explicitly, at the core of consciousness. As James Mark Baldwin (1894/1968) first claimed and we all accept today, a coordinating core cluster of personal (affective and cognitive) self-schemes emerges, as self-referential functional invariants, in interaction with others and the world. When a dynamic core of consciousness is constituted by highly activated coordinating self-schemes, the self may appear in introspection—as William James emphasized; particularly the Me-self of James, that is, the person's figurative or representational self.

This Me-self appears early, in the preschool period (4 to 5 years). Our grandson, Jasper, in a surprising utterance to his father Antonio, illustrates this well. Antonio described the following exchange, when Jasper was close to 5 years old. In a dispute with his dad about nap time, Jasper suddenly retorted, "You're not the boss of me!! The inside ME is the boss of me! The inside of you thinks that you're the boss of me, but you're not!" Damasio (2012) localizes processes for this representational self in the posteromedial cortex (posterior cingulate, retrosplenial cortex, precuneus). However, there is also an operative self (James' I-self). We hypothesize this operative self to have a processing "centre" in the medial prefrontal cortex, possibly including the anterior cingulate gyrus.

Notice that these constructs of an operative self and a figurative self are not in contradiction with the Buddhist or the current psychoanalytic insistence (Safran, 2003) that the self tends to become a *no-self* and functionally disappears from phenomenological expression as persons mature (with or without meditation methods) and approach wisdom. The I-self (operative) and the Me-self (figurative) are not just phenomenological (i.e., subjectively descriptive) but are also causal-organismic—metasubjective factors in executive control. As psychological maturity and wisdom progress, these self-executive processes persist, albeit hidden, and they mature toward a low-key non-self-subjectivity/phenomenology, often providing easier-than-before empathic identification with others.

It is this causal-organismic I-self that common sense considers an agent of volitional, intentional activities (initiator of good or bad praxis). The *unconscious* (the manifold repertoires of schemes, together with hidden operators and principles) exists, but it is not a main cause of intentional behavior. Conscious intentionality, willful activity, is mostly caused by the operative self (I-self)—our repertoire of self-referring executives, action schemes, and schemas. This operative consciousness can be causally effective, because of its dominant, high level and encompassing, schemes (Edelman's dynamic core), which often are boosted by endogenous/maturational mental attention.

This is the model of intentional consciousness that our book implies, radically different from other current theories of consciousness. Edelman and Dehaene do not have an independent activation-boosting function for schemes and schemas as found in mental attention (i.e., *M*). They only seem to recognize language, and a limited unexplicated working memory, as organizer and energizer of consciousness. There is now some consensus that this limited aspect of working memory may be caused (e.g., Buzsaki, 2006) by limits in the temporal conjoint holding of schemes, which may be expressing limits in the coupling of slow (e.g., theta) with fast (e.g., gamma) brain waves (see chapter 11). This coupling would keep separate the gamma waves (which express schemes) and enable the schemes to remain both distinct and coactivated. However, to explain the causal power of intentional consciousness there is also need for an independent scheme-boosting function (*M*); otherwise, particularly in misleading situations, task-relevant schemes with low activation level could not be boosted enough to be part of the dynamic core of consciousness, the functionally dominant schemes included in the couplings. Damasio (e.g., 1999, 2012) seems to suggest that bodily affects, *primordial feelings*, may be the tacit scheme-boosters of consciousness. This is indeed important, but it would not suffice in misleading situations, because affects are often misleading in these situations; intentional consciousness must have a separate mental-attention booster if it is to attain control in difficult situations.

In chapter 3 we presented four cumulative developmental stages of emergent consciousness (see also Pascual-Leone, 1990a, 1990b, 2000a, 2000b; Pascual-Leone & Irwin, 1998). These developmental stages complement views of Damasio and other non-developmental modelers of self and consciousness. We also introduced, via task analysis, an explicit causal-organismic developmental perspective—predicated on maturational growth of mental attention.

Our model has four initial cumulative stages of consciousness, followed by other stages after self-consciousness has been achieved (refer to chapter 3 for details): *sentience* (from before birth), *protoself* (at about 8 months of age), *self1* (at about 18 months), and *self2.1* (at about 35 months). In sentience, infants can feel external stimulation without having a distinction between object and self-subject (Pascual-Leone, 2000a). In protoself, consciousness of the object (but not the self-subject) appears; in self1, there is experience of the object as well as the own self-subject, distinct and physically separate from the experienced objects. In self2.1 (at 3 years of age), the child is now distinctly aware of the object, the self-subject, and of a minimal reflective (operative) self that can intuitively contemplate self-subject and distal object co-existing in the mind. In self2.2 (at 5 years of age), the growth of mental attention allows self-consciousness to evolve into Damasio's *autobiographical self* (Damasio, 2012). The person can now reflect about her or his own life, consciously recollecting memories. Children can now recall three symbolic schemes/schemas concurrently: the object of experience, their self-subject (the one who knows), and their own reflective inner self (both I-self and Me-self) that can contemplate object and self-subject as distinct and coexistent.

Up to adolescence *M*-capacity continues growing and brings more activation energy and greater effective complexity to self-judgment and the autobiographic self, as chapter 3 explained. Damasio does not mention these developmental aspects. Later developments of consciousness are caused by growth of reflective abstraction via constructivist learning, which could increase experience and wisdom. Consciousness (including inner self) is regarded by common sense and many scientists (including William James) as a key causal determinant for planning and good reasoning.

The TCO explicates these constructs: consciousness results from strong activation of high-level and informationally complex schemes (*self-schemes*), which are often executives. These self-schemes carry multiple relevant meanings, are boosted by mental attention, and are served by progressively (developmentally) stronger knowledge schemas. Operative consciousness relates to frontopolar activity in some complex tasks, and to both frontomedial cortex (I-self) and posteromedial cortex (the Me-self—see chapter 9 of Damasio, 2012), it can serve as supervisory system (highest executive level of control) of ongoing mental processes. This characteristic has been interpreted as a mental "global workspace" or "blackboard" accessible to other cortical processes (e.g., Dehaene, 2014).

TCO and the Will

The Will exists when the self (that dynamic core of operative and figurative self-schemes) is able to judge, decide, and act intentionally on personal decisions. Freedom of choice exists if the person can judge, mindfully decide, and act congruently with the decision.

Judgment is essential in acts of Will (psychologically, judgments are dynamic syntheses that appraise alternatives, driven by conscious processes, executives, the self, and mental-attentional effort). Unconscious automatisms or overlearned habits (shadow schemes) do not override freedom when the Will (inner self) is strong enough—when people are project driven and responsible. Common sense agrees with this conclusion, but some psychologists (e.g., B. F. Skinner), neuroscientists, and philosophers think of humans as refined versions of animals of habit and associative learning. These researchers doubt the scientific reality of Will, self, and freedom. It is possible to justify Will and the inner self scientifically. We shall not review this literature, to which we made a small contribution (Pascual-Leone, 1990a, 1990b). Neuroscience is beginning to see where these hubs of scheme-coordination and structuring are found in the cortex (e.g., Damasio, 2012; Edelman & Tononi, 2000).

Jaspers, the distinguished existential philosopher and psychiatrist, maintained similar views when he wrote, "Volition is a *relation to oneself*, a self-awareness in which I am the object of my active conduct rather than my contemplative scrutiny. … as Kierkegaard put it: 'The more will the more self'" (Jaspers, 1970, p. 135). Thus, power of the Will stems from the person's *operative self*, related to the use of mental attention to boost task-relevant complex operative schemes/schemas driven by executive schemes. As William James (1892/1961) wrote, "*Effort of attention is thus the essential phenomenon of the will*" (his own italics, p. 317).

Arguments against Will and against freedom (B. F. Skinner, 1971) show that the key issue is not so much existence of Will but its capacity to overcome many overlearned bad habits, addictions, unconscious misleading dispositions, and automatic social conventions (i.e., shadow schemes and what has been called *outer self* or *persona*). These are tendencies in the person that may oppose/disrupt willful plans and cause failure. Unless we can explain how truly novel (creative) willful achievements can be reached against shadow schemes and other misleading factors (which established theories often fail to do) the existence of human freedom may be denied by science, contradicting key assumptions of democratic societies. The TCO explains Will and freedom by recognizing, in its theory and in brain processes, constructs and sites for executive processes, mental attention (Matt), the inner self (operative I-self and figurative Me-self), as well as the outer self or persona. TCO has constructs and methods of process/task analysis to identify relevant neuropsychological constructs by interpreting neuroscience.

The Matt system can boost task-relevant schemes and inhibit irrelevant ones, and after training by others and via self-reflection, it can lead the inner self to seek new social contexts and social environments (suitable new milieux) that could compel the person (even against bad habits and dispositions) to acquire needed missing schemes good for the willed project. Complex professional careers of all sorts proceed willfully in such intentional trial-and-error. Affects, emotions, life projects, the willful inner self explain (together) the seeking and choice of new milieux that appear project-suitable and could develop the person (outer and inner self) as was intended by the inner self—the milieu offering opportunities for learning, social networking, and acquisition of suitable skills.

The active working of a primitive but willful self can already be found in infancy. A good example was given in chapter 2, in the section The Meaning of Meaning. Piaget's (1948/1963, p. 249) Observation 133, about his 9-month-old daughter, Jacqueline, illustrates this intertwining of affect and incipient willful self-choice in young infants (when the Will is likely boosted by sensorimotor mental attention). Talking about her, Piaget said, "She likes the grape fruit in a glass but not the soup in a bowl.... When the spoon comes out of the glass she opens her mouth wide, whereas when it comes from the bowl, her mouth remains closed" (see discussion in chapter 2). Thus, Jacqueline acts intentionally, using circumstantial cues, to assert and bring about her "project"—her choice of food.

We can briefly illustrate more advanced self-heuristic strategies by describing how an adult (JPL) willfully changed his life from being a medical psychiatrist to becoming a research psychologist and co-author of this book. This was done with a succession of conscious decisions that used circumstantial cues from the milieu's situational conditions (as Jacqueline did) to progressively (with some good luck) transform his life and himself in the chosen/intended direction that he envisioned in his life project. JPL was a young psychiatrist in Spain during the 1950s, who (right or wrong) felt psychiatry often lacked analytic insights into the person's (inner self) feelings, thinking, and causal individuation or developmental processes. JPL's overambitious life project was to help correct this deficiency. He reckoned that working with Piaget (an author discussed in a significant psychiatry handbook he had studied) could help advance his project. He sought and obtained a Spanish fellowship to study with Piaget in Geneva, Switzerland. This four-year experience made him a Piagetian developmental research psychologist. Then, recognizing the importance of individual differences and styles, he discovered (in psychiatry books and with advice from Inhelder, Piaget's key collaborator) the work of Herman Witkin in New York. He wrote to Witkin, who obtained a fellowship for JPL to spend the following year (1964) in New York. Thus, in 1964 he worked in Witkin's New York lab and tested (with help from three lab assistants) New York children and adults for his doctoral thesis.

This experience made JPL knowledgeable in cognitive-style and individual-difference research, including psychometric intelligence, which he related to Piaget's developmental intelligence. He was now a true cognitive-developmental researcher with original ideas. When, after a year, he was forced to leave the United States because of his visitor's visa, he decided to take a job in Canada—to continue using English, because his New

York data had to be analyzed. Two jobs were offered to him: one as psychiatrist in a hospital in Quebec, the other as assistant professor in psychology at the University of British Columbia. He took the latter (with less pay) to advance his knowledge of North American psychology, postponing a return to psychiatry. JPL was naive; he never returned to psychiatry. Four years later he was associate professor of psychology at York University and was doing research on which this book—more than fifty years later—is based. As in Jacqueline, but with more complexity, acts of Will to change milieux, and the milieux reactions (and some amount of good luck) brought JPL to be the one that his inner self and Will had foreseen—via willful existential trial and error.

At every turn, Jacqueline and JPL had been confronted with decisions about what to do next; they consistently decided in a direction closer to their own preferences or intended goals. Thus, good advice, a bit of luck, and many acts of Will (Matt-operations, executive-driven, and motivated by affect-loaded long-range plans) can bring willful goal-seekers to new milieux that progressively help to change the person and approach his or her life choices.

Brief Conclusions

In this final chapter we have examined epistemological aspects of our theory, the TCO, and compared its constructivist (empirical rationalist) approach to that of Charles Darwin's theory of evolution, to contrast differences between constructivist (empirical rationalist) science and empiricist science. Then we briefly discussed contributions that TCO and its methods could make to relevant areas of human science: cognitive psychology, neuroscience, education, psychotherapy and emotional change, consciousness, the self, and the Will.

For the purpose of brevity, we have not summarized the book, because the abstracts of chapters already do so. Instead, we re-emphasized constructivism in the context of two very distinct sciences, biology and psychology, following up the reference to Darwin's theory (Edelman, 1987). We hope to have given pointers to how TCO could be used as tool for thinking and analysis across domains, including education, where causal-organismic theories are still rare and not often available. Kurt Lewin, a Gestalt psychologist and eminent researcher on human relations, thought that there is nothing as practical as a good theory. Jean Ullmo (a French constructivist epistemologist and physicist) reached the same idea in a more concrete manner: "An experiment is a theory in action; an instrument, a materialized theory; a scientific concept (the sun, the atom of carbon) an objectified theory" (Ullmo, 1967, p. 657, translated by JPL).