

POLYLOGE

Eine Internetzeitschrift für „Integrative Therapie“
(peer reviewed)

Materialien aus der „Europäischen Akademie für
biopsychosoziale Gesundheit, Naturtherapien
und Kreativitätsförderung“

2001 gegründet und herausgegeben von:

Univ.-Prof. Dr. mult. **Hilarion G. Petzold**, Europäische Akademie für biopsychosoziale Gesundheit, Hückeswagen,
Donau-Universität Krems, Institut St. Denis, Paris, emer. Freie Universität Amsterdam

In Verbindung mit:

Dr. med. **Dietrich Eck**, Dipl. Psych., Hamburg, Europäische Akademie für biopsychosoziale Gesundheit,
Hückeswagen

Univ.-Prof. Dr. phil. (emer.) **Liliana Igrić**, Universität Zagreb

Univ.-Prof. Dr. phil. (emer.) **Nitza Katz-Bernstein**, Universität Dortmund

Prof. Dr. med. (emer.) **Anton Leitner**, Department für Psychosoziale Medizin und Psychotherapie, Donau-Uni. Krems

Dipl.-Päd. **Bruno Metzmacher**, Europäische Akademie für biopsychosoziale Gesundheit, Düsseldorf/Hückeswagen

Lic. phil. **Lotti Müller**, MSc., Psychiatrische Universitätsklinik Zürich, Stiftung Europäische Akademie für biopsychosoziale
Gesundheit, Rorschach

Dipl.-Sup. **Ilse Orth**, MSc., Europäische Akademie für biopsychosoziale Gesundheit, Düsseldorf/Hückeswagen

PD Dr. **Sylvie Petitjean**, Universität Basel

Prof. Dr. phil. **Johanna Sieper**, Institut St. Denis, Paris, Europäische Akademie für biopsychosoziale Gesundheit,
Hückeswagen

© FPI-Publikationen, Verlag Petzold + Sieper Hückeswagen.

Polyloge ISSN 2511-2732

Ausgabe 14/2019

Recent developments in cognitive neuroscience from the
perspective of *Integrative Therapy*

Robert Stefan, BA MA MSc ..*

* Aus der *Karl Landsteiner Private University for Health Sciences*, Department *Psychology and Psychodynamics*,
Division Psychodynamics, Krems, Austria, Psychotherapist (*Integrative Therapy*) in Krems and Vienna, Austria
Research funded by Fonds Niederösterreichische Forschung und Bildung (NFB) [SC16-025]

In Verbindung mit der „Europäischen Akademie für biopsychosoziale Gesundheit, Naturtherapien und
Kreativitätsförderung“ (EAG), staatlich anerkannte Einrichtung der beruflichen Weiterbildung, Hückeswagen
(Leitung: Univ.-Prof. Dr. mult. Hilarion G. Petzold, Prof. Dr. phil. Johanna Sieper. Mail: forschung@integrativ.eag-fpi.de,
oder: info@eag-fpi.de, Information: <http://www.eag-fpi.com>).

Summary: Recent developments in cognitive neuroscience from the perspective of Integrative Therapy

This article examines current developments in cognitive neuroscience from the perspective of Integrative Therapy. Starting from the integrative concept of the informed body and its predecessors, questions and problems that arise with the integration of theories from the cognitive neurosciences are discussed. On the one hand, recent developments in the cognitive field have strengthened many basic assumptions of Integrative Therapy. On the other hand, naturalistic research on the brain is in need of the phenomenological-hermeneutic method in order to not lose sight of living, embodied subjectivity.

Keywords: 4E cognition, active inference, cognitive neuroscience, *Integrative Therapy*, predictive processing,

Zusammenfassung: Neueste Entwicklungen in der kognitiven Neurowissenschaft aus der Perspektive der integrativen Therapie

Der vorliegende Artikel untersucht gegenwärtige Entwicklungen in den kognitiven Neurowissenschaften vom Gesichtspunkt der Integrativen Therapie. Ausgehend vom Begriff des informierten Leibes, dessen Herkunft skizziert wird, werden Fragen und Probleme diskutiert, die bei der Integration von Theorien aus den kognitiven Neurowissenschaften begegnen. Es zeigt sich einerseits, dass durch gegenwärtige Entwicklungen im kognitiven Feld viele Grundannahmen der Integrativen Therapie gestärkt werden, andererseits aber auch, dass die naturalistische Forschung am Gehirn immer auch auf die phänomenologisch-hermeneutische Methode verwiesen bleibt, um die lebendige, leibliche Subjektivität nicht aus den Augen zu verlieren.

Schlüsselwörter: 4E cognition, active inference, kognitive Neurowissenschaften, *Integrative Therapie*, predictive processing,

Introduction

Science is constantly producing new research results and knowledge, Integrative Therapy, which centers around the concept of the lived-body, constantly investigates its core foundations. It is the responsibility of scientifically based psychotherapy to understand and critically examine results from related sciences and, if necessary, to integrate them.

In the future, essential developments for integrative forms of psycho- and body therapy, their theory and practice, can be expected from medicine, especially from neurophysiology and the neurosciences, especially the cognitive neurosciences. (Petzold 2003a, 55 [translated by R.S.])

In what follows, currently much-discussed theories from the cognitive neurosciences are presented and examined within the framework of Integrative Therapy. The basics and essentials of the concept of the lived-body are fleshed out in order to understand what is important for Integrative Therapy with regard to the integration of models from neighboring disciplines. After that, I will present important findings on the current state of cognitive neuroscience, which investigates the social, ecological, anticipatory and predictive aspects of the lived-body. This is followed by a synopsis and some critical reflections from the perspective of Integrative Therapy.

Integrating cognitive neuroscience

From the perspective of subjective bodily experience by means of the phenomenological method, tension may arise if one aims at integrating findings and theories of cognitive science or neuroscience. Regarding the mind-body or mind-brain problem, Andy Clark sums up the classical perspective in cognitive science which is commonly endorsed by neuroscience as well.

The computer scientist Marvin Minsky once described the human brain as a meat machine – no more, no less. It is, to be sure, an ugly phrase. But it is also a striking image, a compact expression of both the genuine scientific excitement and the rather gung-ho materialism that tended to characterize the early years of cognitive scientific research. (Clark 2014, 7)

Since the so-called decade of the brain that was postulated in 1990 it has been quite common to define everything in terms of brain-centered determination. It's for example not very controversial these days to claim the following: "[T]he world around you, with its rich colours, textures, sounds, and scenes is an illusion, a show put on for you by your brain..." (Eagleman 2015, 37)

More often than not the brain is thus conceptualized as a passive computer device sitting in our skulls, calculating inputs in order to produce the illusion of a phenomenal world. The respective Illusion gives rise to thoughts and makes us act in some way or another eventually. Eagleman goes on to say: "If you could perceive reality as it really is, you would be shocked by its colorless, odourless, tasteless silence." (Ibd., 37) Accordingly, the brain-centered view results in a position that can be termed reductive physicalism or reductive brain-centered functionalism (Stefan 2019).

As with most sciences which have the concept of the *embodied mind* at the core of their theorizing, Integrative Theory draws a lot from the French pioneer of phenomenology

Maurice Merleau-Ponty. What is particularly interesting about Merleau-Ponty's philosophy is that he was always engaged with empirical research, which is why current neuro-cognitive research could be inspired by him and can therefore be connected to him. In following Merleau-Ponty, most importantly, from an embodied perspective, we must not epistemologically abandon subjective bodily experience in favor of some reductionist form of physicalism.

The physicist's atoms will always appear more real than the historical and qualitative face of the world, the physico-chemical processes more real than the organic forms... as long as the attempt is made to construct the shape of the world (life, perception, mind) instead of recognizing, as the next source and as the ultimate court of appeal in our knowledge of these things, *our experience* of them. (Merleau-Ponty 1962, 20 [italic emphasis added])

In short: if we take physico-chemical brain processes as our epistemological or ontological foundation (alone), we run into trouble in terms of not being able to make full sense of our *subjective bodily experience in our worldly engagement*. Because the lived-body is not “a spatiality of position, but a spatiality of situation”. (Merleau-Ponty 1962, 100) The lived-body cannot exhaustively be explained by its spatio-temporal position, since it is a situated lived-body from the first-person-perspective. “My body is wherever there is something to be done.” (Ibd., 224). Trivial or innocent as this may seem, this is, in a nutshell, the very core of what is nowadays being called the *embodied, enacted mind*. The lived body never stands still, it is in constant action and interaction, it is a constant doing in motor or operative intentionality, even if it is not purposely doing anything and it has an irreducibly subjective aspect (Fuchs 2018).

Merleau-Ponty speaks of the *bodily being-to-the-world*. Being-to-the-world is a dynamic and active being. What is meant is a certain way to treat the world, being towards the world (*d'être au monde*) or to exist (cf. Merleau-Ponty, 1974, 141-142). To be and to exist in the world means to be in a kind of mapping towards the future. The body-subject is always intentionally mapped towards a future space of possibility. It is situated in a phenomenal field, which it creates and from which it draws itself within this field (Stefan 2018).

In the concept of the “informed body” (Petzold 1988n, 192) a multiplicity of body concepts of phenomenological and hermeneutic thought as well as neuroscientific insights, in particular also neuromotor concepts, are brought together in an integrative concept of the body.

From the interplay of the lived-body and the mundane, humans can develop as personal body-subjects as world-rooted corporeality in processes of continuous mutual resonances of mentalization and embodiment...

The “informed body” contains and reflects interiorizations of “collective mental representations”..., i.e. ways of “thinking, feeling, wanting, communicating” and ways of “perceiving, neurophysiological processing and sensory-motor action”. (Petzold & Orth 2017a, 14 [translated by R.S.]

All these processes have formed and informed the lived-body in the phylogenetic processes of hominization and still form it in the ontogenetic processes of socialization, enculturation

and ecologization. All information that forms the lived-body, all interiorizations, mentalizations and habitus formations in turn preform the body-subject's coping with life in its social and ecological environment and are thus the basis of self-control and cultural work (Petzold & Orth-Petzold 2018a, 374).

The informed body is thus a hub of experience and future possibilities. It is a capacity to feel, to understand and to see. This capacity is predisposed by the "body memory" (Petzold 2009c). Experiences sediment and habitualize to bodily faculties, habitus formation, attitudes, actions and behavior. If one speaks of an experience or consciousness of the "here and now", body memory and anticipations are always already integrated in a vital, existential relation to the world with its possibilities. A body-subject is never to be thought of as pure here and now or as worldless, even if it seems to be able to temporarily detach itself from its lifeworld through highly focused efforts of deep abstract meditation. The neuroscientifically supported research on *grounded cognition* and *situated conceptualization* shows that cognitive processes are always determined by microecological context conditions, by *situatedness* (Barsalou 2008; 2016). The intentional entanglement of subject and world and thus of space and time, past and future can be disturbed or permanently deprived, but the *chiasm*, the crosswise entanglement of subject and world cannot be dissolved as long as life is alive (Merleau-Ponty 1968).

So, to summarize this section: Integrative Therapy with the concept of the informed body at its core is, on the one hand, by no means just body therapy. On the other hand, it does not treat isolated psyches in bodies detached from social and ecological contexts and continua.

Current Developments in the Cognitive Science and the Neurosciences

It should be noted that non-reductive, non-brain-centered models of the brain and its functioning have been increasingly established in the mainstream of neuro- and cognitive science research in recent years. For example, the emergence of social neuroscience has brought about changes in theory formation (Cacioppo & Decety 2011; Decety & Ickes 2009). The brain is no longer conceptualized as a passive but all-determining, information-processing, individual computing device in the skull, but as an *irreducibly social brain* (Freeman 1995; Frith 2007). Brains, in this line of reasoning, are always already geared towards social interaction. Likewise in cognitive science, where cognition was long regarded as internal symbol or information processing, cognition is now understood as an *embodied, socially extended and environmentally embedded* phenomenon (Gallagher 2017).

From the nineteen-eighties onwards, the terms *embodied, enacted, embedded cognition* developed (Di Paolo & De Jaegher 2015; Hutto & Myin, 2012; 2017; O'Regan & Noë 2001; Noë 2004; Petzold 2002j). Leading in this field were neuroscientists and cognitive scientists, who also had interest and knowledge in phenomenological philosophy. Said authors tried to combine phenomenology and cognitive science before embodiment was on everyone's lips, as a result of the so-called bodily turn – one of many periodically occurring turns in the human sciences. Furthermore, the concept of extended mind or extended cognition has caused controversial debates (Clark & Chalmers 1998; Clark 2008). Today, all of this is simply referred to as 4E cognition (Newen, de Bruin & Gallagher 2018).

Integrative Therapy, well aware or sometimes even ahead of these sorts of developments, speaks of the *processual embodiment of the world and the embedding of the body subject in context/continuum*, which also includes ecologisation (Engemanna et al. 2019; Petzold 2002j; Petzold & Orth 2017b). Thus, and, in some way as a result of these lines of reasoning, Integrative Therapy has always already included "new natural therapies" like

garden-, landscape-, forest-therapy or green meditation (Petzold, Ellerbrock & Hömberg 2018).

Predictive processing and active inference models

At present, the predictive, i.e. anticipatory or prospective performance of the brain, but also its situational adaptations to social and ecological contexts, are being studied particularly in cognitive science and neuroscience (Barsalou 2016; Clark 2016; Friston 2018; Petzold 2018c). The so-called *predictive coding approach*, also *predictive processing theory* or *prediction error minimization theory* is currently a hot topic in the field.

In the 20th century we thought the brain extracted knowledge from sensations. The 21st century witnessed a “strange inversion”, in which the brain became an organ of inference, actively constructing explanations for what’s going on “out there”... (Friston 2018, 1019)

It is intended to be a universal theory that claims to provide a common theoretical and conceptual framework for all disciplines entrusted with mind and body, such as philosophy, psychology, cognitive science and, of course, the various branches of neuroscience (Clark 2013; Friston 2010). This theory is based on sophisticated mathematical operations, which make the model interesting not only for cognitive science but also for artificial intelligence research and robotics (Linson et. al. 2018).

The current predictive processing approach is mainly inspired by Hermann von Helmholtz, who in his day regarded perception as an unconscious testing of hypotheses and explanations of external causes in relation to internal effects. Accordingly, the task of perception is to estimate the causes of the stimuli that affect the organism via the senses by means of presuppositions and thus to predict them (Clark 2016; Friston 2010; Hohwy 2013; Seth 2019).

In predictive coding schemes, neuronal representations in higher or deeper levels of neuronal hierarchies generate predictions about representations in lower levels. These descending predictions are compared with lower-level representations to form prediction errors, which are passed back up the hierarchy to update higher-level representations... (Seth 2019, 241)

“Prediction” means a process that interprets the incoming data with probabilities, typically with unconscious expectations and beliefs. An essential component of predictive processing models is that these probabilities are calculated with Bayesian statistics. Thus, within the field, there is talk of a Bayesian brain (Seth 2019).

Explanations, hypotheses and beliefs should in this context be understood not as consciously held mental states, but as neuronally encoded probability distributions (i.e. Bayesian beliefs) over the hidden causes of sensory signals. (Seth & Friston 2016, 1)

The brain or the neural network tries to control and regulate the incoming stimuli in permanent feedback processes by means of presuppositions or assumptions that are as suitable as possible. If there is a prediction error and thus a surprise, a state of increased attention and arousal arises.

This means that in predictive processing models, perception and action are closely linked, and reductive computer models of the mind, in which a passive system receives information and stimuli from its environment, which it then calculates and processes, are rejected (Clark 2013; Seth & Friston 2016). In the predictive processing paradigm, the organism-environment-interaction is one of permanent anticipation, or, if mistakes arise, a cascade of adaptations and improvements, which successively lead to an ever more fitting inner model and corresponding mental representations of the world. According to the predictive processing approach, the organism generates hypotheses as prior beliefs in order to predict the variability of the world in the best possible way.

Inner models of these actions and interactions with the environment are subsequently created, these so-called *generative models* function as *neuro-cognitive schemes* for most efficient processing of stimuli and are constantly evolving (Friston 2012a). The predictive processes aim at the highest possible coherence in the sense of the precision of the assumptions with reference to the generative models (Seth 2019). Within this framework, further theoretical developments aim at addressing action-perception cycles as active inference.

Active inference: a formulation of self-organization that extends predictive coding to include action, planning and adaptive behaviour – explained in terms of minimizing the surprise (i.e., free energy) expected under a course of action.
(Pezzulo, Rogoli & Friston 2018, 295)

The active inference approach within the predictive processing framework uses concepts of thermodynamics, which reformulate the predictive processing model with quantifiable mathematical terms in order to bridge the gap to empirical-experimental research. The purpose of active inference is to reduce errors in predictions and the resulting cognitively demanding surprises in order for the system to lose as little energy and to maintain itself in its operative state as good as possible (Friston 2012b). In the respective terminology, the aim is to avoid entropy. “Entropy” means a measure of disorder or disturbance, “the law of entropy [is] simply a law of increasing disorganization.” (Nicolis & Prigogine 1993, 4) The concept of the free energy principle is associated with the assumption that a system always strives to prevent disorganization and the irreversible outflow of energy, in order to prevent the increase of entropy (Friston 2012c).

The following is decisive: As soon as the active behavior of a living organism is involved, predictions do not simply precede or “wait” for the incoming stimuli. The organism becomes proactive itself. The brain has two possibilities to adapt its predictions and generative models to the world. It either finds the best explanation for the incoming sensory signals in perception, or it changes the modality of the sensory signals by its own activity in order to adapt them to the assumptions.

Active inference emphasizes that prediction errors can be minimized either by updating predictions (as in standard predictive coding schemes), or by changing sensory inputs via action, to match predictions. (Seth 2019, 242)

Clark (2018) and Seth (2015) argue that by means of active inference, the system also works with variations or modifications of the generative models which are added to and tested in the inference process. Through the tight coupling of anticipation and action, with which the organism permanently tries itself out on its environment, a context-sensitive conception of

the organism-environment-relationship emerges, as Barsalou (2016) has also pointed out with the model of *situated conceptualization*. Against highly influential (neuro-)philosophers and cognitive scientists of the likes of Dennett (1991) or Metzinger (2015), for example, who have discredited the phenomenological research program strongly and blanketly, it seems that essential phenomenological basic principles, which are also at the very core of Integrative Therapy, are confirmed and strengthened by the predictive model.

“A central claim of this ‘active-inference’ view is that top-down predictions and bodily actions co-evolve in circular and self-organizing ways.” (Miller & Clark 2018, 2561) Against the background of integrative metatheory, in which, as explained above, context/continuum cannot be detached from the body subject, and in which *co-creative, co-relative and autopoietic* processes play an important role, this is a welcome thrust. Here are a few of Andy Clark’s very ambitious claims for a universal theory of action, cognition and perception by means of the predictive framework:

Our ongoing sense of embodiment ... depends upon accommodating the full (interoceptive and exteroceptive) sensory barrage using a generative model whose dimensions crucially track aspects of ourselves. (Clark 2016, 231)

[I]nteroceptive, proprioceptive, and exteroceptive predictions are constructed differently in different contexts, and each provides guidance to the other. A single inferential process here integrates all these sources of information, generating a context-reflecting amalgam that is experienced as emotion...

PP models also illuminate a variety of pathologies and disturbances, ranging from schizophrenia and autism to “functional motor syndromes” (in which expectations and altered assignments of confidence (precision) result in false sensory “evidence” of illness or injury). (Clark 2016, 3)

One may wonder how many of these cheques can be cashed in the future. Shaun Gallagher appreciates that “an emphasis on active inference leads to a recognition of the importance of embodiment and interaction, reflected in recent dynamical variants of predictive coding” but also points out that “emphasizing only the first type of operation, prediction-error minimization, PC [predictive processing, R.S.] remains strictly internalistic, and active inference only serves the central processes that do the real work.” (Gallagher 2017, 25) According to this critical remark, much hangs on the way embodied enactivism is conceptualized within the predictive framework. “[O]n the enactivist model the dynamic adjustment/attunement process that encompasses the whole of the system is not a testing that serves better neural prediction; active inference is not ‘inference’ at all, it’s a doing, an enactive adjustment, a worldly engagement.” (Gallagher 2017, 27) At least as far as Andy Clark’s line of theorizing goes, Gallagher’s critique is only partly grounded, because Clark claims that “the whole embodied organism... is treated as a prediction-error minimizing device.” (Clark 2015, 3|7)

For the test of a good model is how well it enables the organism to engage the world in a rolling cycle of actions that maintain it within a window of viability. The better the engagements, the lower the information-theoretic free energy... (Clark 2015, 4|7)

Emotion, cognition, and preparation for action here form a single whole, selforganized around precision weighted, prediction-error minimizing interactions that span cortical and sub-cortical circuits. These interactions couple the active body to the predictive brain. (Miller & Clark 2018, 2572)

It has already been highlighted that in active inference models the successful congruence of assumptions and stimuli is assumed as goal orientation of the organism in its environment. The main and exemplary issue here was adaptation to the environment, i.e. exteroceptive active inference. Seth and colleagues (2012) discuss an interoceptive inference model for better understanding of the feeling of subjective presence. At stake here is the subjective impression or feeling of presence of oneself and the world – Integrative Therapy speaks of *eigenleibliches Spüren* (Petzold & Orth 2017a; b): *feeling in one's own lived body*, that conveys the sense of and reference to reality for the body-subject. "Presence" here means that one has an integrated consciousness of oneself as a self-effective actor in the world.

The core concept of the model is that a sense of presence arises when informative interoceptive prediction signals are successfully matched to inputs so that prediction errors are suppressed. (Seth et al. 2012, 3)

This is necessary for the general orientation of the subject in its environment. Seth and colleagues believe that too strong a prediction error would dissolve the feeling of integrated presence, which could be the basis of schizophrenia, for example. According to this model, certain psychopathologies could then be a disruption of the interoceptive predictive processes. But even in less or non-pathological cases, it could be experimentally demonstrated that higher ability to predict interoceptively would be accompanied by higher personal autonomy and sovereignty (Seth & Friston 2016). From an IT point of view, presence experience alone is not sufficient, it must be "sufficiently coherent presence", as Petzold (2018k, 910) emphasizes in his autocasualistic description of a postoperative transit syndrome with reference to interoception theory.

Discussion and outlook

The core statement of predictive processing models is that brains do not sit passively inside skulls and receive information from the world. Since its beginnings, Integrative Therapy has emphasized the dimension of active anticipation and focused on the development and advancement of anticipatory competence. Clinically, anticipatory competence was taken into account by the development of specific techniques. Methods such as *time travel*, the *future projection*, the *anticipatory life panorama*, the *mapping of life goals*, etc., linked back to the life span developmental theory of Integrative Therapy, to its practice of *éducation permanente*/ life long learning and its methodologies of preparation for retirement and ageing, show this just as much as its theory of time (Petzold 1981g; 1991o; 2010r). The task of brains in contemporary predictive models is to best support the organism in which they are embedded. Brains help by being dynamically and interactively connected to the structures of the world in multiple spatial and temporal dimensions.

Such a view is very well compatible with the metatheory and clinical theory of Integrative Therapy, in which such approaches, and in particular the biomechanical and neuromotor pioneering work of Nikolai Bernstein (1967), were adopted early on. In his theories, Bernstein has developed a synthesis of corporeality and cognition in the sense of

what's now called embodied, enacted cognition (Biryukov & Sirotkina 2014). Bernstein "stressed the central role of the relationship between body and brain morphology. He emphasized the important role of behavior ('effector function') in the survival and evolutionary success of organisms." (Spons & Edelman 1998, 283) With Bernstein, movement is always mapped onto the future, which in Integrative Therapy led to the concepts of emphasizing *anticipatory competence* and *proactive action* in context/continuum, i.e. in the world and in the lifespan (Petzold & Orth 2017a; b; Sieper 2007b).

Integrative Therapy thus has a solid basis and welcomes the theoretical support from current theory formation on predictive processing models in the cognitive neurosciences, just as it has good interfaces to the context-oriented ecological neurosciences (Petzold 2018c), which focus on situatedness. With the "Tree of Science" (Petzold 1994a; 2003a), Integrative Therapy has developed a meta-theoretical integration model with which concepts of the predictive coding model can be critically examined and thus used with regard to a general psychotherapy science that crosses methodological boundaries.

With this model, wariness is due with regard to concepts such as entropy and the free energy principle. Such terms from thermodynamics, which primarily describe physical micro- and macro-processes, should be considered with caution in highly complex *living organisms* such as body-subjects. Category errors, such as the physical interpretation of biological phenomena, need to be avoided. One also needs to consider that nature is often wasteful in finding new solutions, for example in bifurcations or multiple neuron sprouting in the pubescent or adolescent brain, which are drawn in by later pruning when they are not used. According to the free energy principle, the brain constantly tries to deal with the problems of an unsafe and variable world in the best possible way in order to keep the organism in a good enough balance. However, the organism does not only seek rest and sufficient balance, but also stimulation. Explorative curiosity is an essential basic drive (Hüther 1996; 1997; Petzold 2003e; 2007d). This shows how any thorough physicalist theory like the active inference approach seems to be at odds with regard to the informed body, which has an irreducible subjective aspect.

The predictive processing model and particularly the active inference approach in the cognitive neurosciences are nevertheless helpful theory formations which, with the limitations mentioned, are already taken into account by Integrative Therapy. In many respects, they confirm quite fundamental phenomenological and hermeneutic insights into the temporal structure of intentional consciousness, albeit with the reductionisms owed to the neuroscientific method, which must always be critically reflected.

Bibliography

- Barsalou, L.W. (2008). Grounded cognition. *Annual Review of Psychology*, 59, 617-645.
- Barsalou, L.W. (2016). Situated conceptualization: Theory and applications. In: Y. Coello & M. H. Fischer (eds.), *Foundations of embodied cognition, Volume 1: Perceptual and emotional embodiment* (p.11-37). East Sussex, UK: Psychology Press.
- Bernstein, N. (1967). *The co-ordination and regulation of movements*. Oxford: Pergamon Press.
- Biryukov, E. V. & Sirotkina, I. E. (2014). Futurism in Physiology: Nikolai Bernstein, Anticipation, and Kinaesthetic Imagination. <http://www.nadin.ws/ante-study/wp-content/uploads/2014/08/Biryukova-Sirotkina-Futurism-in-Physiology-ed.v2.pdf> (retrieved 11.11.2018).
- Cacioppo, J. T. & Decety, J. (2011). Challenges and opportunities in social neuroscience. In: *Annals of the New York Academy of Science*. 1224(1), 162–173.
- Clark, A. (2008). *Supersizing the Mind: Embodiment, Action, and Cognitive Extension*. Oxford: Oxford University Press.
- Clark, A. (2013). Whatever Next? Predictive Brains, Situated Agents, and the Future of Cognitive Science. *Behavioral & Brain Sciences* 36(3), 181-204.
- Clark, A. (2014). *Mindware. An Introduction to the Philosophy of Cognitive Science*. Second Edition. Oxford: Oxford University Press.
- Clark, A. (2018). Beyond the 'Bayesian Blur'. Predictive Processing and the Nature of Subjective Experience. *Journal of Consciousness Studies*. 25(3–4), 71–87.
- Clark, A. & Chalmers, D. J. (1998). The Extended Mind. *Analysis*, 58, 7-19.
- Decety, J. & Ickes, W. (eds.). (2009). *The social Neuroscience of Empathy*. Cambridge: MIT Press.
- Dennett, D. C. (1991). *Consciousness explained*. New York, NY, US: Little, Brown and Co.
- Di Paolo, E., De Jaegher, H. (eds.). (2015). *Towards an Embodied Science of Intersubjectivity: Widening the Scope of Social Understanding Research*. Lausanne: Frontiers Media.
- Eagleman, D. (2015). *Incognito: The secret lives of the brain*. New York: Pantheon Books.
- Engemann, K. & Pedersen, & Arge, L. & Tsirogiannis, & Mortensen & Svenning, J.-C. (2019). Residential green space in childhood is associated with lower risk of psychiatric disorders from adolescence into adulthood. *Proceedings of the National Academy of Sciences of the United States of America*, 116 (11), 5188-5193
- Freeman, W. J. (1995). *Societies of Brains. A Study in the Neurobiology of Love and Hate*. Mahwah NJ: Lawrence Erlbaum Associates.
- Friston, K. (2010). The free-energy principle: A unified brain theory? *Nature Review of Neuroscience*, 11(2), 127–138.

- Friston, K. (2012a). Predictive coding, precision and synchrony. *Cognitive Neuroscience*, 3(3–4), 238–239.
- Friston, K. (2012b). Prediction, perception and agency. *International Journal of Psychophysiology*, 83, 248–252.
- Friston, K. (2012c). A free energy principle for biological systems. *Entropy*, 14, 2100–2121.
- Friston, K. (2018). Does predictive coding have a future? *Nature Neuroscience*, 21, 1019–1026.
- Frith, C. D. (2007). The Social Brain? In: *Philosophical Transactions of the Royal Society*, 362, 671–678.
- Fuchs, T. (2018). *Ecology of the Brain. The Phenomenology and Biology of the Embodied Mind*. Oxford: University Press.
- Gallagher, S. (2017). *Enactivist Interventions. Rethinking the Mind*. Oxford: Oxford University Press.
- Hohwy, J. (2013). *The Predictive Mind*. Oxford: Oxford University Press.
- Hutto, D. D. & Myin, E. (2012). *Radicalizing enactivism: Basic minds without content*. Cambridge, MA: MIT Press.
- Hutto, D. D. & Myin, E. (2017). *Evolving enactivism: Basic minds meet content*. Cambridge, MA: MIT Press.
- Hüther, G. (1996). The Central Adaption Syndrome. Psychosocial stress as a trigger for adaptive modifications of brain structure and brain function. *Progress in Neurobiology* 48, 569-612.
- Hüther, G. (1997). *Biologie der Angst. Wie aus Stress Gefühle werden*. Göttingen: Vandenhoeck & Ruprecht.
- Linson, A., Clark A., Ramamoorthy, S. & Friston, K. (2018). The Active Inference Approach to Ecological Perception: General Information Dynamics for Natural and Artificial Embodied Cognition. *Frontiers in Robotics and AI*, 5(21), 2-22.
- Merleau-Ponty, M. (1974 [1942]). *Die Struktur des Verhaltens*. Aus dem Französischen übersetzt und eingeführt durch ein Vorwort von Bernhard Waldenfels. Berlin: de Gruyter.
- Merleau-Ponty, M. (1962). *Phenomenology of perception*. Trans. C. Smith. London: Routledge.
- Merleau-Ponty, M. (1968). *The visible and the invisible: Followed by working notes*. Trans. C. Lefort. Evanston, IL: Northwestern University Press.
- Metzinger, T. (2015). *Der Ego-Tunnel. Eine neue Philosophie des Selbst: Von der Hirnforschung zur Bewusstseinsethik*. Aus dem Englischen von Thomas Metzinger und Thorsten Schmidt. 3. Auflage. München: Piper.
- Miller, M. & Clark, A. (2018). Happily entangled: prediction, emotion, and the embodied mind. *Synthese*, 195, 2559–2575.
- Newen, A., de Bruin, L. & Gallagher, S. (eds.). (2018). *The Oxford Handbook Of 4E Cognition*. Oxford: Oxford university Press.
- Nicolis, G. & Prigogine, I. (1993 [1977]). *Self-Organization in Nonequilibrium Systems*. New York: Wiley-Interscience.

- Noë, A. (2004). *Action in Perception*. Cambridge MA: MIT Press.
- O'Regan, J. K., & Noë, A. (2001). A sensorimotor account of vision and visual consciousness. *Behavioral and Brain Sciences*, 24, 939–1011.
- Petzold, H.G. (1981g). Sich selbst im Lebensganzen verstehen lernen. In: Pro Senectute, H.D. Schneider (ed.), *Vorbereitung auf das Alter* (p.89-112). Paderborn: Schöningh.
- Petzold, H. G. (1988n). *Integrative Bewegungs- und Leibtherapie*. Ausgewählte Werke. 3. revid. und überarbeitete Auflage. Paderborn: Junfermann.
- Petzold, H. G. (1991o). Zeit, Zeitqualitäten, Identitätsarbeit und biographische Narration – Chronosophische Überlegungen. *POLYLOGE: Materialien aus der Europäischen Akademie für biopsychosoziale Gesundheit*. <https://www.fpi-publikation.de/home> Textarchiv H. G. Petzold et al. <http://www.fpi-publikationen.de/textarchiv-hg-petzold>.
- Petzold, H. G. (1994a). Mehrperspektivität - ein Metakonzept für die Modellpluralität, konnektivierende Theorienbildung für sozialinterventives Handeln in der Integrativen Supervision. *POLYLOGE: Materialien aus der Europäischen Akademie für biopsychosoziale Gesundheit*. <https://www.fpi-publikation.de/home> Textarchiv H. G. Petzold et al. <http://www.fpi-publikation.de/supervision/alle-ausgaben/13-2018-petzold-h-g-1994a-2018-mehrperspektivitaet-ein-metakonzept-fuer-modellpluralitaet.html>.
- Petzold, H. G. (2002j). Der „informierte Leib“ - „embodied and embedded“ - Leibgedächtnis und performative Synchronisationen. *POLYLOGE: Materialien aus der Europäischen Akademie für biopsychosoziale Gesundheit*. <https://www.fpi-publikation.de/home> Textarchiv H. G. Petzold et al. <http://www.fpi-publikationen.de/textarchiv-hg-petzold>.
- Petzold, H. G. (2003a). *Integrative Therapie. Modelle, Theorien und Methoden für eine schulenübergreifende Psychotherapie*. 3 Bände. Paderborn: Junfermann.
- Petzold, H. G. (2003e). MENSCHENBILD und PRAXEOLOGIE - 30 Jahre Theorie- und Praxisentwicklung am „Fritz Perls Institut für Integrative Therapie, Gestalttherapie und Kreativitätsförderung“ (1972 –2002) – Teil I bis III. *POLYLOGE: Materialien aus der Europäischen Akademie für biopsychosoziale Gesundheit*. <https://www.fpi-publikation.de/home> Textarchiv H. G. Petzold et al. <https://www.fpi-publikation.de/polyloge/alle-ausgaben/06-2003-petzold-hilarion-g-menschenbild-und-praxeologie-30-jahre-theorie-und-praxis.html>.
- Petzold, H. G. (2007d). „Mit Jugendlichen auf dem WEG ...“- Biopsychosoziale, entwicklungspsychologische und evolutionspsychologische Konzepte für „Integrative sozialpädagogische Modelleinrichtungen“. *POLYLOGE: Materialien aus der Europäischen Akademie für biopsychosoziale Gesundheit*. <https://www.fpi-publikation.de/home> Textarchiv H. G. Petzold et al. <https://www.fpi-publikation.de/polyloge/alle-ausgaben/09-2007-petzold-h-g-mit-jugendlichen-auf-dem-weg.html>.
- Petzold, H.G. (2009c). Körper-Seele-Geist-Welt-Verhältnisse in der Integrativen Therapie. Der „Informierte Leib“, das „psychophysische Problem“ und die Praxis. *POLYLOGE: Materialien aus der Europäischen Akademie für biopsychosoziale Gesundheit*. <https://www.fpi-publikation.de/home> Textarchiv H. G. Petzold et al. <https://www.fpi-publikation.de/artikel/textarchiv-h-g-petzold-et-al-/petzold-h-g-2009c-koerper-seele-geist-welt-verhaeltnisse-der-informierte-leib-das-psychoph.html>.
- Petzold, H. G. (2010r). Der Wille für gelingende Hochaltrigkeit. Integrative Perspektiven. In: H.G. Petzold, E. Horn & L. Müller (eds.), *Hochaltrigkeit* (p. 279-324). Wiesbaden: VS Verlag. <http://www.fpi->

publikation.de/polyloge/alle-ausgaben/26-2008-petzold-h-g-der-wille-fuer-ein-gelingendes-hochbetagtsein.html

- Petzold, H.G. (2018c). Ökopsychosomatik und ökologische Neurowissenschaften – Integrative Perspektiven für die „Neuen Naturtherapien“ und das Engagement „Pro Natura!“ in: *Green Care Fachzeitschrift für Naturgestützte Interaktion* 1/6-9 und *Grüne Texte*, 2/2018. <https://www.fpi-publikation.de/images/stories/downloads/grueneTexte/petzold-2018c-oekopsychosomatik-oekologische-neurowissenschaften-pro-natura-gruene-texte-02-2018.pdf>
- Petzold, H. G. (2018k). Episkript: „ ... in a flow of green“ – Green Meditation als Hilfe in belastenden Lebenssituationen und bei schwierigen Wegerfahrungen. *POLYLOGE: Materialien aus der Europäischen Akademie für biopsychosoziale Gesundheit*. <https://www.fpi-publikation.de/home> Textarchiv H. G. Petzold et al. <http://www.fpi-publikationen.de/textarchiv-hg-petzold>
- Petzold, H. G., Ellerbrock, B. & Hömberg, R. (eds.). (2018.). *Die neuen Naturtherapien. Handbuch der Garten-, Landschafts-, Waldtherapie und Tiergestützten Therapie, Green Care und Green Meditation*. Bd. I. Bielefeld: Aisthesis.
- Petzold, H. G. & Orth, I. (2017a). Interozeptivität/Eigenleibliches Spüren, Körperbilder/Body Charts – der „Informierte Leib“ öffnet seine Archive: „Komplexe Resonanzen“ aus der Lebensspanne des „body-mind-world-subject“. *POLYLOGE: Materialien aus der Europäischen Akademie für biopsychosoziale Gesundheit*. <https://www.fpi-publikation.de/home> Textarchiv H. G. Petzold et al. <http://www.fpi-publikation.de/polyloge/alle-ausgaben/22-2018-petzold-h-g-orth-i-2017a-interozeptivitaet-eigenleibliches-spueren-koerperbilder.html>
- Petzold, H. G. & Orth, I. (2017b). Epitome. In H.G. Petzold, B. Leiser, B. & E. Klempnauer (eds.), *Wenn Sprache heilt. Handbuch für Poesie und Bibliothherapie und Kreatives Schreiben. Festschrift für Ilse Orth* (p. 885-971). Bielefeld: Aisthesis.
- Petzold, H. G. & Orth-Petzold, S. (2018a). Naturentfremdung, bedrohte Ökologisation, Internetsucht – psychotherapeutische und ökopsychosomatische Perspektiven In: H.G. Petzold, B. Ellerbrock & R. Hömberg (eds.), *Die neuen Naturtherapien. Handbuch der Garten-, Landschafts-, Waldtherapie und Tiergestützten Therapie, Green Care und Green Meditation*. Bd. I (p. 327-448). Bielefeld: Aisthesis.
- Pezzulo, G., Rigoli, F. & Friston, K. (2018). Hierarchical Active Inference: A Theory of Motivated Control. *Trends in Cognitive Sciences*, 22(4), 294-307.
- Seth, A. K. (2015). Inference to the Best Prediction - A Reply to Wanja Wiese. In T. Metzinger, W. Wiese & J. M. Windt (Hrsg.), *Open MIND* (1-8-8-8). Frankfurt am Main: MIND Group.
- Seth, A. K. (2019). Being a beast machine: The origins of selfhood in control-oriented interoceptive inference. In M. Colombo, E. Irvine & M. Stapleton (eds.), *Andy Clark and His Critics* (p. 238-253). Oxford: Oxford University Press.
- Seth A. K., & Friston K. J. (2016) Active interoceptive inference and the emotional brain. *Philosophical Transactions of the Royal Society*, B 371, 1-10.
- Seth, A. K., Suzuki, K. & Critchley, H. G. (2012). An interoceptive predictive coding model of conscious presence. *Frontiers in Psychology*, 2(1), 395-411.
- Sieper, J. (2007b/2011). Integrative Therapie als „Life Span Developmental Therapy“ und „klinische Entwicklungspsychologie der Bezogenheit“ mit Säuglingen, Kindern, Adoleszenten, Erwachsenen und alten Menschen, *Gestalt & Integration*, Teil I 60, 14-21, Teil II 61 (2008) 11-21. Update 2011, in: . www.fpi-publikationen.de/materialien.htm - POLYLOGE: Materialien aus der Europäischen Akademie für Psychosoziale Gesundheit – 5/2011 <http://www.fpi-publikation.de/downloads/download-polyloge/download-nr-05-2011-sieper-johanna.html>

Spons, O. & Edelman, G. M. (1998). Bernstein's Dynamic View of the Brain: The Current Problems of Modern Neurophysiology (1945). *Motor Control*, 2, 283-305.

Stefan, R. (2018). Thomas Fuchs im Gespräch mit der Integrativen Therapie. Ko-respondenzen und Differenzen. *Resonanzen. E-Journal für biopsychosoziale Dialoge in Psychosomatischer Medizin, Psychotherapie, Supervision und Beratung*, 6(1), 3-19.

Stefan, R. (2019). *Zukunftsentwürfe des Leibes. Begriff und Theorien der Integrativen Therapie und deren Bezugspunkte zu den Grundlagenwissenschaften*. Wiesbaden: Springer (in press).