# Essays on Systems Intelligence

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# Contents

# Preface

Systems intelligence, we have proposed, is a fundamental form of intelligence we all actively use when engaging with the interaction-rich systems of our everyday life.

Since the launch of our Systems Intelligence Initiative in 2002, we have served as editors for a series of volumes that have addressed a wide range of themes applying a number of methodologies. The articles have discussed and elaborated a host of aspects of systems intelligence, bringing together numerous seemingly unrelated phenomena, life situations and theoretical issues. The contributors have included researchers, educators, consultants, managers and students of different disciplines ranging from decision theory, environmental studies, architecture, computer science, management, organization research, philosophy, psychology, theology and psychotherapy. The current volume is the fourth in the series published in English, following three previous volumes in Finnish.

In the present volume the emphasis is on the foundational, conceptual, psychological as well as practice-oriented aspects of human intelligence. As is customary with systems intelligence, the essays represent a number of different methodologies, disciplines and topics of interest.

In the opening essay, Esa Saarinen and Raimo P. Hämäläinen elaborate on systems intelligence as an original form of human intelligence paying particular attention to the origin of intelligence in the light of infant research. The paper argues for systems intelligence as an integrating framework which complements earlier work on human intelligence. In his three essays, John Rauthmann discusses conceptually and empirically systems intelligence with respect to classical conceptualizations of intelligence and with respect to certain essential psychological themes. His first article studies systems intelligence as a trait and ability, investigating the connections of the construct to previous psychological intelligence literature. In his second contribution, Rauthmann develops a new systemic meta-model of personality. In his third essay, Rauthmann proposes a trait-SI scale for operationalizing the concept. Based on his original proposal, Rauthmann goes on to report what is the first empirical attempt to measure systems intelligence.

In his methodologically innovative essay, Kalevi Kilkki creates a social systems map of systems intelligence by presenting and applying a novel web search engine methodology to the construct of systems intelligence. The result is a description of the connections of the notion of systems intelligence with concepts in other disciplines and with some leading scholars in those disciplines. This is followed by an essay by Otso Palonen with a discussion of learning from the perspective of systems intelligence. In their contribution, Ella Rönkkönen and Esa Saarinen take the bold step of applying chemical engineering to an analysis of the Broaden and Build Theory of positive emotions developed by Barbara Fredrickson, and then link Fredrickson's insights with systems intelligence. Anne Birgitta Pessi uses systems intelligence to analyse volunteerism, presenting a fresh conceptualization of that domain. The final essay by Pia Tikka reflects cinema as an intersubjective neuroscientific experience. The concepts of embodied simulation and the cinema author's mental workspace simulatorium are discussed in their relation to systems intelligence.

We hope the essays in this volume, along with those of the previous books, will inspire researchers and practitioners from different backgrounds and disciplines to find new insights on their own field, practices and themes of interest in the light of systems intelligence.

Espoo, Finland 25 March 2010

Raimo P. Hämäläinen Esa Saarinen

Systems Intelligence volumes:

Raimo P. Hämäläinen and Esa Saarinen, eds. 2008. *Systems Intelligence – A New Lens on Human Engagement and Action*. Espoo: Helsinki University of Technology, Systems Analysis Laboratory.

Raimo P. Hämäläinen and Esa Saarinen, eds. 2007. *Systems Intelligence in Leadership and Everyday Life*. Espoo: Helsinki University of Technology, Systems Analysis Laboratory.

Raimo P. Hämäläinen and Esa Saarinen, eds. 2004. *Systems Intelligence - Discovering a Hidden Competence in Human Action and Organizational Life.* Espoo: Helsinki University of Technology, Systems Analysis Laboratory.

All of these books and the individual articles can be freely downloaded at http://www.systemsintelligence.tkk.fi.

See also these recent papers:

Jukka Luoma, Raimo P. Hämäläinen, and Esa Saarinen. Forthcoming. Acting with systems intelligence: Integrating complex responsive processes with the systems perspective. *Journal of the Operational Research Society*, advance online publication, 13 January 2010 (DOI 10.1057/jors.2009.175).

Esa Saarinen. 2008. Philosophy for managers, *Philosophy of Management,* vol. 7 supplement.

Raimo P. Hämäläinen and Esa Saarinen. 2008. Systems Intelligence - The way forward? A note on Ackoff's "Why few organizations adopt systems thinking", *Systems Research and Behavioral Science*, vol. 25, no. 6, pp. 821–825.

Jukka Luoma, Raimo P. Hämäläinen, and Esa Saarinen. 2008. Perspectives on team dynamics: Meta learning and systems intelligence. *Systems Research and Behavioral Science*, vol. 25, no. 6, pp. 757–767.

# Essays on Systems Intelligence

Chapter 1

# The Originality of Systems Intelligence

*Esa Saarinen and Raimo P. Hämäläinen*

In their groundbreaking essay ”Emotional Intelligence” (1990), Peter Salovey and John D. Mayer define their new concept “as the subset of social intelligence that involves the *ability to monitor one’s own and other’s feelings and emotions, to discriminate among them and to use this information to guide one’s thinking and actions.”* (Salovey and Mayer 1990, italics in the original).

The theory of emotional intelligence advances the work of Howard Gardner (1983) in his theory of multiple intelligences and that of Robert Sternberg (1985) in his theory of “triartic” (three part) intelligence. All these approaches draw attention to factors in human performance not captured by previous proposals and, in particular, in traditional IQ tests (Gerrid and Zimbardo 2010).

We have proposed that the work on emotional, social and multiple intelligence has missed a key form of human intelligence that we have called “systems intelligence.” By “systems intelligence” we mean “intelligent behaviour in the context of complex systems involving interaction and feedback. A subject acting with Systems Intelligence engages successfully and productively with the holistic feedback mechanisms of her environment. She perceives herself as part of the whole, the influence of the whole upon herself as well as her own influence upon the whole. By observing her own interdependence in the feedback intensive environment, she is able to act intelligently” (Saarinen and Hämäläinen 2004, p. 3; see also Hämäläinen and Saarinen 2006, 2007a, 2007b, 2008).

As the phrase suggests, *systems intelligence* relates to *systems*. As is customary in systems approaches, systems for us are complex wholes, the functioning of which depends on its parts and the interaction between those parts (Jackson 2003). Like Salovey and Mayer, we focus upon intelligence as something that “guides one’s thinking and action”.

Key features of the “systems” of systems intelligence include the following aspects, familiar from the systems literature (Senge 1990, Jervis 1998, Jackson 2003, Ramage and Shipp2009):

1) The behaviour of the system displays features that cannot be obtained by summing the behaviours of the isolated components. There are patterns and regularities in system behaviour not revealed by the behaviour of the parts as separate entities: the system can display emergence – “much coming from little” (Holland 1998) – as

well as self-organization where the system creates a new structure. Often the system behaviour is due to the nature of system structure.

2) The relationships between parts are more important than the properties of the individual parts; interaction of the parts gives rise to patterns, regularities and complexity that is not revealed by a direct inspection of the individual parts in isolation.

3) The systems are dynamic, display changing states and behaviours on the time axis often conceptualized in terms of functions, goals, or intentionality, and may involve surprising aspects, frequently referred to as "non-linearity" when a change somewhere in the system creates a disproportionate effect, perhaps due to circular causal interconnections.

4) The boundaries of systems are re-definable, flexible and depend on the perspective taken. "The lesson of boundaries is hard even for systems thinkers to get. There is no single, legitimate boundary to draw around a system. We have to invent boundaries for clarity and sanity; and boundaries can produce problems when we forget that we've artificially created them." (Meadows 2008, p. 97)

The theory of systems intelligence claims that human beings do have *intelligence* with respect to entities thus described – i.e. intelligence with respect to entities that do not functionally reduce to their individual parts, that are dynamic and may involve emergence, non-linearity and surprising cumulative aspects.

Like "system", "intelligence" is also a multi-faceted notion. In the landmark 1921 symposium on "Intelligence and its measurement" intelligence was described as "ability to learn", "the power of good responses from the point of view of truth or fact", "the ability of the individual to adapt himself adequately to relatively new situations in life", "the capacity to acquire capacity" (Thorndike 1921). In a description by Wechsler (1958) that Mayer and Salovey allude to, intelligence is viewed as "the aggregate or global capacity of the individual to act purposefully, to think rationally, and to deal effectively with his environment". More recently, the authoritative Task Force of the American Psychological Association started out their survey by stating: "Individuals differ from one another in their ability to understand complex ideas, to adapt to the environment, to learn from experience, to engage in various forms of reasoning, to overcome obstacles by taking thought. … Concepts of 'intelligence' are attempts to clarify and organize this complex set of phenomena" (Neisser et al. 1996, p. 77). We list these descriptions here noting that our notion of systems intelligence fits naturally into them.

Why *systems* intelligence, and why not "situational intelligence" (acknowledging "the power of the situation", in the sense of Ross and Nisbett 1991) or "contextual intelligence" (Nye 2008), or "pragmatic intelligence" (Sternberg 1985)? The answer is: because of the special, subtle and intriguing aspects of the functioning of human intelligence *in dynamic settings*, the key theme of systems intelligence.

In addition to its conceptual power as a systems concept, our proposal also has considerable communicative force to it. In our consultancies, organizational coaching sessions and philosophical lecturing (Saarinen and Slotte 2003, Saarinen 2008) we have been struck how easily people of various backgrounds adopt the notion. It makes immediate intuitive sense. The concept empowers people, making them mindful (Langer 1989) of something they can improve. People seem to be able to approach their systems intelligence with a "growth mindset" (endorsing "implicit incremental theory") as opposed to "fixed mindset" (endorsing "implicit entity theory", in the sense of Carol S. Dweck (2000, 2007). In other words, people find it natural to reflect on the possibility of enhancing their systems intelligence. The concept, while personally relevant, does not seem too threatening to people.

On the face of it, there is a difference between systems intelligence as a concept and the intelligences discussed by the multiple intelligences research community. To wit, it seems there is a difference in the way the "systems" of systems intelligence exist as compared to emotions, the social sphere, the body and movement, the visual, space, music, language or mathematical entities. It seems there is an element of abstract conceptuality in the notion of systems intelligence.

Indeed, systems are abstract and constructed. Yet so is language. The ontological status of a category such as "bodily-kinaesthetic" is also far from trivial. Besides, theories of intelligence are not supposed to be about ontology but of the thought-related mental abilities that account for human learning, adaptability and success in life. The theory of emotional intelligence assumes that humans have an innate cognition of emotions; we assume that humans have an innate cognition of systems. Making that assumption and focusing upon systems intelligence leads us to address vital phenomena the other intelligence constructs are not able to cover.

Let us recall that human life is fundamentally systemic at its core. Systemicity is at the heart of all of life and all of reality – not only as phenomena "out there" but also as something humans cannot help but engage with every moment of their actual lives. A person can live with some success without significant verbal, bodily, visual, mathematical, emotional, social, intrapersonal or musical intelligence. But without at least rudimentary abilities to manoeuvre intelligently within the systems of one's environment, a human being is lost. There simply is no way to orient oneself in any successful way for any significant length of time, except in relation to and in contact with what is taking place systemically around oneself.

*The success and survival of a human individual, for any significant length of time, calls for systems intelligence.*

All human life is embedded and located in what is going on systemically, locally and globally. All human life takes place in the systemic process contexts of something-larger-than-self. That something requires a constant and lively relating to. The success and survival of a human individual, for any significant length of time, calls for systems intelligence.

## Baby Brilliance

As academic intellectuals, it may be tempting for many of us to take rational intellectualism of the adult age, along with its emphasis on explicit and verbal knowledge, as the primary and paradigmatic form of intelligence. The systems intelligence approach radically rejects such a notion.

Instead, we look to babies for insight.

In the course of the past three or four decades, infant research has demonstrated "the infant's capacity to construct expectations of action sequences, which are then represented in a presymbolic, procedural format" (Beebe et al. 2003, p. 752). The capabilities of an infant go far beyond what one might have thought prima facie. As one meta-study emphasized, "1-year-old infants infer dispositions and future behaviors of others in relatively mature ways" (Uleman et al. 2007 p. 347). "Infants can also distinguish between intentional and accidental acts, a skill that requires mental state attributions" (ibid). All this highlights what Jerome Bruner has called the striking "systematicity" in the endowment of an infant. (Bruner 1983, p. 28) As Bruner put it "there may be differences of opinion concerning the 'rules' that govern this orderly behavior [of an infant], but there can be no quarrel about its systematicity." Whatever the details, "*the nature of infant cognitive endowment",* Bruner concludes, " *is that its systematic character is surprisingly abstract."* (Bruner 1983, p. 29, italics in the original).

The critical acumen is the "joint anticipatory system" (Bruner 1983) that the infant is capable of creating with her caretaker through "extraordinary early infant capacities" (Beebe and Lachmann 2002, p. xiv).

The powerhouse at work is the infant's innate capacity for "interpersonal engagement" (Hobson 2004) through her abilities for emotional and non-verbal exchange. "Infants are highly attuned to other people" – they have "an active social life right from the start" (ibid, p. 43). With their remarkable non-verbal abilities to perceive and respond to the behaviour of other people in interaction, the infants "are developing increasingly rich and pleasurable forms of mutually sensitive interpersonal engagement." (ibid, p, 42).

It is instructive to consider the concepts leading infant researchers use to describe the endowment of capabilities the infant displays in the first weeks and months of her life in relation to her mother: *mutual regulation, mutual influence* (Beebe and Stern*)*, *syncronization* (Stern)*, reciprocity* (Brazelton et al.)*, behavioural dialogues* (Bakeman and Brown)*, reciprocal and compensatory mutual influence* (Capella)*, accommodation* (Crown)*, co-ordination* (Sander)*, rhythms of dialogue*( Jaffe et al.)*, attunement* (Stern et al.)*, protoconversation* (Beebe et al.)*, the moment of meeting* (Sander)*,* and *forms of intersubjectivity* (Meltzoff, Stern, Tervarthen, Tronick) (for a discussion and a review, see Beebe et al. 2005). Even without closer analysis these concepts speak out: the infant contributes as an active partner to the process of her own growth.

Particularly importantly, the infant is able to operate in relation to her mother and with respect to the time axis as part of the dynamics that feeds development. This is a sophisticated undertaking. "Patterns of experience are initially organized in infancy as *expectancies of sequences of reciprocal exchanges* … in which each partner contributes to the ongoing exchange" (Beebe and Lachmann 2002, p. 13). As one researcher put it, infants are endowed with a "motive system that is seeking another emotional being with whom to play together a cooperative, complementary, intersubjective game" (Kugiumutzakis 1998, p. 80).

Far from being a passive receiver, the infant is an active partner of the process of her own growth. She actively contributes. Anticipation is in a leading role here – the infant's abilities for forming *expectancies*. She *is* expecting personal engagement, attunement, co-ordination and emotional availability of her mother. Through her abilities to anticipate, to imitate, to perceive emotion and to react to emotion, she influences her mother to influence her, and vice versa. The two of them together give rise to a higher-level phenomenon with emergent properties and non-linear features of considerable sophistication. The infant and her mother are involved in non-verbal communication that is typically extremely rapid and frequently simultaneous. They create together a whole that has a direction and is goal-oriented, although not consciously intentional.

## The Dyadic System as a Basic Unit

Stemming from the seminal work of Louis Sander (1977, Amadei and Bianchi 2007, for an overview, see Nahum 2000), a number of leading researchers have made explicit use of the systems concept to account for the principal features of "the first relationship" (Stern 1977, 2002) and the "interpersonal world of the infant" (Stern 1985). It amounts to a view according to which the origin of mind is dyadic, dialogic and intersubjective, involving the participation of a relational partner (Beebe et al. 2003).

The formation of a *dyadic system* that the infant "co-creates" with her mother becomes "the basic unit of interest" (Beebe et al. 2003, p. 752). That dyadic system influences the baby and the mother, while they influence the system. In particular, the dyad moves ahead, is goal-directed on the time axis and has features not detectable by the inspection of the baby and the mother separately as isolated individuals.

It is important to appreciate that the infant possesses "unsuspected capacities to regulate his own state" (Beebe and Lachmann 2002, p. 22; Beebe and Lachmann analyse the case of a particular baby boy but the point is generic). These capacities are due to the remarkable infant skills in the art of relatedness. They reflect the infant's ability to engage in interactive processes. Remarkably, interactive regulation and self-regulation become integrated in a coordinated and goal-directed process-whole of a higher order.

*The skills of relating that facilitate development in infancy, will later be the basis from which the subject can tune in to systems beyond what one knows objectively or conceptually about those systems*

The fundamental point is that intersubjectivity precedes subjectivity. Relatedness is prior to isolation. This amounts to a radical rejection of "the myth of an isolated mind" (Stolorow and Atwood 1992). The dyadic system becomes the fundamental unit "within which both interactive regulation and self-regulation can be defined, each affecting the other" (Beebe et al. 2003, p. 752). The "patterns of expectation" amount to "the anticipation of the partner's pattern in relation to one's own" and "define presymbolic representation in the first year" (Beebe et al. 2003, p. 752).

The intersubjective system of the infant and the mother is not one of alternating turn-taking and of a ping-pong-like reciprocal exchange where each partner would generate her actions in response to the other's isolated actions. Instead, the infant and mother tune in to one another and synchronically work together. This is highly important from the point of view of systems intelligence. The non-verbal, procedural, and affective skills of relating that facilitate development in infancy, will later be the basis from which the subject can tune in to systems beyond what one knows objectively or conceptually about those systems.

Since her early infancy, the baby is dealing effectively with certain unfolding emergencies of her environment and is able to create expectancies. She is able to regulate her own states at the same time as she influences the interactive processes which in turn influence her.

We find it remarkable that leading researchers in the empirical field of infant studies have used the concept of *a system* to describe what may be the single most warmly attuned theme in human life, the infant-mother relationship. It has not been an obstacle that the infant remains almost totally ignorant of the objective functioning of the system that she cannot represent verbally or conceptually and with which she operates mostly on a non-conscious level. Indeed, infant researchers have made impressive progress in describing how exactly the infant contributes to the emergence of the dyadic system through various forms of implicit processing. Facial mirroring, vocal rhythm, spatial orientation, touching and self-touching are among the non-conceptual means that the baby utilizes in the intersubjective field.

Beebe and Lachmann conclude: "the organization of behavior in infancy should be viewed primarily as the property of the mother-infant system rather than as the property of the individual … It is the dyad, rather than the individual, that is the unit of organization." (Beebe and Lachmann 2002, p. 67) They stress that "it is critically important that interactive and self-regulation be viewed as a system" (Beebe and Lachmann 2002, p. 87) and to view the interaction between the infant and the mother as "an emergent dyadic phenomenon" (Beebe and Lachmann 2002, p. 88) in which "inner and relational processes are co-created in tandem" (Beebe et al. 2003, p. 754). Critical to development, as Alan Fogel puts it, is "the co-regulated communications system" of the baby and the mother (Fogel 1993).

From the conceptual point of view, the dyadic system is an active partner along with the baby and the mother. Beebe and Lachmann stress "the dyad's ability to make use of whatever abilities the infant brings" (Beebe and Lachmann 2002, p. 88). In the context of infant research, the systems concept makes it possible to welcome capabilities from the implicit, non-conceptual realm. This possibility proves essential for systems intelligence.

## Broadening the Scope of Adult Intelligence

The work on multiple intelligences has tacitly assumed that the capabilities of pre-verbal infants need no particular focus. It has been taken for granted that there is no significant dimension of intelligence *that would be paradigmatically represented* in pre-verbal infants. We challenge this assumption.

Systems capabilities are fundamental in infancy *and* later in life, we propose. The skills and capabilities for relating in the non-verbal, procedural, affective, out-of-awareness realms is highly significant for the functioning of intelligence in dynamic settings. They are vital means to *relate to systems*.

The contribution we offer here is conceptual but with a strong empirical footing. We offer a framework and a terminological platform from which to integrate phenomena that relate to intelligence, human adaptability, the systemically embedded nature of human life, and early infant capabilities "of sensitivity and emotional exchange that are a feature of human relations from the cradle to the grave" (Hobson 2004, p. 46). We venture to suggest that prior intelligence research has left gaps we hope to fill.

Our systems intelligence perspective amounts to the vision that humans have a set of skills and abilities that

- Involve relatedness to relatedness (skills that relate the subject to others and to the dimension of relatedness).

- Involve relatedness to the sphere of intersubjectivity.

- Make use of non-verbal and implicit expectations which take place out-of-awareness.

- Involve engagement with larger-than-self entities without clear-cut boundaries and with boundaries that can be re-defined in the course of the process.

- Involve relatedness to the unfolding of qualities that cannot be reduced to qualities of the constituent parts (emergence).

- Make use of human sensibilities, timing and synchronization skills, emotional attunement, and feedback mechanisms that involve non-explicit, non-verbal and non-conscious dimensions.

As already observed, these skills and abilities are critically important for human growth. We find it significant that empirical models of those highly sophisticated capabilities in infants are articulated in terms of systems with the dyadic system recognized as "the basic unit of interest" (Beebe et al. 2003, p. 752). The contribution we offer extends that discourse of systems to address the functioning of human intelligence in dynamic adult contexts.

Accordingly, we suggest that the remarkable human abilities to attune to and live with systems that are uncovered empirically by infant research concern the whole human life span. The infant's capabilities in dimensions such as *attunement*, *mutual regulation and influence*, *coordination, reciprocal and compensatory mutual influence, synchronization* and *intersubjectivity* give rise, among other things, to various forms of *implicit relational knowing* that Karlen Lyons-Ruth has stressed as fundamental to the human relational experience (Lyons-Ruth et al. 1998, Lyons-Ruth 1999) and to *intersubjective systems sensibility* of the kind elaborated in the intersubjective systems view of Stolorow, Atwood and Orange (Stolorow et al. 2002; Buirski 2005).

The seeds of systems intelligence are sown when the infant is engaging with her mother in the dyadic system she co-creates with her, adaptively reaching out towards development and growth.

## Systems Intelligence: A Definition

Consider the following definition of systems intelligence: *Systems intelligence (SI) involves the ability to use the human sensibilities of systems and reasoning about systems in order to adaptively carry out productive actions within and with respect to systems.*

This characterization can be compared with the description that Mayer, Roberts and Barsade (2008) provide of emotional intelligence in their extensive meta-study: "Emotional intelligence (EI) involves the ability to carry our accurate reasoning about emotions and the ability to use emotions and emotional knowledge to enhance thought." (Mayer et al. 2008, p. 511).

Notice the emphasis of the *ability to adaptively carry out productive actions* in our definition of SI. Here we depart from the Mayer et al. (2008) definition of emotional intelligence and from its strong emphasis on knowledge. We prefer to maintain the emphasis on action, like Salovey and Mayer in their (1990) description.

We acknowledge the following two convictions as part of the systems intelligence construct:

1. In terms of what are known as "dual processing accounts" (for a review, see Evans 2008), we note that SI will involve both forms of processing identified in the literature. The ability to attune to and live with systems will involve fast, automatic, intuitive, instinctive, procedural, implicit, non-verbal and non- conscious aspects *along with* the slow, deliberate, explicit and conscious aspects of systems comprehension and relatedness.

2. In the process of development of thought from infancy to adulthood, systems intelligence is nothing short of being the primary form of intelligence, we believe. Intelligence is fundamentally about interconnectivity, relationality, embeddedness, attunement, action, and about oneself-in-relation-to-others and oneself-in-a-larger-whole. Intelligence develops and is demonstrated primarily in dynamic settings.

Typically, "intelligence" is taken to be a faculty exhibited by adults and to some extent by children. Howard Gardner stresses that the study of intelligence should be informed by work with adults and children, gifted persons and people of different cultures, as well as with individuals who have suffered selective forms of brain damage (Gardner 1983; cf. Neisser et al. 1996). Gardner does not include pre-verbal infants on his primary list. This is in line with the commonly accepted idea stressed also by Gardner according to which "a human intellectual competence must entail a set of skills of problem solving … and must also entail the potential for *finding or creating problems* – thereby laying the groundwork for the acquisition of new knowledge" (Gardner 1983, p. 60-61).

Adopting Gardner's description, systems intelligence can be conceptualized as a human intellectual competence that entails skills of problem solving and skills to resolve genuine problems and difficulties that he or she encounters *in systemic settings.*

Space is a systemic setting, as is language, the world of mathematics and music. In as much as these domains give rise to specific intelligences, as argued for by Gardner, those intelligences will involve domain-specific aspects of systems intelligence. This does not change the fact that even before learning to master language or mathematics or her own movements the child already has systemic engagement with her environment of the kind elaborated by infant research. We highlight the general systems skills and ability to live with systems over and above the specialized intelligences like linguistic, mathematical or kinaesthetic intelligence.

What are the most important forms of systemic engagement in human life? This question need not have any once-and-for-all answer. New systemic environments relevant for human adaptability may well arise. Our own times bears witness to this fact. The human race has developed tremendously powerful system structures that have enormous positive leverage within certain boundaries but also potential for enormous destruction from the point of view of certain other boundaries. Minimally what is called for is systems intelligence with the man-made systemic environments in the systemic context of natural life. With the creation of powerful man-made systems environments, new forms of systems skills are taking high priority in terms of success and even survival. Our perspective makes room for the discussion and analysis of the imperatives for human intelligence in that vital and emergent setting.

> *Our vision does not refer to people only becoming* more informed *of an important systems domain. Any knowledge helps, but ultimately it is the actions taken in concrete terms that define the level of systems intelligence of each of us as individuals and of the human race as a whole.*

Notice that this vision does not refer to people *only* becoming *more informed* of an important systems domain (such as the functioning of food chain, the climate system, the functioning of the world economy). Any knowledge helps, but ultimately it is the actions taken in concrete terms that define the level of systems intelligence of each of us as individuals and of the human race as a whole.

## Systems Intelligence is Acting Intelligently with Systems

You walk into a situation, and you enter a system. You meet a person, and something larger than the two of you starts to have a say. No matter where you are, systems embrace you, and no matter what you strive for, systems obstruct and support you, influence you, tempt you, inspire you, hinder you, coerce you and often also suggest how to proceed. The anthropomorphic phenomenology of systems is important to acknowledge because systems intelligence operates with systems as they appear to us. As structures to relate to, working via our beliefs, systems present themselves to us and indeed become part of us. Sensing and figuring out what seems possible and necessary, we set-up a realm of the “real”, along with the narratives that make sense of it, and act on the stage framed by our meaning-giving structures.

What is remarkable is how comprehensive our perspectives typically seem. You catch a glance between two persons and realize that “everything has changed”. The phone rings and you are informed of the sudden death of your loved one, and nothing will ever be the same. Life is conducted in and through changing, meaning-filled contexts and environments that are enormously complex. Those complexes come across as integrated, holistic “onenesses”. We choose to call such coherent wholes *systems*, reflecting the assumption that their internal functioning is relational, their form of being dynamic and their boundaries re-definable.

Life with systems and within systems can be conducted more or less intelligently, depending among other things on

- One's ability to identify the relevant systems with respect to given goals, purposes, functions and ways of meaning making.
- One's ability to act upon the relevant systems and take advantage of their leverage.
- One's ability to take advantage of a potential to change a system.
- One's ability to read other agents' actions and moves within and with respect to systems.

In order to live better with systems it is often beneficial *to know more of systems.* This is where many schools of systems thinking have made remarkable contributions providing descriptions of systems on a general level as well as in specific contexts. Along with the generic contributions of systems theorists, scholars working within various sciences and disciplines have shed light on a number of specific domains through use of the systems framework.

However, as John D. Sterman once so aptly put it, "all models are wrong" (Sterman 2002). Life is richer than any modelling of it. A map is useful for covering a territory, yet movement within the territory will require more than a map.

This is the cutting edge at which our systems intelligence hopes to make a major contribution. This is also where our initiative hopes to spark energy to some of the humanly-tuned and ethical aspects of the early systems thinkers such as Ludwig von Bertalanffy, Kenneth Boulding and C. West Churchman (discussed particularly lucidly in Hammond 2003). Bluntly put, it is more important to get actions within systems right than the theories of those systems right.

*Systems intelligence refuses to bend to the demands of fragmentarism. We insist on context-bound, local holism as part of the very core of human intelligence.*

Systems intelligence is a holistic and action-bound faculty within us humans. As observed above, it is already present in infancy in the form of the implicit and non-verbal yet sophisticated skills that operate in the affective dimension of relatedness and intersubjectivity. Systems intelligence builds on such abilities for interrelatedness, connectivity and sharing. Yet the dominant forms of discourse in our culture are biased because of what physicist David Bohm (1980, p. 7) called the human "habit of fragmentary thought" which "divides everything up" (Bohm 1996, p. 9). What comes naturally in infancy turns out tricky in adult life. The challenge is primarily conceptual. Indeed, one of the reasons systems intelligence as a theoretical perspective is powerful is due to its refusal to bend to the demands of fragmentarism. We insist on context-bound, local holism as part of the very core of human intelligence.

It might well prove difficult to measure an intelligence that is fundamentally tied to sharing, to co-created processes that are ongoing, to intersubjectivity and to abilities that relate to wholeness. Recall how difficult it is even to make scientific sense of what Gardner recently called "the synthetic mind": "Few individuals and even fewer institutions have expertise in inculcating the skill of synthesis." (Gardner 2008, p. 47). Very little is known of the vital act of synthesis. To quote Gardner, "even when synthesizing is desired and cultivated, we lack standards for determining when a productive synthesis has been accomplished" (ibid).

But the fact is, people have been remarkably successful and adaptive in living with complex, unfolding, emergent and interrelated wholes in their environment. It seems to us vital to call attention to the form of intelligence that generates such a remarkable outcome – and also gives rise to what Gardner calls "the synthetic mind". This is the human ability we call systems intelligence.

The result is a proposal that

1) Takes the systems approach of infant research, together with the rich empirical data that accompany it, and adds the notion of *intelligence* to that perspective along with extending to adult life the perspective of early human systemic and relational abilities.

2) Takes *the systems perspective* of the systems sciences and disciplines, along with the holistic orientation of that perspective, integrates them with the concept of intelligence, with the result of introducing the perspective of an adaptive, acting and feeling human subject to the systems framework, along with her capabilities for implicit relational knowing, for systems sensibilities, and for procedural, non-verbal and affect-based interrelating with larger-than-self wholes.

Recall our definition, according to which systems intelligence involves *the ability to adaptively carry out productive actions within and with respect to systems.* The emphasis on action is pivotal here and could hardly be timelier. The point of human intelligence comes from its service to human life. It is in the dimension of actual conduct and behaviours with more and more complex humanly made technological and social systems that a more intelligent relation and "attunement" (Stern 1985) are urgently needed.

The call comes in various guises yet echo the same basic message. We need what the Nobel Laureate Murray Gell-Mann called "a crude look at the whole" (Gell-Mann 1994), in order to bring "the necessary revolution" (Senge et al. 2008) of "healing our fragmented culture" (Goodwin 2007).

The call is to a radical, dramatic increase of systems intelligence.

## The Positivity of Systems Intelligence

Systems thinkers emphasize phenomena of interconnectivity and interrelatedness, representing what has been called "the relational turn".

The relational orientation is based on the idea that whatever is being studied should be thought of in terms of relationships and with respect to something other than itself. (Cf.

e.g., Senge 1990, Capra 1996, Bradbury and Lichtenstein 2000, Stolorow et al. 2002, Beebe and Lachmann 2002). The key idea is that "human cognition and the sense of self are fundamentally and originally *relational*." (Fogel 1993, p. 4)

Along with the emphasis on relations, the systems approach highlights holism and focuses upon "wholes". It is interested in dynamism and change. As opposed to individual events, the focus is upon processes, patterns and performance over time. Instead of single causes, the limelight is upon multiple causes and bi- and multiple-directional relationships. Systems thinkers articulate modes of conceptualizing the world in terms of *the big picture* and *the longer term.*

Thus described, one could say that the systems perspective is relatively straightforward. Key ideas of systems thinking can indeed be found in the folk wisdom of various cultures and traditions where they are presented as rules of thumb, proverbs and sayings. (On this, see Meadows 2008.)

Yet the phenomena of gradual change, delayed effects, feedback, the big picture, reciprocal causality as well as those of gradual change are remarkably difficult to appreciate in actual human practice (for a vivid discussion, see Jervis 1998).

One of the cornerstones of the systems thinking literature is the description and modelling of the most common "systems archetypes". Among them: "Tragedy of the Commons" (made famous by Hardin 1968), "Shifting the Burden", "Fixes that Fail", "Eroding the Goals", and "Limits to Growth" (for discussion, see Senge 1990). Our notion of "the Systems of Holding Back" (Saarinen and Hämäläinen 2004) can also be included here.

These archetypes are powerful. In her highly illuminating and accessible book *Thinking in Systems,* Donnella Meadows goes through the *International Herald Tribune* during one week, and in the coverage of world events that week finds illustrations for each one of the most celebrated traps identified in systems dynamics literature (Meadows 2008). Thinking in terms of wholes rather than parts, in terms of processes rather than time slices, in terms of interconnectivity rather than isolated parts may seem simple enough in theory but is difficult in practice.

Yet as already observed, there is a sense in which even infants can do it. To some extent anybody can do it. There is a sense in which human beings cannot but be systems thinkers. The fact that there is an imperative to improve should not lead us to dismiss the worth of the endowment each one of us has right from the start.

The promise of intelligence is one of adaptability. With your intelligence you can learn and adapt better. While it can be taken for granted that the world is systemic, it is a priori clear that at some point, intuitive systems thinking – like any intuitive thinking – is going to prove insufficient or inadequate (cf. Kahneman 2003). "When the interconnections are dense", Jervis points out, "it may be difficult to trace the impact of any change even after the fact, let alone predict it ahead of time, making the system complex and hard to control." (Jervis 1998, p. 17). That does not change the fact that for the benefit of the much-needed refinement process there is a platform and a base: our innate systems intelligence.

The fact that systems effects are hard to predict and control is bad news but also good news, depending on the perspective. The systems literature often takes the negative stance, emphasizing the problems that arise out of the sheer complexity of the social, political or natural systems. Systems intelligence takes a different tone. For one thing, with its emphasis on human sensibilities and notions such as *feel for the system* (Hämäläinen and Saarinen 2008), the systems intelligence perspective was never about the command and control of systems. The interface with systems, as with life in dynamic settings, was always assumed to be broadband.

The systems intelligence perspective emphasizes what we do right, with the hope of generating more of it, as opposed to what we do wrong. Accordingly, in place of "Shifting the Burden", "Fixes that Fail" or "Tragedy of the Commons" as negative systems archetypes, the focus is on "Sharing the Burden", "Fixes that Fire" and "Miracle of the Commons" as *systems intelligence archetypes* with distinctly positive emphasis (Hämäläinen and Saarinen 2006). Given the fact that "we can never do merely one thing" (Jervis 1998, p. 10), our actions can backfire but they also yield tremendous success. By just one action we can generate a whole range of right things at the same time – with others, with our wide-ranging humanity, with the help of richly and prudently facilitated systems.

In terms of its tone, our approach matches that of positive psychology (Seligman and Csikszentmihalyi 2000) and positive organizational scholarship (Cameron et al. 2003). It is in line with Fredrickson's Broaden and Build Theory in its emphasis on the significance of positive emotions (Fredrickson 2003, 2009). Indeed, as we see it, the initiative of systems intelligence advances the original idea of Gardner's "Project on Human Potential" (Gardner 1983) and also follows Sternberg's insights (1985) of appreciating intelligence in terms of its practical value and sensitivity to the varying aspects of the context.

## Turning the Tide with Men and Women in the Loop

We would like to see our perspective encourage a growth-mindset in the sense of Carol Dweck. Trivially, the linguistic abilities of a child are lesser than those of an adult, or of a Shakespeare. Nobody takes this as an argument to dismiss the significance of what she does right with her linguistic endowment. Similarly, it is obvious that no matter how skilful someone is in identifying feedback loops and patterns over time in a given area of life, still it is possible to improve as a practitioner in that area. No matter how brilliantly adaptive someone is in acting within the confines of a given life system, surely there is room to do even better. The more there is complexity to the unfolding environment, the more there is space for creativity, productive actions, and for systems intelligence to grow.

In view of the possibilities to improve, it is particularly important to realize that there is no particular reason to think that in the realm of systems skills, symbolically-coded and explicit *knowledge* should reign alone. It is useful to learn science-based systems disciplines and thereupon become a better systems thinker. But this is not sufficient. People still need to act with their systems knowledge with respect to systems – intelligently. To the extent the world is a mess globally and locally, we need more intelligent systems "out there", but even more intelligence with systems *in here*. It is not only the understanding of the loops that need to be improved. Also men and women *in the loops* need to change.

In the human world, the malfunctioning of systems is often humanly made, and hinges on people. Many systems thinkers have explained the world in systems terms, but the point is to change it through our increasing systems intelligence. Here our proposals bring back the ethical and emancipatory emphasis of the early systems thinkers, in particular *the* *humanistic concern* of Ludwig von Bertalanffy (von Bertalanffy 1969, p. xxiii). That ethical emphasis has often been marginalized in the name of modelling, objective description, and command-and-control oriented systems practices (for an extensive discussion, see Hammond 2003). Our initiative attempts to turn the tide here and do justice to the founding fathers.

Knowledge is the essential ingredient of the good society, yet humanity is even more fundamental. One should be careful not to fall into *the cognitive systems trap* – into believing that once we have cognitively identified the relevant systems, most of the work is done. From the point of view of systems intelligence, an adequate representation of a system is only the beginning, and the lively challenge lies ahead, calling for personal involvement. There cannot be systems intelligence with respect to systems without intelligent actions supported by personal responsibility as the backbone of those actions.

We may note in passing that along with the cognitive systems trap there is *the cognitive trap of complexity*. That goes off when the concepts of complexity theory are used to articulate how complex the complexity is in a given field of application. A diagnosis might be intellectually illustrative and indeed mesmerizing but the main question concerns the cure. More often than not, a modelling via complexity theory does not yield much more than an intellectually extravagant celebration of the complexities that have been found, without any indication of what to do about them. (For inspiring exceptions, see Losada 1999, Fredrickson and Losada 2005, Stacey 2003, Taylor 2004.)

## Sensing the System of Betterment

In general, the systems perspective emphasises connections and warns against isolation. It warms against cut-and-dried approaches to boundaries (Midgley 2000). The systems intelligence perspective takes these points very seriously. We should take note not to separate actions from systems, systems from human sensibilities, and intelligence from the non-verbal, non-conscious abilities for interconnectivity that are part and parcel of the human condition. We should take note not to cut off intelligence from the dynamic setting in which it takes place.

*We should take note not to cut off intelligence from the dynamic setting in which it takes place.*

Recall the fact, often overlooked by scientists, that human beings not only have abilities to measure and calculate quantity but also capabilities to *sense quality*. That endowment is the basis of art and of much of what makes life worth living. It is also the base from which a mother and an infant regulate and co-regulate their intra- and inter-personal processes in a highly cost effective way. Something just feels right – the smile of the baby, the face of the mother – and something else – the cry of the baby, the inanimate object next to the face of the mother – does not. Systems intelligence looks at the whole of human potential as a resource for better systems-living with others and with the environment. The human ability to feel, sense and to resonate, the ability to move and be moved, to enhance and be enchanted, to uplift and be uplifted are some of those ways holism works within us as our innate systems intelligence.

As noted above, Beebe and Lachmann emphasize the infant-mother “dyad’s ability to make use of whatever abilities the infant brings” (Beebe and Lachmann 2002, p. 88). It is indeed intelligent to use whatever abilities you have in order to cope with and live with the systems at hand – it is systems intelligent.

This is where our perspective of systems intelligence pays homage to the vision of Donella Meadows, in her posthumously published synthesis, when she states that “Living successfully in a world of systems requires more of us than our ability to calculate. It requires our full humanity – our rationality, our ability to sort out truth from falsehood, our intuition, our compassion, our vision, and our morality.” (Meadows 2008, p. 170).

More human intelligence is needed, more systems intelligence. The point of intelligence is that it can foster learning and improvement. Our initiative seeks to give positive impetus to that vital process of uplift, glory and necessity as part of the human condition in our time.

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Chapter 2

# Psychological Aspects of Systems Intelligence: Conceptualisations of a New Intelligence Form

*John F. Rauthmann*

*The construct of systems intelligence (SI) by Hämäläinen and Saarinen (2004, 2007, 2008) is a new concept to social and human sciences and to the study of man. This article aims firstly at providing a psychological articulation of SI by using different concepts of "intelligence" as offered in psychology. The second aim of this chapter is to demonstrate how properties of abilities, competences, styles, and traits can be used to propose different approaches to SI (e.g., Trait-SI, Ability-SI). A basis for a psychologically informed yet multi-disciplinary perspective on SI is set which aims at fostering future research.*

## Introduction

*Systems intelligence (SI)* is a wide-ranging and applicable new concept to social and human sciences. It focuses upon *thinking, acting, and getting involved into dynamic processes with feedbacks within a complex system* (see Hämäläinen and Saarinen 2004, 2007, 2008).

Even though there has been a considerable amount of impressive theorisation on the nature of SI (e.g., Hämäläinen and Saarinen 2004, 2007a, 2008a, 2008b; Luoma, Hämäläinen, and Saarinen, 2008), empirical studies are still needed. What is also lacking is an articulation of SI from the point of view of psychological science. The aim of this paper is to provide the first steps in that direction and to present a psychological view on SI. The results of this paper will hopefully provide a useful theoretical underpinning for empirical SI-assessment in the future.

The foremost goal of this article is to inspire researchers to attend to empirical studies on SI. Hence, several different (and maybe even competing) possible approaches to SI are articulated, in the hope that other researchers will find some of them interesting and conduct empirical studies exploring their usefulness for SI research as well as their applicability for practice.

## "Classical" Intelligence in Psychology and its Different Conceptualisations

This paragraph will (a) outline different conceptualisations of "classical intelligence" in psychology and (b) go on to show how these conceptualisations can be applied to the study of SI. Then, conclusions are drawn on SI as a form of "intelligence".

An important question – before conceptualising SI as an ability or intelligence – is: *What is "intelligence"*?

Indeed, numerous definitions have been given, and indeed not all find common ground, but the following from Mayer, Roberts, and Barsade (2008, p. 509) subsumes a lot of them and is yet concise:

> Intelligence: a mental ability (or set of mental abilities) that permit the recognition, learning, memory for, and capacity to reason about a particular form of information

Neisser and colleagues (1998, p. 77) give another, more detailed definition in the APA Task Force on intelligence ("Intelligence: Knowns and Unknowkns"):

> Individuals differ from one another in their ability to understand complex ideas, to adapt effectively to the environment, to learn from experience, to engage in various forms of reasoning, to overcome obstacles by taking thought. Although these individual differences can be substantial, they are never entirely consistent: A given person's intellectual performance will vary on different occasions, in different domains, as judged by different criteria.

Not even clarified what exactly "intelligence" is, the question of its *structure* arose: Can intelligence be seen as a single, homogeneous variable or should it rather be reckoned a subsuming term for multiple, more heterogeneous abilities, skills, and competences in the cognitive-intellectual domain? This question, which is answered in a number of different ways in psychology, is critically essential to SI.

### Spearman's theory of two factors of intelligence: g and s

Spearman (1904) posited two factors of intelligence he was able to extract from several different tests: *g* for a *general mental ability* ("brain power") or a kind of mental energy (Spearman, 1927), and *s* for *specific mental abilities*. The *s* refers to the fact that Spearman found specific factors for the different mental tasks he used. He also found that individuals scoring high on one specific ability (e.g., mathematical skills) also tended to be good in other domains (e.g., language skills). The different abilities correlated positively with each other in a moderate way, which is referred to as a "positive manifold". This suggests that there could be a superordinate variable behind the correlations, the *g*-factor of intelligence. The broad *g*-factor or *general factor of intelligence* tends to cover about 50 % of variance in cognitive tasks of all sorts (Sternberg and Grigorenko, 2002) and seems to be very important for everyday life and work activities (Gottfredson, 1997). Yet, its interpretation varies (e.g., mere statistical regularity: Thomson, 1939; generalised abstract reasoning ability: Gustafsson, 1984; index measure of neural processing speed: Reed and Jensen, 1992).

### Thurstone's model of primary mental abilities

Spearman's assumption that the intercorrelation of *s*-factors leads towards one broad, general intelligence factor was opposed by Thurstone (1938) who proposed multiple "primary factors" of intelligence or *"primary mental abilities"*: *v* (verbal comprehension), *w* (word fluency), *n* (number; computational ability), *s* (space; visuo-spatial imagination and thinking), *m* (memory), *p* (perceptual speed), *r/i* (reasoning, induction). These factors are not uncorrelated and separate factors. Indeed, they intercorrelate and also form higher-order factors. Thurstone's assumptions fostered lines of research in the field of primary abilities, and over 70 primary mental abilities were found (Carroll, 1993).

### Hierarchical models of intelligence

The *g*-factor of intelligence could not alone account for the correlations between the different kinds of cognitive tests which participants had to complete. This triggered research following the notion that there are several factors of intelligence, perhaps on different levels of abstraction. These conceptualisations usually propose a *hierarchical model of intelligence factors* (e.g., Burt, 1949; Vernon, 1950, 1965). There are specialised abilities at the very bottom of the hierarchical system, followed by minor group factors, and above those again major group factors. Above all, at the apex, is the *g*-factor. Each level is more abstract than the other and comprises more abilities, thus enhancing heterogeneity in ability content and diminishing correlations with behavioural manifestations which are located at the very bottom of the system. Further, the factors are still correlated; only the intercorrelation of lower factors can lead to the extraction of higher factors. In general, there are two mathematically equally viable solutions (Amelang, Bartussek, Stemmler, and Hagemann, 2006): First, one can extract a *g*-factor strong in variance and some more or less specific "residual factors" (*s*-factors). Second, one can accentuate the specific *s*-factors at the expense of the *g*-factor. No solution can be accounted as the "only and right" way as both could be transferred into each other. In this sense, hierarchical models can be seen as a synthesis between Spearman's Two-Factor model and Thurstone's model of primary mental abilities: While Spearman uses solution 1 (a *g*-factor and some minor *s*-factors), Thurstone prefers a radical solution 2 (only relatively strong *s*-factors, no *g*-factor). A hierarchical model can account for both sides and help elicit the structure of intelligence(s).

### Cattell's model of fluid and crystallised intelligence

Cattell (1963) provided a synthesis of Spearman's two-factor theory and Thurstone's primary mental abilities model by introducing the concept of *fluid and crystallised intelligence*. Cattell ran factor analyses over the different (already factor analysed) primary factors that still showed intercorrelations due to the oblique rotation of the factors1. So-

[1] Factor analysis aims at reducing the data and bundling it into factors (data in a factor correlate highly with each other and lower with data from other factors). In general, there are two different *rotation forms*: orthogonal and oblique. *Orthogonal* designs lead to no or only very small intercorrelations of factors: The data within a factor correlate highly with each other but not or only to a minimum with data in other factors. *Oblique* rotations allow the factors to be intercorrelated with each

called secondary factors or factors of higher order from the factor analysed primary factors were obtained: These are broader and more abstract factors, comprising several aspects in them and being more heterogeneous in content.

*Crystallised general intelligence* ($g_c$) refers to the cognitive ability of applying learned knowledge when solving problems. It is gained by education, culture, and socialisation which makes it highly dependent on socio-cultural and socio-economic factors as well as on an individual's learning history, experiences, and autobiography. Crystallised general intelligence can be seen as the "end product" of fluid intelligence and individual learning processes.

In turn, *fluid intelligence* ($g_f$) refers to the innate (and genetically determined) ability of solving a problem without any specific or previous knowledge and thus adapting to given problems and situations. This form of intelligence is usually assessed with so-called "culture-fair" or at least culture-reduced tests. There should be no or only minor intercultural differences concerning $g_f$. Culture-fair tests use no language and can be solved independently from one's education, subculture, socialisation, and socio-economic status; they usually involve pictures that require some sort of logical operation (e.g., completing a series of symbols or figures). Tests for assessing crystallised intelligence usually involve language (and may also require a certain education level); they therefore mainly assess verbal comprehension, experiential evaluation, and semantic relations (Amelang et al., 2006).

Statistical analyses showed that primary mental abilities had loadings on crystallised *and* fluid intelligence; $g_c$ and $g_f$ had a relatively high correlation of $r = .50$ (which can be attributed to many factors, however). By extraction of a superordinate variable of $g_c$ and $g_f$, $g_{f(h)}$ or *"$g_f$ historical"* is obtained which resembles Spearman's *g*-factor. $g_{f(h)}$ is more closely associated with fluid intelligence as this intelligence form is more prominent and important in early years of development (Cattell, 1971; Horn and Cattell, 1967). $g_c$, $g_f$, and $g_{f(h)}$ as well as variables of interest, memory, and educational experiences are integrated into Cattell's model of intelligence.

## Guilford's structure of intellect model

Guilford's model (e.g., Guilford, 1956, 1967) is not based on a hierarchical structure of interrelated factors: Not oblique rotation forms are used but rather orthogonal ones (to obtain relatively uncorrelated factors). This complicates finding a *g*-factor as there is not enough variance from which it may be extracted by further higher-order factor analyses. Guilford's model can be seen as an attempt to organise and structure all the existing intelligence concepts at his time. His theoretical underpinning is cognitive information processing which he used analogous to a stimulus-organism-response paradigm.

Hence, he distinguished three dimenions: *Input (content), operation,* and *output variables*. All three dimensions have certain subclasses. *Input variables* can be quite different in their stimulus character and thus have different contents and complexities (Guilford and Hoepfner, 1971): *visual / figural, symbolic, semantic / meaning, behavioural*.

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other: Data within a factor correlate quite highly but also correlate with data from other factors to some extent. Before using a certain rotation method, one usually has to take theoretical assumptions into account: Do we expect orthogonal, uncorrelated factors or interrelated, correlating factors?

Sometimes *auditory* is also included or mentioned with *visual*. There are mediating cognitive operation processes (information processing) between environmental stimuli with certain content (input variables) and the eventually resulting responses (output variables). The "organismic" *operations* can be classified as follows: *cognition, memory, divergent production, convergent production, evaluation*. The *products (output)* of the stimuli processed by the operations are: *units, classes, relations, systems, transformations, implications*. By combining all three dimensions with their subclasses, a 4 × 5 × 6 cube with 120 factors in total is obtained. Each block of the resulting cube (which serves as a good illustration), can be seen as a separate information processing process defined by a specific input, operation, and output.

The model has great heuristic value as it allows to explore different processes one at a time or in combinations – but still having a system integrating the different forms. A problem is that the factors postulated by Guilford are not uncorrelated; there are still rather high and meaningful correlations. This indicates that there are still higher factors to be extracted; thus, the complexity of the model can be reduced (not assuming 120 separate factors). Also, there were several facts in Guilford's studies that even reduced the amount of significant correlations (Brody and Brody, 1976): sample homogeneity, low reliability of tests, heterogeneous abilities in the study.[2]

### Jäger's Berliner intelligence structure model

Jäger (1984) posited a model that takes into account the two dimensions *operations* and *contents* which are crossed with each other and form 12 cells which are understood as certain *performance forms* and not as primary abilities. *Operations* are: *information processing capacity, richness of ideas, memory, velocity of information processing*. *Contents* are: *verbal, numeric, visual-figural*. Further, Jäger was able to extract a non-differentiated *g*-factor.

### Carroll's three stratum theory of intelligence

Carroll's (1993) model of intelligence relies on a comprehensive database (he reanalysed over 450 datasets) and basically posits three levels (strata): *Stratum III* can be deemed as a general factor of cognitive abilities, *stratum II* comprises crystallised and fluid mental abilities as well as velocity of information processing, and *stratum I* contains more specific mental abilities. All in all, Carroll's analyses support (a) the view of a superordinate *g*-factor with more specialised *s*-factors and (b) a hierarchical structure of intelligence.

### Implications of intelligence research for SI research

After briefly outlining some of the most prominent psychological conceptualisations of (cognitive) intelligence, useful elements of intelligence research to SI (see Figure 1 for an illustration) shall now be shown.

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[2] Upon conducting empirical studies in the field of SI, these are factors that should also be taken into consideration.

- First of all, given the fact that SI comprises so many different concepts (especially cognitive, emotional, and motivational ones) there should be a “super-factor” underlying all of these abilities. Therefore, SI might also have a *general factor* $g_s$ *(“g systemic”)*. $g_s$ would be an abstract super-factor that can be extracted from the different areas of SI. Further, there should be lower-order but still relatively abstract factors $g_{s(f)}$ *(“g systemic fluid”)* and $g_{s(c)}$ *(“g systemic crystallised”)*. Beneath these should be quite *specific SI factors* $s_s$ *(“s systemic”)*. As there are no empirical data yet, it is hard to say (a) if there are such things as $g_s$, $g_{s(f)}$, $g_{s(c)}$, and $s_s$ and (b) if they do exist, what purpose (i.e., psychological meaning) they have and how they are structured. $g_{s(c)}$ could probably be settled more in the cognitive domain as it would mostly comprise knowledge structures, and $g_{s(f)}$ could be more of an affective and emotional factor. Nevertheless, I have to emphasise that all of these hypotheses are mere speculations; empirical data will be needed to show structures of SI, possibly hierarchical ones.

- Second, it could be postulated that the factors of SI are interrelated and not orthogonal ones. This, of course, goes along with extracting $g_s$, $g_{s(f)}$, and $g_{s(c)}$ as it would otherwise be hard to do so. Particular tests for specific SI-abilities should be correlated at least in a moderate way (positive manifold) which would suggest that a superordinate SI-factor could be extracted.

- Third, the preceding remarks point towards a hierarchical structure of SI with $g_s$ at the apex, followed by $g_{s(f)}$ and $g_{s(c)}$ at the next level (or stratum), and then followed by more specialised components of SI (see Figure 1). This structure is reminiscent of Carroll’s integrative Three Stratum Theory.

- In analogy to Guilford and Jäger, we should also consider *contents, operations*, and *output* or *performances*. SI probably relates to a vast amount of contents (e.g., even emotions) and there should also be a huge amount of operations. It will be a goal of future research to clarify which contents and operations SI might have. This goes hand in hand with assessing the performance outputs of SI and its related abilities.

- We should not be as quick as to make statements about $g_s$, $g_{s(f)}$, and $g_{s(c)}$ in relation to the *g*- and *s*-factors of intelligence since intelligence (and its associated abilities) are probably an integral part of SI. Eventually, the *g*-factor of intelligence as well as crystallised and fluid intelligence could be separate factors within SI and probably even cover most variance. Of course, this depends highly on the definition and operationalisation of SI, which tasks are used in a study, which abilities are studied, and which characteristics the sample has. Further, it must be taken into account that SI probably relies especially on capacity and velocity of information processing. Indeed, most abilities of SI require this as a prerequisite. Therefore, the *g*-factor of intelligence should be high in SI too. This also leads to the problem of incremental validity: Is there a unique portion of variance that SI can account for when predicting relevant or critical real-life (or test) criteria *above and beyond* certain other variables (e.g., personality traits, intelligence forms, etc.)?

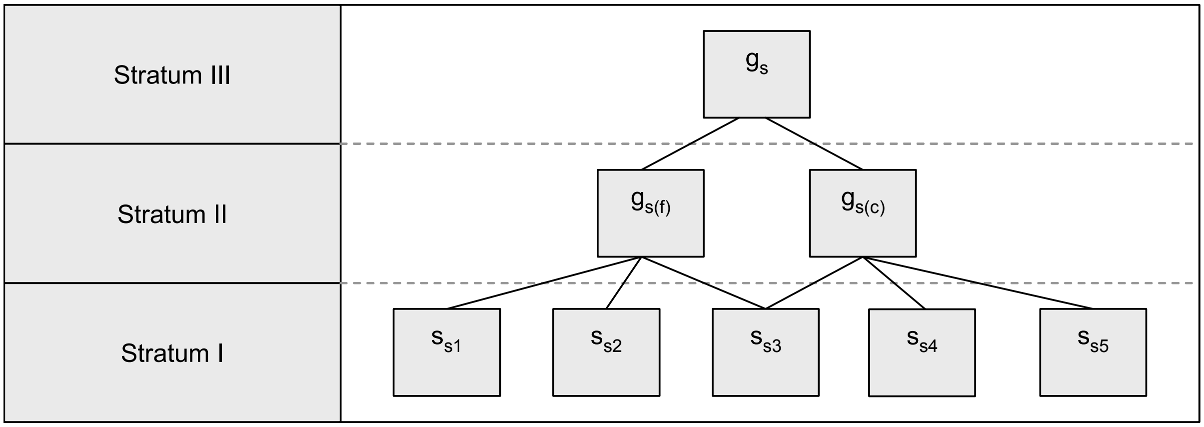


Figure 1. A hierarchical model of systems intelligence

## "Other" Concepts of Intelligence in Psychology

The previous paragraph was concerned with "classical" intelligence, meaning cognitive-intellectual abilities or abilities that are mostly manifested and fostered in school (see Neisser, 1976 with the term "academic intelligence" and most abilities referring to verbal or numeric abilities). It is often associated with a psychometric approach but Neisser and colleagues (1996, p.79) note that "to base a concept of intelligence on test scores alone is to ignore many important aspects of mental ability". This form might be, amongst others, a core factor of SI but certainly not the only one. In the history of psychology, numerous other forms of "intelligence" have been proposed. Some of these other intelligence forms as well as their possible relevance to SI will be briefly discussed.

### Practical intelligence

Neisser (1976, p. 137) proposes an "intelligent performance in natural settings" which refers to some sort of a *practical intelligence* (as opposed to the common "academic intelligence"). Considering the tasks that are administered to measure academic intelligence, it is obvious why there should also be a more practical intelligence (Wagner and Sternberg, 1985; see also Neisser et al., 1996): Most tasks are clearly and well structured, relatively abstract, and not relevant to everyday life ("disembedded from ordinary experience"; Neisser et al., 1996, p. 79); further, nearly all information is given from the beginning on and there is mostly only one right answer or solution to them (with only a single right method). Also, participants tend to have no or only low intrinsic motivation to solve them. As opposed to these, there are tasks in everyday life that are not well structured and poorly defined; fairly complex, dynamic, and intransparant; require own searching, generation, utilisation, and modification of information; affect our needs, emotions, and cognition (personal involvement; "embedded in and require prior everyday experience"; Neisser et al., 1996, p. 79); do not have only one single way of solving them; and there is no single solution that can be deemed as the only and right one (see also Charlesworth, 1976, p. 150). Further, these rather "practical" tasks require more flexibility and situation adaptation while solving them or gathering information to do so. In many ways, practical intelligence resembles more a concept of complex problem solving and tacit knowledge. Tacit knowledge is knowledge that is more practical and informal, not directly taught, and gained mostly implicitly and by experience (cf. Wagner, 1987; Wagner and Sternberg, 1985, 1986). It is defined as an "action-oriented knowledge, acquired without direct help from others, which allows individuals to achieve goals they personally value" (Sternberg, Wagner, Williams, and Horvath, 1995, p. 916). However, practical intelligence seems to be more of a competence than intelligence as not only mental aspects are of concern but also behavioural ones. Practical intelligence might not be a homogeneous construct and rather an "epiphenomenon" of the interactions of other abilities (such as "academic intelligence", tacit knowledge, and control mechanisms).

When assessing[3] practical intelligence or practical competences one can either try to (a) use *self-reports* (which are not very effective here), (b) tap into the *motive(s)* of people activating intellectual and practical abilities in their everyday life (which may also not yield sufficient results, mainly because the motives cannot be assessed in a way that would suit basic psychometric criteria), (c) use certain *structured forms of interviews* asking for situations and experiences referring to practical competences and people's coping with the situations, (d) conduct *simulations* perhaps in an assessment centre setting (Frederiksen, 1966), and (e) use *comparisons of experts and novices* (e.g., Wagner and Sternberg, 1986) (see Amelang et al., 2006).

**Successful intelligence**

Sternberg (1985) proposed in a triarchic theory three fundamental aspects of intelligence: analytic, creative, and practical. Later, Sternberg (1998) introduced a construct that referred to factors beyond education, knowledge, and creativity which are responsible for success in one's career. He basically lists adjectives that refer to persistence, self-assurance, (control of) impulsivity, frustration tolerance, etc. (Amelang et al., 2006). Sternberg (2003a) concretised his theorisation and research programme on successful intelligence and specified the original theory into a triarchic one (Sternberg, 2003b): Successful intelligence may be achieved by an interaction of *metacomponents*, *performance components*, and *knowledge acquisition components*, thus integrating analytical, creative, and practical aspects (see for these aspects also Sternberg, 1985). This makes the construct of successful intelligence in some terms broader than practical intelligence as it also comprises it to a certain extent.

**Social Intelligence and Social Competence**

There are individual differences in people's *interpersonal skills*: how adept they are at assessing and interpreting others' thoughts, feelings, motives, and intentions; handling social situations; and generating verbal and nonverbal social signals. When asking lay

[3] These ways of assessment could also be used for SI.

persons about “intelligence” (e.g., Sternberg, Conway, Bernstein, and Ketron, 1981), that is tapping into implicit intelligence theories of lay persons (non-psychologists), then often abilities are found relating to efficiency in the social or interpersonal domain but also in the intrapersonal one (e.g., self-regulatory control mechanisms). Many interpretations of a “social intelligence” have been proposed throughout the years, such as Thorndike’s (1920) “social competence” as “the ability to understand and manage men and women, boys and girls – to act wisely in human relations” (p. 228), Riggio’s (1986) “social skills”, Gardner’s (1993) “personal intelligences”, and different forms of an “emotional intelligence” (e.g., Salovey and Mayer, 1990).

A crucial question is whether these abilities (a) are alternative forms of intelligence, (b) can be seen as intelligence applied in the social domain, or (c) are not or only barely related to intelligence and form separate competences. Also, social intelligence is very heterogeneous in content as it encompasses many different factors such as: empathy; flexibility and situational adaptability; knowing people and what makes them tick; acting “intelligently” in difficult or awkward social situations; adjusting one’s demeanour to others and situational requirements; understanding and dealing with people; predicting people’s thoughts, feelings, motives, desires, and behaviors; “managing” people and even manipulating them to one’s will (e.g. Weinstein, 1969, p. 755). In addition to these *interpersonal dimensions*, social intelligence can also have an *intrapersonal dimension*, that is “the ability of understanding and managing oneself” (Salovey and Mayer, 1990, p. 187): Having insight into one’s own thoughts, feelings, motives, intentions, desires, and behaviours (see also constructs such as self-monitoring) and acting upon these insights. Hence, social intelligence contains both *personality traits* (e.g., agreeableness, flexibility) and *abilities* (e.g., handling others, adjusting to the situation) in the social domain, and researchers tend to lay emphasis on either one of them or sometimes confound both types in mixed models.

Despite the heterogeneity of social competence(s) or intelligence, it may still be divided roughly into two factors (e.g., Thorndike, 1920): the aspect of *social sensitivity* (perceptive and cognitive variables in processing behavioural cues) and the aspect of *acting or behaving appropriately in social situations* (behavioural variables based on social information processing). Both aspects are quite difficult to assess due to the following reasons4 (cf. Amelang et al., 2006):

- Different tests and tasks seem to be barely intercorrelated which points towards lacking homogeneity of the examined attributes (see also Probst, 1982).

- External validity may be low as objective ratings do not correlate highly with other criteria such as self-reports.

- There is only poor discriminant validity to (“traditional”) intelligence as most tests have correlations with the IQ that are too high to assume that social intelligence is a distinct factor.

[4] These reasons are also very important for the study of SI.

- Self-reports on social competence usually do not correlate highly with behaviour in real social situations (although the Act Frequency Approach by Buss and Craik, 1980, 1981, 1983a, 1983b, 1984 can be used to enhance the psychometric criteria of self-reports, and people could rate the frequency of behavioural indicators for a certain construct).

- Assessment centres use trained assessors to evaluate people's social competence(s) by letting them interact in group discussions or simulations and by observing their behaviour in those situations. Even though interrater agreement might be high, people show low cross-situational consistency in social competence. This points towards a lacking homogeneity of the construct but also implies that social competences are quite situation-specific (or rather specific in the terms of the content of the situations: Some situations might be more likely to trigger socially competent behaviours than others; these links between situation and behaviour are, however, interindividually different although they can be intraindividually stable; see also if-then dispositions by Mischel and Shoda, 1995). This point of view implies rather a disposition model of social competence than an intelligence model.

All in all, there is not just a problem in the conceptualisation of social intelligence but also in its assessment. Specifically, the question is asked whether we need to assume social intelligence as a distinct form of intelligence; it might just be (cognitive) intelligence applied to social matters and associated behaviours manifested in interpersonal situations.

**Emotional intelligence**

The construct of an "emotional intelligence" (EI) can be seen as a sub-factor of a very broad social intelligence but is usually studied as a distinct variable since it is itself not very homogeneous and also usually encompasses several different aspects (among them, inter- and intrapersonal competences). Even though Salovey and Mayer (1990) first developed the concept of EI, it was Goleman (1995) who popularised the construct with his bestseller book "Emotional Intelligence: Why it can matter more than IQ", leading to more research in the field. In the course of time, roughly three different types of EI concepts emerged (cf. Mayer, Roberts, and Barsade, 2008): First, there are *ability models* (Salovey and Mayer, 1990), also called *specific-ability approaches*. Second, there are *integrative-model approaches* which "describe overarching frameworks of mental abilities that combine skills from multiple EI areas" (Mayer, Roberts, and Barsade, 2008, p. 527). Third, so-called *mixed-model approaches* or *trait models* have been brought up (e.g., Bar-On, 1997), which focus on trait-like attributes that can be associated with (social-) emotional intelligence. Using an ability-model, Mayer and Salovey (1997) distinguish four broad branches of EI: (1) *emotion perception* (perceiving emotions in one self and others) and *emotional expressivity*, (2) *facilitation of thinking* (using emotions to facilitate thought), (3) *understanding and analysing emotions and their meanings*, and (4) *emotion regulation* (managing emotions). The branches thus encompass perceptual, cognitive, regulative, and behavioural domains. Trait models do not conceptualise EI as ability or intelligence per se but rather as a conglomerate of different traits (that may have already been explored). Mayer, Roberts, and Barsade (2008, p. 527) write that the EI-related trait attributes which are brought up in mixed-model approaches "are not primarily focused on emotional reasoning and emotional knowledge" and thus do not fall within their conceptualisation of EI. Specifically, they conceptualise EI as "the ability to accurate reasoning focused on emotions and the ability to use emotions and emotional knowledge to enhance thought" (p. 527). As far as EI's standing within a nomological network of abilities and its criterion as well as incremental validity is concerned, it is indeed a "predictor of significant outcomes [...] in a number of real world domains" so that "it predicts social relations, workplace performance, and mental and physical well-being" (Mayer, Roberts, and Barsade, 2008, p. 527).

**Gardner's multiple intelligences**

Gardner (1983/1993, 1993, 1999) proposed in his theory of multiple intelligences several different forms of "intelligence": verbal-linguistic, logical-mathematical, visual-spatial, bodily-kinaesthetic, intra-personal, interpersonal, musical, naturalistic, spiritual, existential, and moral. It can be argued whether the last four should be seen as intelligences. In general, most of Gardner's so-called "intelligences" might only reflect certain abilities or talents (not intelligences) or maybe just intelligence applied to special domains (such as music). Also, there is the possibility that we do not need to assume all forms of intelligence as there might be a small superordinate group tying all together.

Gardner reviewed the existing literature and eventually defined eight criteria that should be met if we were to talk about an "intelligence" (Gardner, 1983/1993, p. 62–69): First, we ought to have neurological evidence for an intelligence; that is, there should be circumscribed brain areas "responsible" for the functions and operations of the intelligence. Furthermore, lesions in these areas should cause the intelligence-related abilities to be impaired. Second, there should be individuals exceptional in the domain of the intelligence (e.g., savants, prodigies, etc.). Third, there should be an identifiable set of (core) functions and operations associated with the intelligence form. Fourth, there should be a distinctive development history of the intelligence. Fifth, there should be evolutionary plausibility behind the intelligence. Sixth, it must be able to explore the intelligence (or rather its operations) by experimental means (in tasks). Seventh, there should also be psychometric findings concerning the intelligence. Eighth, there should be a susceptibility to encoding in a symbol system. According to Gardner, any ability that should be labelled "intelligence" needs to meet these eight criteria.

**Implications of the research on different intelligence forms for SI research**

Even though "classical" intelligence might be a strong factor in SI or even underlying it to a large extent, more specific aspects are probably covered by the "other" intelligence forms, the so-called "hot intelligences" (Mayer, Roberts, and Barsade, 2008) such as practical, successful, and socio-emotional (inter- and intrapersonal) intelligence.

- *Practical intelligence* should be an integral part of SI as it refers to certain implicit and explicit knowledge structures and processes (cf. Wagner, 2000). Systems intelligent people sometimes just "know" what is right and how to behave as SI can be seen as "behavioural intelligence of human agents in systemic environments" (Luoma, Hämäläinen, and Saarinen, 2008). This systems intelligent "intuitive performance within a system" can indeed be seen as a part of a practical intelligence. The question which has got to be answered is whether practical intelligence is a part of SI or if it may also be the other way around. Again, the topic of SI's incremental validity needs to be addressed: can SI predict certain (critical) real-life outcomes above other intelligences (i.e., when statistically controlling them)? Research is badly needed in this field and I am positive that it will yield interesting results for SI in the near future.

- Persons high in SI should also be very successful. It will be interesting to see whether SI or *successful intelligence* predict variables of success in people's lives better (see again the incremental validity of SI as mentioned above). In particular, the triarchic system (metacomponents, performance, knowledge acquisition) might be of interest for SI as *(meta-) cognitive* as well as *behavioural* or *action-related aspects* seem to be essential to SI.

- Especially the distinction between more *intra- and interpersonal aspects* in *social and emotional intelligence* forms seems interesting for the concept of SI: Both domains should be covered in a systems intelligent person. Being systems intelligent does not just mean self-reflection and (self-related) deep thoughts but also (pro-) active interaction with the surrounding systems. In this sense, SI should indeed be seen in an intra- *and* an interpersonal manner. Possibly, more perceptual, cognitive, and meta-cognitive (and even affective-emotional and motivational) domains of SI refer mostly to intrapersonal mechanisms, whereas domains of control, management, regulation, and action can be considered as a part of interpersonal competences in the domain of SI. Same as social intelligence, SI should include capacities of appraisal and understanding of human relationships (cf. Lee, Wong, Day, Maxwell, and Thorpe, 2000). SI was also linked to the social competence of reading others' intentions (Hämäläinen and Saarinen, 2008b, p. 823).

- EI offers four branches of abilities that seem very similar to the five levels of SI from Hämäläinen and Saarinen (2007, p. 50; see also Table 7) without the leadership level (that can rather be seen as a result from the preceding levels): *perception-*, *cognition-*, and *action-related domains* are addressed. This triarchic constellation subsumes several lower factors (especially the action-domain) and allows us to create a preliminary more detailed (hypothetical) structure of SI (see Figure 2). Yet, we must consider that this is solely a theoretical assumption (in analogy to the conceptualisation of EI) and that empirical data should guide further approaches. Specifically, perception might dissolve in a higher-order cognitive domain and more emotion-based factors could evolve. Admittedly, this will be more likely if we do not see SI as a mere ability but also as a construct that resembles people's *disposition(s)* (in the sense of a trait) to think and perform systems intelligently.

- It can be debated whether SI should be regarded as an addition to Gardner's intelligences or not. In particular, associations with naturalistic, spiritual, existential, and moral "intelligence" forms could be explored. Also, SI should be critically assessed regarding Gardner's eight criteria of what we can assume to be an "intelligence" (see for a brief discussion 4.1. "Ability-SI: systems intelligence as an intelligence"). Mayer, Roberts, and Barsade (2008, p. 521) come to the conclusion that "it appears likely that other intelligences beyond EI will add to the prediction of critical life outcomes such as academic and work performance, social relationships and how well one attains psychological well-being". SI could turn out to be one of these.

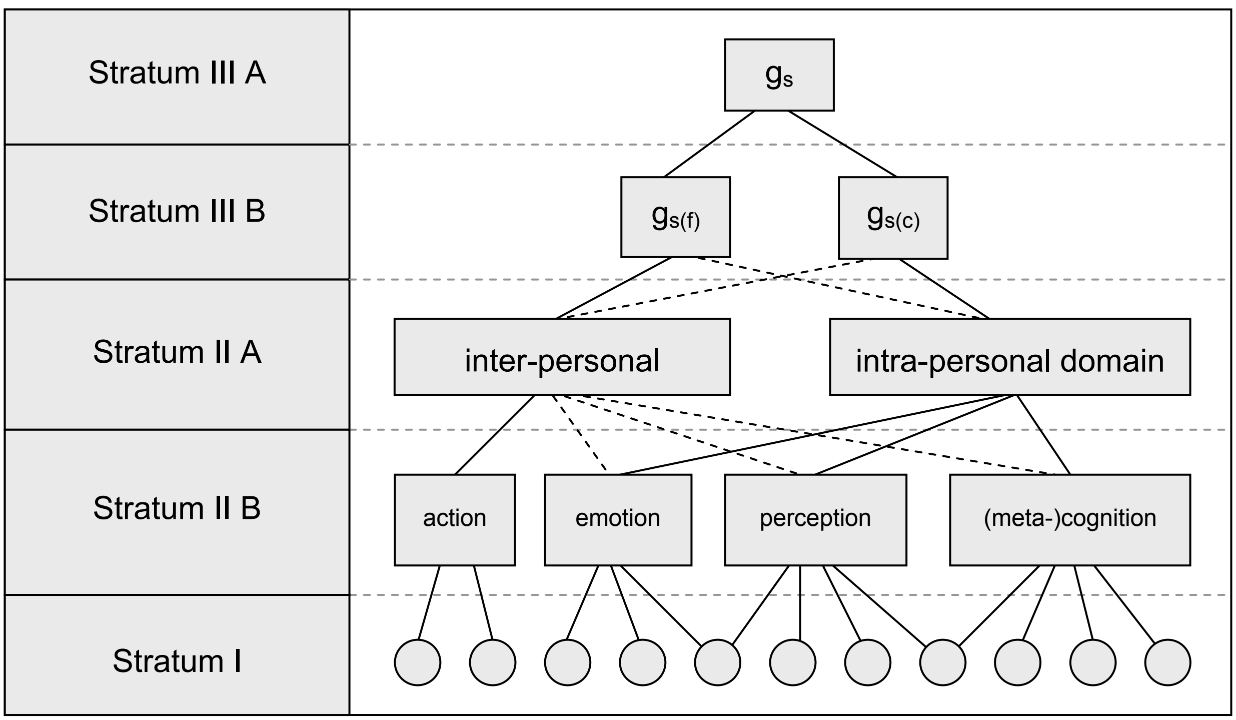


Figure 2. An extended hierarchical model of systems intelligence and hypothesised relationships

## Systems Intelligence: Trait, Style, or Ability?

### A general problem: *Trait vs. style vs. ability*

In personality psychology, one can very roughly distinguish:

- *traits* or *dispositions* – opposed to momentary states – that describe stable, consistent, and enduring characteristics (i.e., cognitive, affective-emotional, motivational, behavioural patterns),

- *styles* that describe the manner of mental processes (cognition, emotion/affect, motivation, etc.) or behaviour, and

- *abilities* that describe a (maximum) form of performance of individuals,

- as well as *needs* and *motives, habits*, and *preferences*.

Even though these four are part of a personality and dynamically interact in everyday life, they still ought to be distinguished as there are not just conceptual differences but also different methodological approaches in measuring them. These distinctions are essential as SI may be seen as a trait, motive, style, or ability (i.e., intelligence, skill, competence).

Generally speaking, we can ask: when am I doing what how much how often?

- The *"what"* can be any mental process or behaviour: *what is exhibited?*

- The *"when"* refers to domain specifics, circumstances, contexts, and situations of a "what": *When is what exhibited?*

- The *"how much"* refers to degrees, levels, and intensities of a "what": *how much is what exhibited?*

- The *"how often"* refers to frequency and representativity of a "what": *how often is what exhibited?*

Depending on how the questions are answered, different psychological concepts can be distinguished, such as traits, styles, and abilities as well as different mixed models (see Table 1):

- If the "*how"* is not of concern, the "*when"* rather generalised, and "*how often"* and "*how much"* more of interest, then we may speak of *traits* or *dispositions* as enduring characteristics of a rather broad "*what"* in relation to a broad "*when"*.

- If the "*how"* and "*how often"* are of concern, "*how much"* and "*when* not", then we may speak of *styles* as enduring manners and preferences of a "*what"*.

- If the "*when*", "*how*", and "*how often*" are not of concern, but only the (maximum) "*how much*" of a "*what*", then we can speak of *abilities* as enduring performance aspects of a "*what*".

- If the "*when*" plays a role or is specified more closely (i.e., domain-specifically), then we might want to speak of certain specialised *competences and skills*.

Based on the preceding remarks, we can conceptualise SI from the point of view of five broad categories: it can either be seen as (1) a trait or disposition of enduring mental and behavioural patterns, (2) a need-like construct that refers to the motive of behaving systems intelligently, (3) different styles of behaving systems intelligently, (4) an ability to perform systems intelligent actions, and (5) specific competences and skills in the domain of behaving systems intelligently.

The trait of being systems intelligent:
*systems intellect (Trait-SI)*

The motive or need of thinking and performing systems intelligently (as a special form of Trait-SI):
***need-SI (nSys), need for SI (NFSI)***

Individual style(s) of thinking and performing systems intelligently:
***style-SI***

The general ability of thinking and performing systems intelligently:
***systems intelligence (ability-SI)***

Specific abilities concerning different parts of the broad systems intelligence construct, $\boldsymbol{g_s}$ ***("g systemic")***, may be referred to as ***specific systems intelligence skills and competences, the*** $\boldsymbol{s_s}$.

Even though need-SI and style-SI might also be interesting facets of SI that should be explored, I will only focus on Ability-SI and Trait-SI in this work. This has following reasons: It is debatable whether Need-SI and Trait-SI are really genuinely different constructs although we should not jump to the conclusion that needs and motives are the same as traits. Rather, both interact and bring forth different patterns of behaviour in relation to certain contextual aspects. Style-SI, on the other hand, is a matter of its own as it could be conceptualised near to traits or near to abilities (see the remarks stated below). Therefore, Trait-SI and Ability-SI comprise most important aspects of SI for the beginning but further theorisation and empirical studies should also be concerned with need- and style-SI.

Table 1. Properties of traits, styles, abilities, competences, and mixed models

| | ***when*** | ***how*** | ***how much*** | ***how often*** | Classification |
|---|---|---|---|---|---|
| | ✓ generalised | × | ✓ typical level | ✓ frequency | trait (disposition) |
| | × | ✓ manner | × | ✓ frequency | style |
| | × | × | ✓ maximal performance | × | ability |
| Criteria of a *what* | ✓ specific domain | × | ✓ maximal performance | × | skills, competences |
| | ✓ specific domain | × | ✓ (maximal) performance | ✓ frequency | mixed model: ability + skill |
| | ✓ specific domain | ✓ manner | ✓ (maximal) performance | × | mixed model: ability/skill + style |
| | ✓ specific domain | ✓ manner | ✓ performance | ✓ frequency | mixed model: ability/skill + style + trait |

Figure 3 shows the general relationship between different factors related to the domains of dispositions, styles, and abilities. The subsuming term “information processing” is used as this is one of the most prominent factors in SI.

An individual’s biological basis (with its anatomy, neurophysiology, biochemistry, endocrinology) is expressed through its genes. This basis determines basic dispositional or *temperamental aspects of information processing*. “Dispositional”[5] means in this context that biological dispositions are the main influence on psychological functions. These basic dispositional factors can be referred to as *abilities*. Although some abilities can be trained, information processing abilities are usually determined to a large portion by genetic and biological aspects. There is only a certain quantity of information we can process and hold

[5] Note that “disposition” often means the same as “trait”. However, “disposition” can be used as an umbrella term for any psychological variable that is characteristic for an individual and usually is determined by more biological factors (but does not have to be). I will use the term “disposition” in its broadest sense: It refers to any person-related structure or process that can describe the individual (in general) – be it genetically and biologically determined or acquired through learning and training.

(capacity) and some individuals process information faster than others (velocity). These basic abilities of information processing are a crucial prerequisite to SI: One can hardly act systems intelligently if he or she cannot identify and process systemic information (that is usually fairly dynamic, time-dependent, and interrelated). These abilities mostly merge into cognitive and meta-cognitive ability branches of SI. However, also the emotional and motivational ability branch is affected as temperament factors also play a significant role. *Temperament* is related to variables of *activation*, *affect*, and *attention* (Asendorpf, 2004 called them the "three *A*s of personality") and usually refers to *form aspects* of affect and behaviour. When speaking of *form aspects* we are near the term of *style* as both concepts describe *manners of psychological functions*. Yet, *styles* are merely *tendencies* towards a certain manner which is a mixture of the dispositional, temperamental (and ability-related) form aspects, the learning history, and autobiography of the individual; they can be flexible to some extent. Form aspects, on the other hand, are more genetically and biologically determined and can hardly be modulated unless modifying aspects of one's neurophysiological basis and biochemistry (e.g., accidents, operations, intoxications, etc. which can cause changed behaviours, even maladaptive ones). One's tendencies or style(s) of thinking, feeling, acting, etc. usually result in certain *habits* or *preferences*. This might also be due to the fact that individuals tend to seek and avoid situations that are congruent or incongruent respectively with their individual preferences (except there are inevitable external obligations to do something). These habits differ from styles in the sense that they are heavily influenced by the individual's *self-concept* and associated cognitions. We also have a *self-concept of our abilities and styles*; it might be congruent in some terms with the actual abilities and styles but need not be. We can ask someone about his abilities and he or she might not be able to evaluate them properly; he or she might down- or upsize him- or herself when thinking about own abilities. Also, the *tendential style* is not directly accessible to oneself: to assess one's own styles of thinking, feeling, acting, etc. we would need a great deal of meta-cognition and monitoring of ourselves. Some parts of styles might, however, be expressed if we ask people. Yet, we would obtain best results if we ask people about their preferences and habits: they would be able to verbalise them and think about *what* they like or dislike doing and *how* they like or dislike doing it. These *habitual preferences* can still be confounded with the subjective self-concept (in the respective area) and need not be accurate. The chance of accuracy is still higher for habitual preferences as for dispositional abilities and related tendential styles.

These differences make it evident that we have to use different methods to assess these constructs: We cannot just simply ask someone "How systems intelligent are you?" and think that we are tapping into the actual ability domain of SI; rather, we are inquiring the individual's subjective self-concept of his or her abilities in SI (or a related domain of SI). Abilities are best assessed by objective tests; styles could be assessed by behavioural observation (i.e., "*How* does someone behave?") and partly by self-reports (but we would have to be careful not to merely tap into preferences and self-conceptual information). These problems will be addressed more in detail in part II of this chapter, where Q-data (data from questionnaires), L-data (data from one's life: observations, writings, biography, etc.), and T-data (data from objective tests) are described.

Taking all of the preceding remarks into account, we can state for SI: The genetical and biological basis of an individual determines its dispositional *ability of systems intelligence*.

By interacting with its surroundings, the individual learns and gains experience. Due to dispositional and learned aspects, certain *tendential styles of systems intelligence or Intellect* arise (e.g., a person could be more affective-emotionally, cognitively, or interpersonally systems intelligent) which can also be preferential to the individual. The individual develops hence certain *habitual preferences of systems intelligence or Intellect* that are expressed most of the time in its everyday life and are somewhat characteristic and representative for it. These preferences can also merge into the individual's *subjective self-concepts, self-evaluations,* and *self-related cognitions (and emotions) concerning its abilities of systems intelligence and styles of systems intelligence or Intellect*. They, in turn, may also affect preferences. Additionally, when very often exhibiting preferences that an individual might want to adopt and thus habitualise, they may also affect styles in some way as styles are flexible to a certain extent. Still, the *dispositional form aspects* will not or only barely be affected as they are genetically and biologically determined to a large extent. Styles, preferences, and self-concepts are associated with a trait-conceptualisation of systems intelligence, *systems intellect*. There can be congruencies and incongruencies between ability, style, preference, and self-concepts (the last three are more trait-like) but the strongest dichotomy arises between *ability* and *preferences* (along with self concepts), whereas style stands somewhat in between of these two concepts.

Even though we can theoretically or conceptually divide SI in these categories, there must be a debate on which of these are best for SI: for example, classical intelligence is best seen as an ability, not as a style or trait; thinking styles should not be reduced to abilities or traits; traits such as Extraversion, for instance, are best seen as traits and not as abilities or styles.

Since SI comprises so many different aspects, it could very well be conceptualised by different concepts equally well. However, I doubt this and plead in favour of further research. Also, we need to assess if we should at all distinguish these different concepts and if all of them are necessary: *do we really need style-SI and/or Preference-SI or is it enough to distinguish Ability-SI and trait-SI?* We should treat the different concepts equally, though – and try to elucidate their properties as well as their advantages and limitations. I hope that these quite different SI conceptualisations will inspire other researchers to refine and advance the basic theorisations presented here as well as provide bottom-up research as opposed to the top-down style of this work.

Now that the general properties of traits, styles, and abilities – along with their similarities and distinctive characteristics – have been clarified and possible different concepts of SI proposed, I will go on to specify Ability-SI and especially Trait-SI along with elucidating the properties of a systemic-synergetic disposition model for Trait-SI.

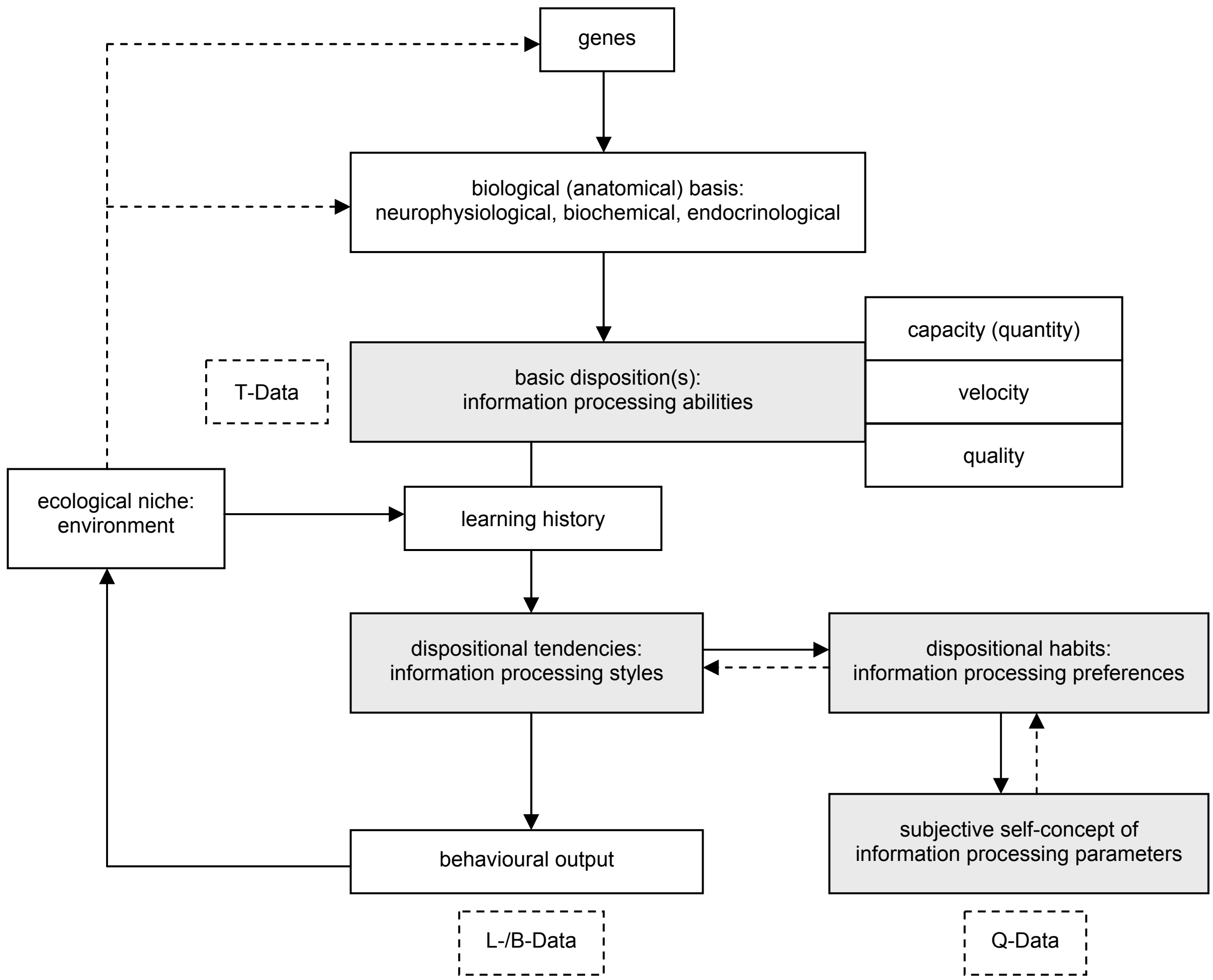


Figure 3. The relationships between information processing abilities, styles, and preferences as well as the data-type (L/B, Q, T) associated with them

**Ability-SI: systems intelligence as an "intelligence"**

Without going too deep into different definitions of "intelligence", it might be best to evaluate an intelligence and also SI according to Gardner's eight criteria that an intelligence should meet (see Table 2). From the eight criteria, SI currently does not meet five of them which makes it difficult to label it an intelligence at present (at least according to Gardner). However, this does not mean that SI is not an intelligence or that it will never be one; the construct is simply too "young" and not "popular" enough to have already undergone extensive top-down and especially bottom-up research. SI's future will indeed be exciting as it will be a key task to evaluate whether or not SI meets Gardner's eight criteria. In the process of investigating this, it will also show which conceptualisations of SI are more "useful"[6] than others. There is one advantage of the young construct SI, though: It has

[6] The "usefulness" is judged on the research aim and, in appliead areas, what SI is needed for.

frequently been linked to more applied areas and shown to be very useful there (organisations: Salonen, 2004; Fischer, 2004; Hukki and Pulkkinen, 2004; Särs, 2004; Nuorkivi, 2004; Westerlund, 2004; leadership: Hämäläinen and Saarinen, 2007b, 2007c; Viluksela, 2007; Ojala, 2007; public policy: Siitonen and Hämäläinen, 2004; social systems and interactions: Lavikka and Luoma, 2008) as SI is a genuinely applicable construct.

*People perform intelligently in ever-changing dynamic systems with positive and negative feedback loops*

There is, however, a problem with the term "intelligence" that needs to be addressed if we were to call SI an intelligence: The term "intelligence" is mostly associated with a psychometric approach and "test psychology" (see also Neisser at al., 1996). This approach focuses on the measurement of intelligence and also emphasises the outcome- and performance-aspects of intelligence (rather than the underlying processes). The question is now whether SI fits into this view of "intelligence". Of course, there are other conceptualisations of "intelligence" (see, for example, trait-models of emotional intelligence) but it is often debated whether these meet the criteria for being an intelligence. Ultimately, this results in the question what "intelligence" is and what not.

As I do not want to delve into these difficult questions, I focus on SI: is it an "intelligence"? It is important to acknowledge that Hämäläinen und Saarinen did not conceptualise SI as "just another intelligence" but rather there was a necessity to assume that there is something else beyond the "usual" intelligences if we look at everyday life: people perform intelligently in ever-changing dynamic systems with positive and negative feedback loops. As Luoma, Hämäläinen, and Saarinen (2008, p. 757) put it, "SI looks for efficient ways for an agent to change his/her own behaviour in order to influence the behaviour of a system in different environments." There are two implications from this SI-approach which makes it difficult to conceptualise SI in psychological terms as an "intelligence".

First, SI goes beyond regular psychology in the sense that it might be a construct that is very difficult to assess and measure. Classical tests will then be insufficient in determining one's SI level – they may rather assess only sub-constructs of SI. For example, tests might measure some kind of interpersonal intelligence which might be a factor in SI but certainly not SI. This problem stems from SI's "macro-character". This means that a systems intelligent person acts over a certain time-span intelligently within a system. What is "intelligent" is then defined by the person × system characteristics rather than by absolute standards. SI can then only be inferred from dynamic aspects and is thus not clearly defined. In contrast, an intelligence test is more "absolute": a task can be solved or not. In SI this view cannot be taken: there is no absolute standard to be systems intelligent and it cannot be defined nomothetically. Also, it might seem at some point that the person x systems interactions are not working well but this can easily change again. This makes it necessary to not just observe a person at one or two occasions but in many. Further, a person might be only in some situations systems intelligent and in most others not (which would imply that we would need to distinguish state-aspects of SI but also determine whether these SI-states follow a certain intraindividually stable pattern; cf. if-then dispositions by Mischel and Shoda, 1995). In short, outcomes of SI cannot be that easily defined without reducing SI to some kind of subcomponent. This makes it difficult to measure SI as an ability.

Table 2. Gardner's eight intelligence criteria and SI's standing on them

| Gardner's eight criteria for an "intelligence" | Are they met by SI currently? | Could systems intelligence potentially meet them in the future? | Where are we currently standing in the study of systems intelligence? |
|---|---|---|---|
| *specialised brain areas, potential isolation by brain damage* | ✗ | (✓) Since SI is a holistic concept, there should be associations between brain areas and SI functions. Their relationships remain unclear as of yet. It will be a future goal to obtain neurological evidence for SI- capacities. | No neuro(physio)logical studies in the area of SI have been conducted yet. |
| *existence of exceptional individuals* | ✓ | ✓ If SI is an ability- or trait-continuum, then there should be exceptionally low and high ends of SI. | Hämäläinen and Saarinen (2007b) list several exceptional individuals. |
| *identifiable set of (core) operations* | (✓) | ✓ If there is such a thing as SI, then there ought to be core operations too (that distinguish it from other concepts). This also taps into the debate of SI's incremental ability which will have to be fought in the near future. | We are beginning to explore sets of operations specific for SI, and core operations have been identified to some extent but the descrilption is in qualitative language. |
| *distinctive development history, along with a definable set of "end-state" performances* | ✗ | ✓ There should be lifespan developments of SI. | Developmental (and cross-cultural) studies have yet to come in the field of SI. |
| *phylogenesis: evolutionary history and evolutionary plausibility* | (✓) | ✓ SI ought to have some evolutionary function. | SI has been linked to human phylogenesis (see Timonen, 2004). Yet, more integrative research is needed on the evolutionary basis of SI (Hämäläinen and Saarinen, 2007d, p. 297/298). |
| *support from experimental psychological tasks* | ✗ | ✓ There should be SI-specific laboratory tasks. | No experimental psychological tasks have been conducted yet in SI research. |
| *support from psychometric findings* | ✗ | ✓ SI could potentially be measured in individuals, groups, and organisations. Different concepts of SI should be distinguished (e.g., ability, trait, need, style, etc.) | No psychometric findings have been proposed thus far. However, this volume provides a first scale for measuring trait-SI that can be revised in the future by rigorous validation studies. |
| *susceptibility to encoding in a symbol system* | ✗ | (✓) To which extent SI fulfils this criterion is unclear as of now but, generally speaking, it seems not too far-fetched to assume it. | This criterion of SI has yet to be explored, even though SI challenges the justification of this criterion |

A second point concerns the SI approach per se: Hämäläinen and Saarinen (2008b, p. 822) state that the "systems intelligence approach wants to pay homage to the full systems capacity in the human being-in-the-world and acting-in-the-world." Noteworthy is that SI is tied very much to practical aspects – for example, in organisations. The positive and practical note that the SI approach spreads is, however, likely to lead us to focus more on "that SI works" than "how and why it works". One of SI's biggest assets is its rootedness in philosophy (it goes beyond systems thinking; see Hämäläinen and Saarinen, 2008b) as well as its applicablity to so many different topics (see the volumes by Hämäläinen and Saarinen, 2004, 2006, 2007). The question is now whether the SI approach, as a form of philosophy, is compatible with psychology. SI addresses such a wide range of topics and offers a plethora of applications but this makes it difficult to grasp it as an "intelligence". Somehow SI has got to be measured, and then we will have to evaluate whether SI has incremental predictive abilities above and beyond other forms of intelligences (and also traits). Perhaps SI shows no incremental abilities beyond other intelligences and it could be fully explained by (the interaction of) different already known intelligences. Even if this were to happen, it does not mean that there is no SI: the dynamic interaction of different intelligences may constitute SI. It would therefore be more of an emergent (order) parameter. Probably, psychologists have been referring to "systemic competences" all along but never seen them in the big picture and combined them to an integrated view – one that the SI-approch provides. There are perhaps different perspectives and different terms but we may be looking at the same.

In summary, it is debatable whether SI is an intelligence simply because psychological thinking and terms might not suit the SI-approach. However, SI is a genuinly multi-, trans-, and inter-disciplinary construct, and it should be possible to at least conceptualise some parts of it psychologically and also use psychometric approaches. We should be aware of the difficulties that come with the term "intelligence", but be uninhibited by it and proceed with exploring psychological aspects of SI.

## Concluding Remarks

The main purpose of this article was to conceptualise SI in a "psychological way" and outline different conceptualisations of SI. It was not a goal to provide an integrated framework for SI and its different components. This should be done after empirical studies have been conducted and further theorisations (based on empirical findings) done.

In particular, I foresee following multiple and productive lines of research on SI in the (near) future if we continue to work across disciplinary boundaries:

- refinements of different conceptualisations of SI (trait, ability, motive or need, style, preference or habit, skill or competence, mixed models, etc.)

- integration of different SI conceptualisations and aspects in overarching frameworks

- constitution of a nomological network for SI and its aspects

- identification of SI-relevant contexts, mental processes, and behaviours (in everyday life)

- identification of (critical) real-life criteria and outcomes for SI and its different aspects

- construction and validation of measurements for SI (with Q-, T-, and L-/B-Data)

- conducting sound empirical studies for SI

- integrating theory, empirical findings, and evidence from practice into the study of SI

- determining the structures, processes, and dynamics of SI

- determining the underlying neurophysiological structures of SI

- developing an evolutionary approach to SI by evolutionary genetics and sociogenomics

- determining biological, psychological, and social factors of SI

- assessing Gardner's eight criteria for intelligence regarding SI

As a general way of approaching SI, following steps could be employed:

First, we should clarify what or which aspects of SI we are looking at (trait, ability, etc.) and especially which we need or do not need (e.g., style-SI might not be necessary but that concept has not yet been elaborated and might still prove useful in some research areas). Subsequently, we ought to identify the respective mental processes involved (be they explicit and/or implicit) and assess behavioural manifestations. This will be a major goal of research as it will enhance the understanding of SI the most and also bear important insights for furthering SI in individuals, groups, and organisations. To go beyond this would be to propose integrative structure- and process-oriented models of SI to obtain overarching frameworks. SI is quite a complex construct and there might be multiple and even competing lines of research in the field; therefore, it will become more important to tie together the different approaches and try to integrate them. This also means that approaches will have to be tested empirically and empirical evidence will have to be interpreted in the light of previous theorisation. By doing this, we can also proceed to elucidating the underlying biological/physiological structures of SI and its aspects. This, however, requires razor-sharp operationalisation of what SI is and which specific aspects are of interest. Another step further would be to describe the evolutionary genetics and sociogenomics of SI (as well as its evolutionary significance). By doing all of this, we should step by step try to assess Gardner's eight intelligence criteria – and show that systems intelligence may indeed be considered as a (new) form of intelligence.

Theorisation and research might want to study SI from different psychological aspects which can also be seen as major lines of (possible future) research:

*General view:* a general view on the mental processes and behaviours of SI should be formulated. This will help to understand how SI manifests most of the time for most of the people. Cognitive and behavioural sciences will be major disciplines contributing to this line of research.

*Differential view:* this view is concerned with inter- *and* intraindividual differences of SI and its aspects. Whereas the general view yields information on general factors of SI and its aspects, a differential view can account for individual and maybe even idiosyncratic forms. Social and personality psychology will be key disciplines in this area.

*Developmental view:* this view regards the development of SI and its associated aspects. Longitudinal data of SI should be obtained. Short-time developments can be of interest (e.g., when training individuals in SI) as well as long-time outcomes (e.g., SI over the lifespan). Developmental and lifespan psychology as well as gerontopsychology will be of particular use in this line of research.

*Biological view:* the underlying neurophysiological processes, anatomical structures and "localisations" of SI and its aspects should be explored. This can be complemented by evolutionary approaches and genetics. Besides biological and physiological psychology, especially (cognitive and affective) neurosciences could prove fruitful here.

*Social view:* while most other lines of research might tend to focus on intrapersonal aspects, SI and its aspects require also a heavy duty of interpersonal research. Not only individual–environment inter-/transactions should be viewed but also communication and interaction between individuals. Dyadic and group processes should be studied in both face-to-face and mediated (e.g., by computer) communication. Also, socio-cultural aspects of SI should be explored in intra- *and* intercultural designs. This interpersonal view will complement the intra-personal perspective and will most likely benefit from social psychology, culture sciences, anthropology, and sociology.

*Organisational view:* to enlarge the scope of SI to a macro-variable that is even manifest in large groups and organisations, organisational SI should be explored. This, however, is a genuinely applied branch of research that takes place mostly in actual practice, whereas the preceding areas are more theoretically grounded in their research purposes. The focus will be on assessing and furthering SI in groups and organisations.

*Clinical, pathological, abnormal view:* this view could also prove fruitful to study "abnormalities" in SI. This could include any abnormal state of SI (e.g., exceptionally high and low SI). Also, this view could explore if there is such a thing as using one's SI for malicious purposes. Further, lesions and brain damages could be explored with respect to neurophysiological evidence of SI. Also, it could be explored which clinical groups of people generally lack SI (or simply do not attain high scores), have high SI (if this were to be the case), and why that is. To adopt this view, it will be necessary to *at least* have findings in the area of the general, differential, biological, and social view.

*Methodological view:* how to assess which aspect of SI should be a separate line of research from which all other lines will benefit. Methodology, research methods, and statistics should be pointed out for an empirical approach to SI and its aspects.

A psychologically informed view on SI should also consider – besides theory and empirical research – practical aspects of SI in individuals, groups, and organisations. Positive psychology might be a branch very fruitful for the study of SI: Emphasised key areas of positive psychology include, among others, flourishment, hope, upward spirals, growth-fostering, life-giving, aliveness, transcendence, etc. (e.g., Cameron et al., 2003; Keys and Haidt, 2003; Lyubomirsky, King, and Diener, 2005; Seligman and Csikszentmihalyi, 2000; Snyder and Lopez, 2002).

As Hämäläinen and Saarinen (2007b, p. 4) state, "the systems intelligence approach combines holistic orientation with a humanly-tuned emphasis that highlights the human potential" and "stems from a deep belief in the human potential." This links it explicitly to positive psychology which seeks to gain an integrated and holistic view on humans and their positive potential in emotions, character, and life. However, it also connects to humanistic psychology (e.g., Maslow, 1998; Rogers, 1961/1989, 1980) and to positive organizational scholarship (e.g., Cameron, Dutton, and Quinn, 2003; Kim et al., 2003) which, in turn, are also linked to notions of positive psychology. Hämäläinen and Saarinen (2007b, p. 5) further point out that SI is not merely an academic or theoretical approach but that it is deeply rooted in practice, that is, SI "strives to be also a source of empowerment and inspiration for action" and it should "be also a trigger for action – intelligent action within systems and in order to create more intelligent systems for people to use as platforms for further intelligent actions." Empowerment, inspiration, and systems intelligent actions can be a guide to a healthy and fulfilled life – one of the things positive psychology emphasises. Thus, the SI approach and positive psychology can very well work together and inform each other in the goal of identifying positive human aspects and possible ways of fostering them. Ultimately, the goal of human growth is tackled.

*SI is not merely an academic or theoretical approach but it is deeply rooted in practice*

"A key point of systems intelligence is its positive emphasis" (Hämäläinen and Saarinen, 2007b, p. 23) and, indeed, the SI approach does not highlight human pitfalls, errors, or negative traps but rather their positive assets – what we (just) do right, even in sheer complex and dynamic systems. "What we do right" refers, according to Hämäläinen and Saarinen (2007c, p. 41), to some kind of "pre-rational and pre-reflective systems-thinking" which is "an inherent feature of the human life-orientational basic intelligence." Positive aspects (e.g., human flourishment), and not negative ones (malfunctions), are in the focus here.

We should refrain from favouring one specific manifestation, aspect, or area of SI. Different aspects of Ability-SI and trait-SI (and maybe also need-SI, style-SI, habit-/preference-SI, competence-/Skill-SI) need to be studied in both a bottom-up (empirico-theoretically: observations lead to theories) and top-down (theoretico-empirically: theories lead to observations) fashion with a good mix of qualitative and quantitative methods. Theory, empirical research, and practice should be fruitfully interlocked in the study of SI.

If this article was a bit inspiring to researchers in the multi-, inter-, and transdisciplinary field of SI and was able to set at least some impulses for further lines of theorisation and empirical research, then the goals of this article have been more than achieved.

It is an an exciting time to conduct research in the field of SI!

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Chapter 3

# Systems Intelligence as a trait: A meta-model for a systemic understanding of personality

*John F. Rauthmann*

*The construct of systems intelligence (SI) by Hämäläinen and Saarinen (2004, 2007, 2008) can be seen as either an ability (Ability-SI) or a trait (Trait-SI). When studying SI as a trait, traditional psychological understanding of "personality", "dispositions", "traits", and "states" might not be sufficient to grasp the dynamic and systemic character that the construct entails. Systems intelligent people exhibit intelligent action within complex and dynamic systems with feedback processes. Therefore, it is necessary to understand structures, processes, and dynamics of situations (contexts), dispositions (traits) and personality, as well as behaviour. Building up on crucial controversies in personality psychology, integrative meta-models for situations and dispositions are presented. Further, the disposition model is transduced into a systemic-synergetic model, and a systemic-synergetic conceptualisation of personality is outlined. The theorisations in this chapter serve to provide a framework for the study of Trait-SI that integrates a structural and process-focused view, and also allows for systemic-synergetic conceptualisations.*

## Introduction

Although systems intelligence (SI) relates to abilities (e.g., intelligent performance within complex systems), there are also trait-aspects. Analogous to emotional intelligence, we can distinguish ability-, trait-, and mixed-models (Mayer, Roberts, and Barsade, 2008). Trait-SI might be a fruitful area in the study of SI. In conceptualising SI as a trait, however, we should do two things: (a) outline crucial controversies concerning traits to get a picture of trait concepts and some of their problems (which can and have been resolved to a great extent) and (b) propose an integrative model of situations and dispositions which will serve as a meta-theoretical underpinning for trait-based SI concepts which can be also seen in a systemic-synergetical manner.

### Crucial debates in personality psychology

There are crucial controversies of personality psychology listed in Table 1. These all do affect how SI is conceptualised as a trait. As can be seen, these controversies are obviously interrelated and taking one position on a rather dichotomous controversy affects also others. For example, if we take the position of "traits" in the state vs. trait controversy, we are very likely to take position for "person" in the person vs. situation controversy, "structure" in the structure vs. process controversy, and “nomothetic” in the nomothetic vs. idiographic approaches debate. This would then reflect the notion that people can be categorised concerning rather structural and aplastic trait dimensions (enduring cognitive, emotional, motivational, and behavioural characteristics or tendencies) that are believed to be stable over many situations and time (consistency). Even though this sounds plausible, reality is not that simple. These positions are not as dichotomous and incompatible as the may seem at first sight; many psychologists (e.g., Fleeson, 2001, 2004, 2007; Fleeson and Noftle, 2008a, 2008b; Funder, 2006; Mischel and Shoda, 1995) have proposed integrative thoughts on how these controversies can be dissolved and combined into an integrative (and modern) personality psychology.

Especially the person-situation debate was very prominent in personality psychology as it affects the core issue of variant (inconsistent) and invariant (consistent) aspects of us: If only situations determine our actions (thoughts, feelings, desires, intentions, and behaviours), then there is no consistency in how we act – except when situations are very similar to each other. Therefore, we need no traits or personality system generating mental and behavioural patterns as all stability and variability can be explained by external influences. As a result, we would not need any personality psychology. Of course, this is a relatively radical position; it is referred to as situationism. It was especially favoured among social and learning (behaviourist) psychologists and is, philosophically, near to external determinism. Opposed to this view is personism: Traits and personality are existent and meaningful. They are expressed in mental processes and behaviour patterns and are mostly due to internal, innate factors (which reminds of internal determinism).

*The person-situation debate was very prominent in personality psychology as it affects the core issues of variant and invariant aspects of us*

The concept of so-called if-then patterns of contexts and thoughts, feelings, and behaviour was a concept to dissolve some problems of the person–situation debate (e.g., Mischel and Shoda, 1995; Wright and Mischel, 1987): if context X, then (re-)action Y. Amelang and colleagues (2006) give the example of glass: glass is potentially breakable (disposition). If it falls (situation), then it breaks (reaction). The disposition “breakable” is only manifested in the reaction “broken” (then-part) under the specific circumstance “(somehow) fell” (if-part). “Fell” would be an abstract functionally homogeneous situation or context class; the glass may fall differently and due to various external reasons but the outcome (being broken after the fall and thus exhibiting the disposition “breakable”) will always be (functionally) the same. This view describes dispositions as latent variables that are only manifested under certain circumstances (which is the if-part) and need not be exhibited at all times or in a general fashion. For example, an individual scoring high on neuroticism (emotional instability) does not necessarily have to be all the time more anxious but tends to be more anxious than other people when confronted with threatful stimuli. This means that individuals high in neuroticism “reveal” their disposition (anxiousness) only and/or more intense if the “right” triggering circumstances (threat- or harmful stimuli) are given. The if-then conceptualisation of dispositions strives to integrate situational triggers, which account for behavioural variability, and remarkable intraindividual stability in one’s behavioural patterns.

Table 1. Crucial controversies in personality psychology

| Controversy | Positions |
|---|---|
| ***Trait vs. State*** | ***Trait:***<br>□ stable, long-term, enduring characteristics that describe people in general<br>□ mostly seen as (more or less central) person characteristics<br>***State:***<br>□ unstable, short-term, momentary conditions of people that can also be atypical for them<br>□ mostly seen as (more or less random) fluctuations |
| ***Person vs. Situation*** | ***Person:***<br>□ exsistence and meaningfulness of traits and personality<br>□ behavioural consistency (stability)<br>□ dominance of traits in behaviour (internal determinism)<br>***Situation:***<br>□ non-existence and non-meaningfulness of traits and personality<br>□ behavioural inconsistency (instability)<br>□ dominance of situations in behaviour (external determinism) |
| ***Structure vs. Process*** | ***Structure:***<br>□ traits as descriptive elements or fixed dimensions that are an accumulation of the reliable elements of states or within-person variability<br>□ states as capricious or error and thus neglected (or avaraged out)<br>***Process / Dynamics:***<br>□ traits as dynamic processes that also integrate states and within-person variability over different situations and time<br>□ states as part of a dispositional density distribution of a trait dimension (with mean, standard deviation, skewness, and kurtosis) |
| ***Nomothetic vs. Idiographic*** | ***Nomothetic:***<br>□ general approach to individuals differing in certain parameters<br>□ interindividual viewing point<br>→ between-person variability<br>***Idiographic:***<br>□ person-centred approach to a unique individual<br>□ intraindividual viewing point<br>→ within-person variability and stability |

Psychological dispositions are seen as certain groups of if-then relations which contain contingencies between antecedent situational cues (environmental stimuli) and (triggered) behaviour forms and mental processes (Amelang et al., 2006, p. 76; see Wright and Mischel, 1987). Intraindividual situation-behaviour[7] relations $s \rightarrow b$ are explained, given a certain situation $s_j$: Only the group $J$ of $s \rightarrow b$ relations to which $s_j$ is functionally equivalent[8] is relevant. This leads to following formula (see Amelang et al., 2006, p. 76): $b_{ij} = f([s_J \rightarrow b_J], s_j) = f(p_{ij}, s_j)$. A disposition would then be a "relation" or contingency of a situation class (comprising functionally equivalent or subjectively homogeneous and similar situations) and a behaviour class (comprising functionally equivalent but not necessarily morphologically similar behaviour forms) which both together form a certain functional link in their relation.

This model of dispositions uses an intraindividual perspective opposed to the commonly interin-dividual one. Further, the model holds implications for consistencies: An individual will be more likely cross-situationally consistent in its behaviour in a homogeneous situation class (a class of subjectively equivalent or similar situations) while cross-situational consistency should be rather low over heterogeneous situation classes. This fact accounts for low cross-situational consistencies of dispositions and specific behavioural reaction forms (which may still be functionally equivalent, though). Further, there is obvious (situational) plasticity, adaptability, and variability of behaviour as well as inherent stability and coherence (within homogeneous situation classes but not in heterogeneous ones). Even within a situation class the morphology and intensity of behaviours might vary, giving rise to within-person variability and intraindividual differences (see also density distributions by Fleeson, 2001, 2007). However, behaviour forms might still be functionally equivalent or serve a higher goal: for example, an individual high in conscientiousness might have a messy working place but is still very tidy and accurate when it comes to designing and sorting documents. Indeed, the individual has sometimes a really messy desk and at other times the neatest and tidiest one. At first, this may seem as the person cannot be adequately described by a single trait as he or she seems not to follow a certain stable pattern that would denote him or her as "conscientious" or "tidy". However, this conclusion might be mistaken: the person can indeed be conscientious. Although neglecting the desk at certain times (e.g., when having a lot to do, being under stress, etc.), the person is very tidy when it comes to his or her documents and work. To tidy them up, the person apparently does not care about leaving his or her desk messy – the work has simply got to be done (which is a specific goal of the individual and high in subjective value). Yet, when having the time he or she will clean up the desk. Hence, there would also be a certain pattern in the variability of "keeping the desk messy (when a lot to do) vs. tidy (when not much to do)" (or, to put it in words of a if-then conceptualisation: "*if* a lot do, *then* keep desk untidy vs. *if* not much to do, *then* keep desk

[7] "Behaviour" is used here as a subsuming term for actual, manifested behaviour *and* mental processes (see e.g., Fleeson and Noftle, 2008a; Mischel and Shoda, 1995).

[8] Note that the functional equivalence and homogeneity of situations is not so much based on objective situation criteria but rather on subjective ones, the "psychologically active situation characteristics" (Fleeson, 2007). These, in turn, are perceived and constructed by personal and subjective "maps" that function as situation filtering perceptional units (see also Mischel and Shoda, 1995). Situation classes should therefore be in their content and overall effects rather homogeneous: A certain disposition may hence only be displayed within a certain situation class (that is subjectively homogeneous in its contextual features) but not in other situation classes as their situational aspects are not triggering in the subjective perception of an individual.

tidy") but also the long-term tendency of being tidy (as seen in the documents and general working style of the individual). Being messy thus serves the purpose or goal of tidying up the documents under certain circumstances (see also Fleeson and Noftle, 2008b, p. 1361; Bem and Allen, 1974). The individual would still be coherent although manifesting obvious within-person variability. The integration of consistency with intraindividual variability is one of the most fascinating things personality psychology has to offer.

Fleeson and Noftle (2008a) "end" the debate on person vs. situation by concluding that there are multiple types of consistencies (Fleeson and Noftle, 2008b) and that behaviour might be "consistent" for some types, but not for others[9]. Not only should the consistency concepts be applied to the scientific investigation of trait-SI but also the lines of research proposed by the authors seem particularly interesting for future SI research in general.

Even though the previously described trait conceptualisation has its flaws and limitations (which cannot be explicated further here), it would serve as a good basis for conceptualising SI as a trait. All further theorisation of Trait-SI in this work partly relies on notions of process-focused trait concepts but also modifies certain aspects. Therefore, it becomes necessary to also take a closer look at situations since they are intertwined with mental processes and behaviour. To understand Trait-SI, we must understand the properties of *situations* and *behaviours*.

**Situations**

There are quite different conceptualisations of "situations" or "contexts"[10]: there is dispute on *what they are, how they may be seen, what influences they have, and how they may be categorised*. Even though some social psychologists might tend to operationalise situations merely as certain external, objectively existing stimuli that somehow impose influences on an individual, this is a very narrow definition of a "situation", leading to various problems with traits and consistencies.

- First of all, a situation can consist of several external stimuli but it should not be limited to them. In the study of personality psychology and especially SI it is crucial to emphasise the *subjective aspects of situations*, meaning psychologically active situation characteristics (Fleeson, 2007). Situations are always subjectively perceived by mediating cognitive-affective-motivational units as "situation filters" (see also the conception of cognitive-affective units in a cognitive-affective personality system by Mischel and Shoda, 1995), and the question whether something can at all be perceived objectively by us humans is rather a matter of philosophy. Therefore, it will be fruitful to explore the cognitive-affective interpretations of situations (while not neglecting the objectively existing situation features, though). Moreover, many homogeneous or functionally equivalent situations (or rather their subjectively perceived characteristics) can also be aggregated to situation classes. The important point is that situations need not be

[9] Fleeson and Noftle (2008b) propose a super-matrix of 36 different consistency concepts. Most have not been explored thus far.

[10] The terms "situation" and "context" are used interchangeably here.

objective. Yet, there is still the question which aspects, besides subjective mediating units and schemata, allow us to form certain "situation classes" (and how and why).

- Second, situations are not just external matters but also *internal* ones. Current moods and other cognitive-affective variables serve as a certain "frame" (internal situation or momentary condition) within each external situation occurs. A genuine, truly existing situation, as we humans experience it, is always an interaction of objective external situation variables, subjectively perceived situation variables, and internal situation variables (see Figure 1), although in some instances some variables might be stronger. This complex concatenation makes it difficult for both social and personality psychologists to grasp interaction effects between person(ality), situations, and behaviour (including mental processes). In a systemic-synergetic point of view (e.g., Haken and Schiepek, 2006) it is quite usual to see situations as the function of external *and* internal factors. This notion should also be applied to other fields of psychology. In particular, research in the field of SI will benefit from such a view that integrates different aspects of situations and persons along with their behaviour.

- Third, the *"influences" of ("strong" and "weak") situations* (however they may be defined) are quite difficult to determine. In general, this is a point where social and personality psychologists divide quite strongly, the former claiming that situations influence behaviour (and often denying the existence of traits), the latter claiming that traits influence behaviour (and confirming that traits do exist).

To summarise the preceding points, "situations" are understood in this work in accordance with Mischel and Shoda (1995) not just as external stimuli affecting us (such as early behaviourism posits it); rather, only certain aspects or situational cues that draw our attention affect us. Moreover, the psychological characteristics of a situation seem more important than their objectively existing ones. Also, one must take into account that persons actively construct and generate their own situations, for example "in thought, planning, fantasy, and imagination" (Mischel and Shoda, 1995, p. 251). Situations can thus be social and interpersonal or intrapsychical (e.g., thoughts, moods, states, etc.). Therefore, when we speak about cognitive-affective-motivational tendencies in relation to certain situations, there might only be certain aspects of situations "of interest" to an individual (depending on its learning history, autobiography, mood, current "state", goals, self-concepts, etc.) which trigger cognitive-affective-motivational tendencies. The "psychological situation" is a mixture of objectively existing aspects of a situation and the interpretation or meaning-giving to those aspects through the individual's personal constructs, concepts, and subjective maps (see also Kelly, 1955; Mischel, 1973; Mischel and Shoda, 1995). According to Mischel and Shoda (1995, p. 252), "individuals differ in how they selectively focus on different features of situations, how they categorize and encode them cognitively and emotionally, and how those encodings activate and interact with other cognitions and affects in the personality system."

Also, we ought to take into account the *occuring frequency of situations* because certain situations might be over- or underrepresented in the daily life of a person. People can choose to a certain extent which situations they seek, avoid, bear, modify, or generate. This makes some situations more or less representative and relevant for the cognitive-affective-motivational reactions and behaviour of an individual: a certain latent disposition might be given, but the then-part (actual, observable, overt behaviour) is not activated very often because the if-part (contextual aspects) is quite seldom.

Many of the preceding points pose an important question to trait assessment: *Should we offer contextualised or decontextualised information (item material) when assessing traits?* This question may be best answered by the research purpose and viewing point(s), that is what one wants to measure. Maybe decontextualised material, as often used in nomothetic approaches, accounts best for broad traits (traits with high bandwidth) and tendencies over time (offering better long-term predictive validity), whereas contextualised material will account better for within-person variability in a short spectrum of time (offering better concurrent and short-term predictive validity) for more narrow traits and thus is more of interest for person-centred and more idiographic measures. This should be taken into consideration when constructing scales for Trait-SI. The question will then be how broad or narrow we want to measure SI and which aspects of it.

The consideration of situations and contexts is indeed essential to SI as systems intelligent people perform intelligently *within* systems. The concept of "systems" (as interrelated and interacting elements) implies some sort of surroundings or environment. Thus, SI can hardly be studied without any concepts of "contexts" and how they are related to traits.

**Behaviour**

The default interpretation of "behaviour" is that of a classical behaviourist: a behaviour is any overt and externally observable movement that can be objectively measured by certain devices. In the following, this limited view of behaviour will be expanded by some other aspects that should also be considered as "behaviour".

- First, *behaviour need not be observed nor (objectively) measured* and may still occur (this is, however, a rather philosophical question and shall not be discussed further here). Also, one could discuss the *extent to which a certain behaviour can be objectively measured and by which methods this can be achieved* (which is a methodological problem that we cannot delve into here).

- Second, there is *uncertainty as to which levels of behaviour* to approach, which levels there are (e.g., molecular vs. molar), if it makes at all sense to distinguish different levels, which implications different levels of behaviour bear, and how they may be manifested.

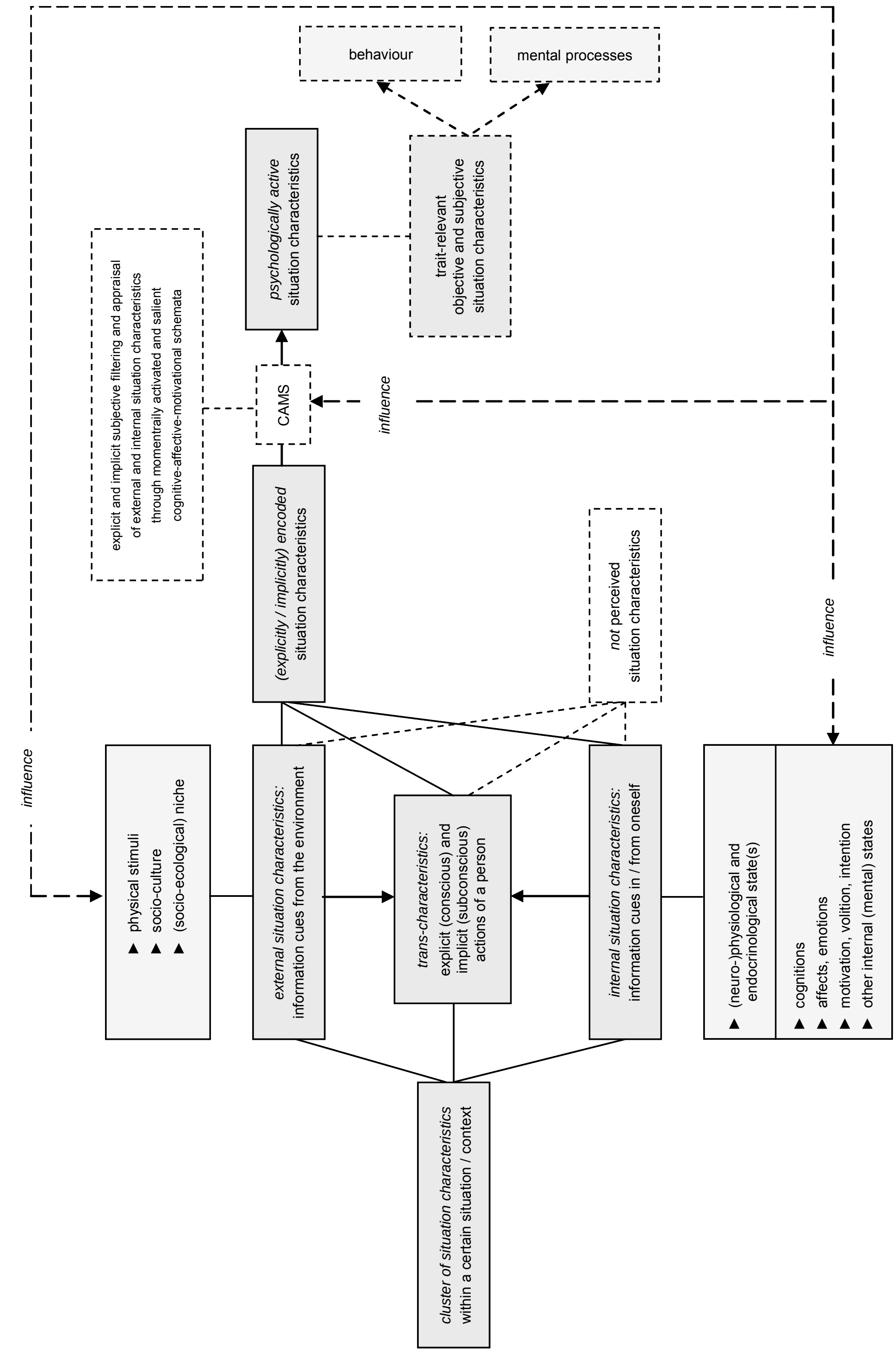


Figure 1. A process-focused situation model

- Third, the *conceptualisation of "behaviour"* is a vital point. Is any externally observable movement a behaviour? Yes, it is. Yet, this definition disregards another aspect of behaviour that cannot be separated from it as easily we would sometimes wish: *mental processes*. Not only the systems psychological position (e.g., Haken and Schiepek, 2006; Strunk and Schiepek, 2006) but also other psychologists (see, for instance, Fleeson and Noftle, 2008a, 2008b; Mischel and Shoda, 1995) explicitly use the term "behaviour" in the sense of behaviour *and* mental processes. This is a broader view on "behaviour" and comes far more nearer to the "real" phenomenon than the default behaviourist definition (although it complicates things). Though many might agree on conceptualising "behaviour" as seen above, there is great divergence on the rather problematic aspects of this conceptualisation: *how are behaviour and mental processes interrelated? Can we presume causal priority for one of the dimensions?* Without delving too deep in this complex problem, we should take to notice that in most cases it will not be sensible to ask what came first (as with asking if the hen or the egg came first) because there is a dynamic flow of person-situation inter-/transaction. In special cases it might be sensible, though. Mental processes and behaviour are interrelated in a dynamic and interactionist way and may seldom be separated from each other without omitting important aspects of one another.

- Fourth, the *"channels" of behaviour* must be distinguished as they may vary and pose *morphological differences in behaviour (enactment) but not in functional ways* (e.g., expressing aggression by kicking, hitting, biting, spitting, insulting, etc.). Rather, *functional (dis)similarities* of behaviour can be important.

- Fifth, the *"relationship" between behaviour and situation (or stimuli of situations)* should be investigated closely. Some psychologists see in the (functional) linkage of behaviour and situation the chance to infer (underlying) mental processes and/or relatively stable characteristics (traits) should these situation-behaviour patterns occur more often and be intraindividually stable. Mischel and Shoda (1995) term these "linkages" or contingencies *if-then patterns*: *if* situation X, *then* behaviour Y. This sentence can be extended to a more complex formulation (taking into account the preceding remarks on situations and behaviour): *IF the in subjective (and objective) situation content homogeneous / functionally similar context class X (which is perceived by mediating cognitive-affective-motivational schemata), THEN the in content and morphology differing and variable but yet functionally similar and equivalent action class Y (consisting of behaviour and involved mental processes)*[11].

[11] Note that this is not meant as a behaviourist term in the sense that "if stimulus X, then response Y" but that these two dimensions, that is the "if" (context) and the "then" (mental processes, behaviour), are somehow associated and occur together which, on the other hand, does not exclude contexts triggering mental processes and behaviour (and even vice versa!).

Closely associated to this is that situations may not just "cause", "influence", or "affect" us but that we can (a) imagine, construct, and generate certain situations ourselves (which may be labeled as "internal situations"), and (b) remain, seek, avoid, modify, and generate external circumstances or situations. The last part is concerned with *passive, reactive, evocative, active, and proactive acting* which may be seen as the (functional) "quality" of the if-then patterns. To illustrate this: The if-then pattern "making experiences with people" (people: if- or situational part; making experiences: then- or behavioural part) can imply different linkage qualities of the abstract behaviour class "making experiences" (which encompasses several different forms of making experiences that need not be morphologically equivalent but are all functionally equivalent in terms of serving the same goal of gaining experience with something or someone) and the abstract context class "people" (subsuming any kind of "people" and being on a considerably high abstraction level). One can passively make experiences with people by just sitting in a room such as the doctor's waiting room with other people; however, this would most likely not be seen as a specific (interpersonal, interactional) experience with people. A teacher can reactively make experiences with people when a crowd of pupils bursts suddenly into his or her room and he or she has to react to their wishes and needs. Evocative experiencing with people would emphasise the aspect of bringing forth certain reactions of others (e.g., when flirting). Active and also proactive experiencing with people would be really going out and seeking people to actively make experiences with them.

**Different levels of behaviour**

Roughly, *micro-, meso-,* and *macro-behaviour* as well as *implicit* and *explicit behaviour* can be distinguished (see Figure 2).

*Micro-behaviour* refers to mostly implicit behaviour on a "molecular" level of behaviour which is particularly reactive, automatic, rapid (i.e., rapidly occurring), and barely noticeable (e.g., eye movements, muscle twitches, sweaty hands, etc.). This micro-form of behaviour is seldom consciously used as the (attentional and intentional) access to such molecular levels is either slim, completely denied, or just not very often used. Even the observer tends to not put conscious attention on micro-behaviour as it is processed implicitly (if at all). Micro-behaviour is closely related to physiological variables, which implies that it can be best measured by objective (physiological) tests (T-data). Q-data cannot be obtained from this level of behaviour (one cannot ask a person how his or her eye movements will be when seeing a certain picture); L-data, in the sense of behavioural data (B-data), may be very difficult to obtain as the observers would have to be trained in recognising and (correctly) analysing micro-behaviour forms. Furthermore, most micro-behaviours are universal and general in the sense that there should be only slight inter(-socio-)cultural differences and that they are largely genetically (and temperamentally) determined.

*Meso-behaviour* basically refers to a wide range of verbal and averbal (para-, non-, extra-verbal) channels of behaviour. These can be used willfully (i.e., consciously or explicitly) but are mostly exhibited in a more implicit fashion (e.g., by gestics, posture, etc.). Meso-behaviour occurs for verbal output most of the time explicitly and for its averbal output rather implicitly. However, when laying attention upon one's (re-)actions, one can moderate, control, or generate certain cues of meso-behaviour. This level of behaviour can be recognised by the exhibitor at will and can be perceived by others at all times (if they pay attention). It is also accessible to reflection: One can think about his or her own words and body language (but it is a prerequisite that one starts thinking about it and puts attention to it). From meso-behaviour, we may thus obtain Q-data und L-data. T-data could also be obtained if it does not focus on the micro-behaviour associated with the meso-behaviour (such as muscle movements while exhibiting a phoney smile) but rather on objective measurement of meso-level behaviour. Moreover, meso-behaviour is heavily affected by socio-cultural determinants.

*Macro-behaviour*, as a more abstract form of behaviour, represents all (re-)actions that somehow concern "doing" (in the broadest sense) something with a "situation" (in the broadest sense), for instance, when a person seeks, avoids, modifies, (mentally) construes and/or generates certain situations. This class would therefore not really fit into the meso-class as meso-level behaviour forms may only be the (instrumental) basis for altering a situation or constituting it. For example, when emigrating to Canada, working and starting a family there (i.e., arranging and building one's own environment and life), this would be macro-behaviour that consists of "conjunctions" of many various meso-level behaviour forms adding up to a bigger whole[12]. Macro-behaviour usually refers to more explicit actions than implicit ones and involves a great deal of cognition, emotion, and motivation as well as volition, intention and regulation. Quite seldom macro-behaviour can be explored without socio-cultural context factors (e.g., display rules for affect) and meso-level behaviour forms. Micro-behaviour forms usually play no significant role in macro-behaviour. Q-data and L-data may be obtained best when dealing with macro-behaviour (e.g., narrative methods). B-data from friends, peers, relatives, significant others, etc. can also bring interesting aspects into light. T-data is not very appropriate here. The macro-behaviour level could be of most interest when studying systems intelligent acting in everyday life.

It is important to note that micro-, meso-, and macro-behaviour as well as its implicit and explicit forms usually occur simultaneously and are not distinguished as three separate forms of behaviour: There is a continuum from micro to meso to macro. This continuum particularly makes it difficult to assess the level of behaviour that is of interest.

Yet, all these behaviour forms have in common that they constitute a certain "link" between the individual and the environment. This link has certain qualities which may be described as the *"functional quality of behaviour"*: behaviour can be *passive, reactive, evocative, active,* and *proactive*. In the stream of behaviour with dynamic interactions and fluctuations of different levels of behaviour, there can be multiple functional behaviour qualities at once. For example, when flirting with someone, one is reactive on the micro-level (the feedback through mimics and oculesics of the other person cause own mimic reactions that may not be conscious and are not willingly expressed, such as smiling back),

[12] This may also hold true for SI: Although SI-related behaviours may occur on the meso-level, the effects of SI manifest on a macro-level and can be studied there.

active on the meso-level (intentionally making and holding eye-contact with the other person, smiling more), and evocative on the macro-level ("sexifying" the situation with various flirt-signals and leading to interest from the other person). Even though each level could potentially constitute all five links, there seem to be certain affinities: Micro-level behaviours tend to be more reactive and at best evocative (only if other people recognise the behaviour, though, and react to it themselves). Meso-level behaviour can be reactive, evocative, active, and/or proactive. Macro-level behaviour can be all five but tends to be evocative and/or (pro-)active (see also Figure 2).

## A Disposition Model for Systems Intelligence Integrating Structures and Processes

If we want to conceptualise SI as a trait or disposition, an integration of process- and structure-focused disposition models instead of merely structure-based ones should be considered. In the following, an integrative disposition model (see Figure 3) as a meta-model that aims at unifying the different controversies and especially integrating the view of structure- and process-focused trait concepts is described. The model can be used as a meta-model that depicts dispositional structures as well as processes and dynamics in general. This model can be greatly applied to systems intellect – the Trait-SI. The previous remarks on situations and behaviours serve as a basis for this meta-model.

The highly complex, multifaceted, and dynamic "personality system" is conceptualised as a latent, mental as well as behavioural (re-)actions generating, and heterogeneous macro-variable that represents a "reservoir" of different structures and processes: There are certain information processing modes that can be triggered (e.g., cognition, affect or emotion, motivation, etc.) and chronified structures (obtained, for example, through one's learning history and autobiography, stable environment, genome, etc.) such as self-related variables (e.g., social and non-social schemata, scripts, self-concepts, social roles, identity or identities, etc.). Certain chronified structures can be triggered or activated by environmental stimuli and then represent momentarily activated and salient cognitive-affective-motivational schemata (CAMS) which in turn "filter" the objective situation characteristics. These CAMS generate through subjective perception mechanisms psychologically active situation characteristics which need not be equivalent with the objectively triggering ones. CAMS are actually constantly activated as long as we are awake but their content and filter mechanisms vary in relation to the contexts (internal *and* external ones) we are in. The subjectively filtered, psychologically active situation aspects are then processed within the personality system. Depending on the "state" of the system and the incoming situational information, different modes of information processing occur. Also, different other chronified structures can be activated and add to the momentarily occurring processing (e.g., activated memories, needs, desires, etc.). In this state, certain structures are salient (which, in turn, might contribute to the situation filtering) and different processes with these structures are established. There are intrapsychic (i.e., psychic, mental) processes (cognition, emotion, motivation, volition, etc.) and extrapsychic (behavioural) dynamics that emerge. The intrapsychic ones stem directly from the information processing processes and can contribute to subjective perception mechanisms of the CAMS by adding new

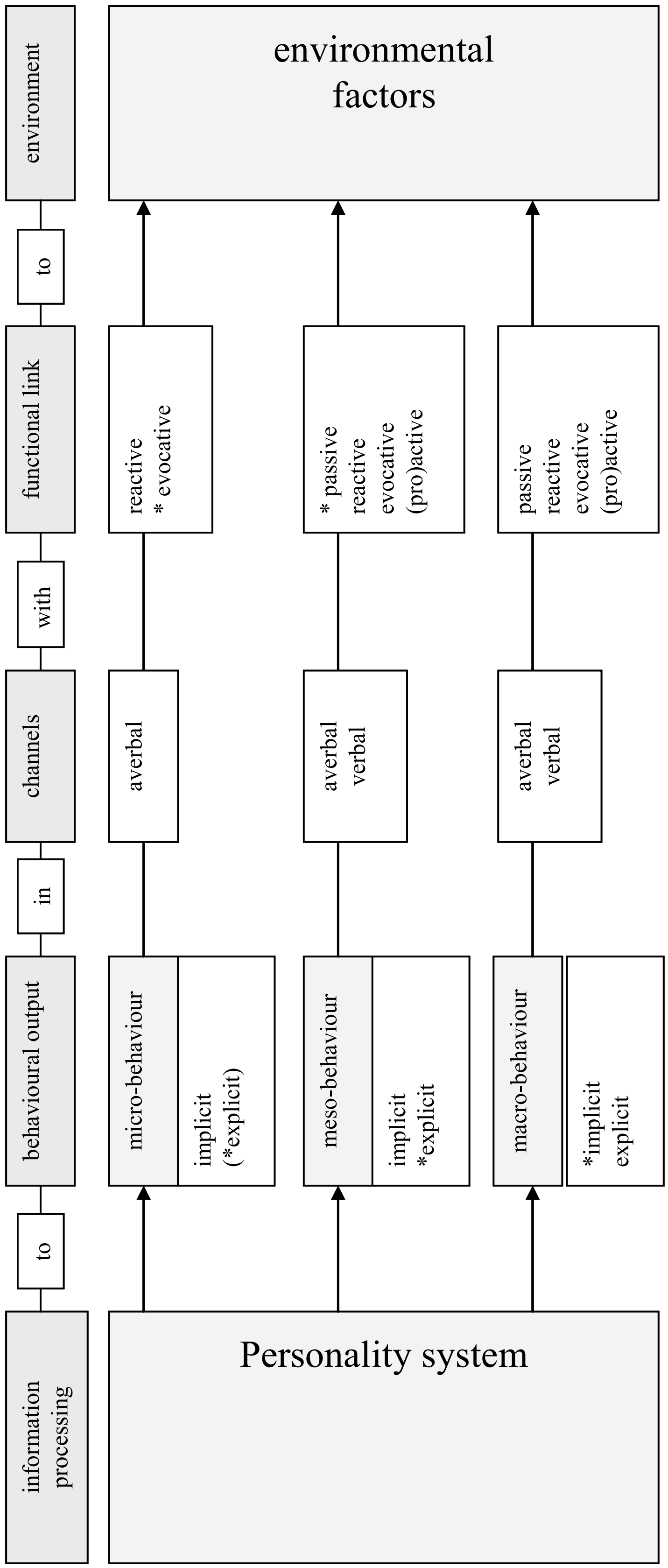


Figure 2. Different levels of behaviour and their environmental ”linkage” qualities

salient aspects to the situation filtering (e.g, thoughts, feelings, etc.) or modifying the active ones. Then, different situation components are explicitly and/or implicitly appraised and filtered. The behavioural output can occur on various levels (micro, meso, macro) and is exhibited explicitly and/or implicitly in verbal and averbal (non-, para-, extra-verbal) channels. This constitutes a certain "linkage" (passive, reactive, evocative, active, proactive) to the person's socio-ecological surroundings (niche). By this, the person "(re-) acts" to the situation and his or her surroundings (environment) as he or she can seek, avoid, bear, modify, and/or generate contexts.

Momentarily activated CAMS and behavioural (re)actions are part of the "personality" but are still rather momentarily occurring states within a dynamic flow of person–environment transaction. The latent system behind all of this provides with its chronified structures the basis or repertoire for these transactional processes. If these dynamic transactions occur with increased frequency (and in a similar manner), then emergent patterns of thoughts, feelings, desires, and behaviours may arise which are chronified step by step. States can then be transient to traits although this conceptualisation does not aim at specifically distinguishing these two concepts. All of these structures and processes can, however, only be established if the biological basis of the personality system is intact. Environmental stimuli (e.g., intoxication, car crash, radiation, etc.) can also have a bearing on (neuro-) physiological structures.

In summary, person and environment are interlocked in the following way (without the intention to give causal prioritisation to any process):

> . . . → objective environmental stimuli → different momentarily active and salient CAMS are triggered → CAMS filter objective environmental stimuli through subjective perception mechanisms relying on situation-specific information processing → subjectively perceived, psychologically active situation characteristics emerge (from the former objective environmental stimuli which were filtered and subjectified by the CAMS) → structures and processes within the personality system are momentarily highly activated and salient → subjective stimuli are processed in different modes of implicit and/or explicit information processing within the personality system → implicit and/or explicit intra- and/or extrapsychical (re)actions (passive, reactive, evocative, active, proactive; verbal and/or averbal; micro, meso, macro) emerge → different objective and/or subjective "influences" on oneself and one's surroundings (environment in socio-ecological niche; current situation or context) → . . .

## A Systemic-Synergetic Personality Paradigm for SI Research

Having proposed a meta-model for dispositions which can be used to describe Trait-SI, I move forward to a systemic-synergetic conceptualisation of "personality". Trait-SI (with its behavioural manifestations from which we infer Trait-SI) is constituted by an underlying personality system. Personality should also be looked at to grasp SI within a trait-theoretical approach. SI needs to be integrated into a personality theory in order to proceed with its trait-conceptualisation. It will be my hope that other theorists will refine the basic thoughts I propose here and that researchers will rigorously evaluate their usefulness in empirical studies of SI.

**Remarks on the term "Personality".** "Personality" has seen many interpretations throughout the history of its etymology. But where does the word "person" come from? Widely, the word is derived from the Latin word *persōna, -ae* "mask (of an actor), role, character; personality, person" (Kluge, 2002; Stowasser, 2004). In turn, Stützer (1975, pp. 87 et seq.) deduces *persōna, -ae* from the Etruscan *Phersu*, which is a masked figure on a mural painting dated back to about 550 BC. (Indeed, there are many loanwords from the Etruscan language in Latin.) Notwithstanding, there are also other more or less plausible derivations: for instance, lat. *persŏnare* "to sound through" (e.g., the voice of an actor sounds through his mask); lat. *per se sonare* "to sound through onself" (again, maybe a reference to sounding through from a mask?); lat. *per se una* "being one through oneself"; lat. *per-sōnare* < *per-zōnare* "to disguise" from the ancient Greek word περίζωμα [*perídsōma*] "that what has been begirded / cinctured"; ancient Greek πρόσωπον [*prósōpon*] "visage, face, mien", which obtained the connotation of "mask, role" in the New Testament. Eventually, *Phersu* seems the most likely derivation for „person". Interestingly, the ancient Greeks would have translated "personality" with ψυχή [*psuk$^h$ē*], from which we have "psyche" today. This is mainly due to its holistic grasping as it could mean "breath; vital energy, life; soul, mind, spirit; intellectual power (~ lat. *ratio*), reason, sense; temper; heartiness; place of passions and lust; characterisation of the entire person" (Gemoll, 1965, p. 815). Seemingly, the topics "living" (breath, vital energy, life), "cognition" (intellectual power, reason, sense), and "emotion" (temper, heartiness, passions, lust) are covered[13]. Interestingly, ancient Greeks about 2,500–3,000 years ago might have had a holistic meaning of "psyche = person and his or her cognitive and emotional characteristics". In a modern systemic-synergetic approach to personality, the holistic understanding of the "psyche" is revived by conceptualising "personality" as an information processing system, consisting of many macro-modules such as cognition and emotion. This exciting conceptualisation makes it easier to see SI as a trait within a personality system. After all, SI requires a more "systemic" view on personality and individual differences in order to fully integrate it and understand how it may operate.

**Systems psychology.** *Systems psychology*, *systemic psychology,* or *systems-based psychology* is a relatively young branch of psychology which aims at explaining such phenomena as perception, memory, cognition, affect and emotion, motor control, identity, self, consciousness, neural networks, etc. by use of *systemics* (i.e., systems theory, chaos theory, and synergetics). The field of systems psychology offers many new and innovative approaches to old phenomena and also a vast set of methodical strategies (see, for example, Haken and Schiepek, 2006; Schiepek and Strunk, 1994; Strunk and Schiepek, 2006). Little has personality psychology been influenced by systemics so far, though. However, there are exceptions such as Haken and Schiepek (2006), Kuhl (2001; PSI-theory – personality-system-interactions), Mayer (1993-1994, 1995a, 1995b, 1998, 2005; system-topics framework), and Mischel and Shoda (1995; CAPS – cognitive-affective personality

[13] These are all topics that are also covered by SI (see Figure 2, for instance).

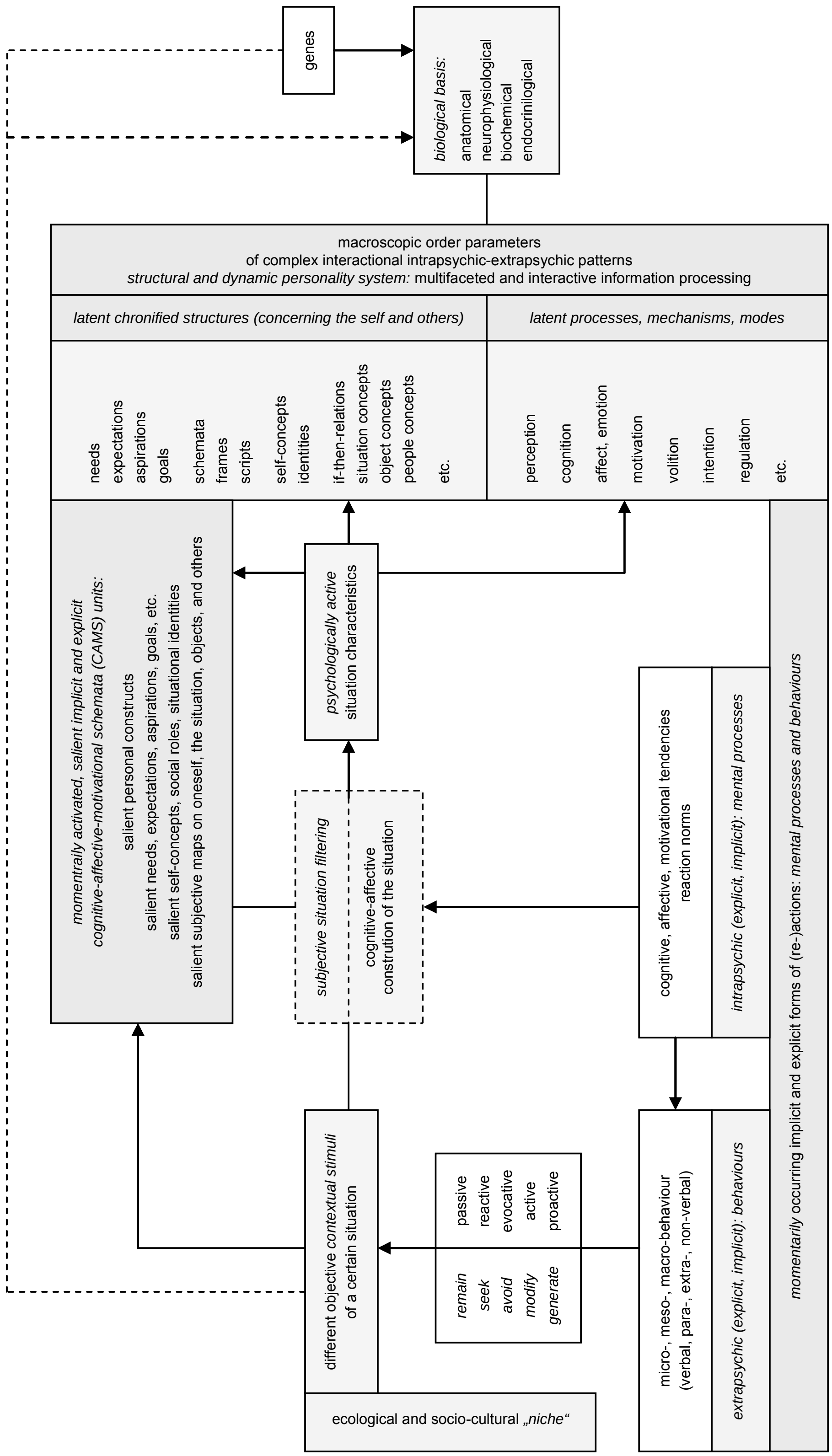


Figure 3. A disposition meta-model integrating structures, processes, and dynamics

system) who all conceptualise "personality" as a system. A *systemic-synergetic personality paradigm* should use theoretical conceptualisations, terminology, and methodological implications of systemics. Hence, the theoretical framework will be more abstract, formalised, and should allow certain properties of a personality system to be mathematised, modelled, and eventually simulated (see also Mischel and Shoda, 1995; Shoda, 2007). The "theoretical and methodological kit" of systemics can supply new powerful means and tools for research.

**Conceptualising personality systemic-synergetically.** SI could be nicely integrated into a systemic-synergetic conceptualisation of personality. In the following, basic properties of a *systemic-synergetic conceptualisation of a personality system and dispositions* are outlined (see also Figures 7 and 8). These should serve as a – skeletal, yet first – theoretical underpinning for a systemic view on trait-SI and its integration into a personality system.

The system of personality is defined as follows (in one long sentence):

> A person has a "personality" (in its broadest sense) – on a biological basis (genetic, anatomical, neuro-physiological, biochemical, endocrinological) and in constant reciprocal interchange (physical-material, energetic, informational) with its animate and inanimate surroundings –, which is a highly complex information processing system (functionally closed, dissipative, multidimensional, adaptive, non-linear, dynamic) and constitutes a systemic bio-psycho-environmental network in (a) varying configurational structures, (b) complex macro-, meso- and micro-organisations, and (c) multi-level interaction of explicit and implicit intra- and extrapsychical factors (mental processes and behaviours) with self-organisation as well as emergence of order parameters and attractors.

Basically, any system is a set of interrelating parts (e.g., Haken and Schiepek, 2006; Strunk and Schiepek, 2006). A pile of sand would therefore be no system: the grains of sand do not interact. When examining a system like personality we at first should analyse „1) its components, 2) how these components are organized, and 3) how the components and organization change over time" (Mayer, 1993-94, S. 106). By doing so, we can zoom in on various degrees of detail; for example, we can focus more on the macro-structure and the overall-properties or analyse the micro-structure and its characteristics.

Following core aspects characterise the systemic-synergetic view on personality:

- *Systemic-synergetic:* personality is a complex and holistic system, consisting of many interrelating and interacting parts on multiple levels.

- *Informational:* information is permanently fluctuated and processed throughout the personality system as well as internalised and externalised while person–environment inter-/transactions.

- *Highly complex:* the personality system consists of many and heterogeneous variables thatare intertwined and interacting with each other at various hierarchical and heterarchical levels.

- *Functionally closed:* the personality system can be seen as an "entity" separate from its environment; however, it can interact (transact) with it (being dissipative or permeable).

- *Dissipative:* the personality system is permeable for (informational) interexchanges and interactions with the environment.

- *Multidimensional*: the personality system can be studied on multiple levels of abstraction.

- *Adaptive:* people can adapt to certain situations and therefore exhibit adaptivity and plasticity of behaviour. As the personality system is dissipative for certain external parameters and shows self-organisational patterns, it can adapt to both internal (intrasystemical) and external (extrasystemical) parameters. Maladaptations could indicate tendencies to psychopathologies.

- *Non-linear:* a personality system cannot be analytically seen as a linear sum of its single elements. The personality system parts are dynamic and interrelated: A change in one part of the system can lead to various changes and complex effects in other parts (which can give rise to the phenomenon *chaos*). Even though the personality system may be potentially non-linear, this does not mean that the whole system behaviour per se is unpredictable and chaotic. Indeed, there are periodic phases and, due to the self-organisation and auto-regulation mechanisms of order parameters and attractor emergences, there is a certain stability, consistence, and coherence within the system – in relation to external *and* internal control parameters. Hence, the system behaviour becomes more predictable. In fact, many natural phenomena are non-linear such as the weather, for example; still, the weather can be forecast to a certain exent (knowing the deterministic processes and core variables interacting).

- *Dynamic:* personality and its factors are seen as complex interactive processes, not as static structures. The dynamicity may give rise to certain structures but these can "oscillate" and vary to a certain degree. Still, there are "preferred" intraindividual structures that occur most of the time. Every structure emerges from dynamic processes, though. For example, an emotion (with accompanying appraisals) that is exhibited by expressive behavioural patterns is a multi-level process because the information processing underlying this "emotional structure" is a dynamic process of intra- and extrasystemical information fluctuation.

- *Self-organised: periodical and aperiodical – chaotic and stable, consistent, coherent* (in relation to internal and external control parameters as well as order and attractor emergence)

An individual's unique personality pattern can be referred to as its "system gestalt" or "system configuration". Different system elements are functionally interwoven in a hierarchical and heterarchical manner, which characterises the system as multifactorial, multidimensional, multidirectional, multifunctional, and multicausal or multidetermined. These strongly interrelated system parts can be deemed as "personality domains". On an abstract level, there is a systemic informational personality network with diverse information fluctuations. Connections and pathways between subsystems (e.g., personality domains) may vary due to internal and/or external stimuli and are thus not stable under all circumstances. Hence, short-, middle-, and long term configurational patterns can be detected. Within the complex personality system, which can display periodic as well as chaotic patterns, there are also processes of self-organisation and -regulation, which makes it necessary to assume emergent characteristics from the interplay of different system compounds (see Haken and Schiepek, 2006). Basic elements of this system are intrapsychical (e.g., perception, cognition, affect or emotion, volition, motivation, intention, regulation, etc.) and extrapsychical (i.e., all forms of behaviour) processes of information fluctuation and processing (upon adopting a macroscopic view). Considering the permanent interexchange of energy (e.g., when eating proteins and carbohydrates, gaining ATP from them, and using the provided energy for activities) and especially information (cf. information theory; e.g., Shannon and Weaver, 1949; Haken, 2006), the ancient Greek phrase ΠΑΝΤΑ ΡΕΙ [pánta reĩ] "everything is in stream" (by Simplikios modified from Herakleitos) attains indeed new honours.

When speaking of personality as a systemic network, one might like the analogy of the human brain to illustrate its basic structure(s): there are certain functional modules, such as traits (stable configurations), states (transient configurations), habits, needs, motives, skills, actions, physics, etc., but these modules are cross-linked with each other to vast networks of dynamic information processing systems in which one compound influences another. These modules may be distributed throughout the entire systemic network but they still have functional focal points. The processes of intra-, inter-, and transsystemical information fluctuation and processing are an essential part to the understanding of a human being with a unique personality in his or her surroundings.

Traits are conceptualised as stable, for the system "attractive" states of information fluctuation and processing, which constitute "pathway activations" or patterns. This generates the characteristic system configuration for a specific trait in the personality system (such as Trait-SI). The personality system with its emergent characteristics and self-organisational patterns is prone to procure an "attractive state" in the course of time (i.e., system time), causing stability of information processing patterns and system-surroundings-connections. Therefore, traits can be operationalised as attractors and states as transient (meaningful and non-meaningful) fluctuations within such attractors or as ephemeral bio-psycho-social patterns. Both forms as well as the resulting dynamics and system behaviour may be mathematically computed, to a certain extent predicted, and illustrated (e.g., an der

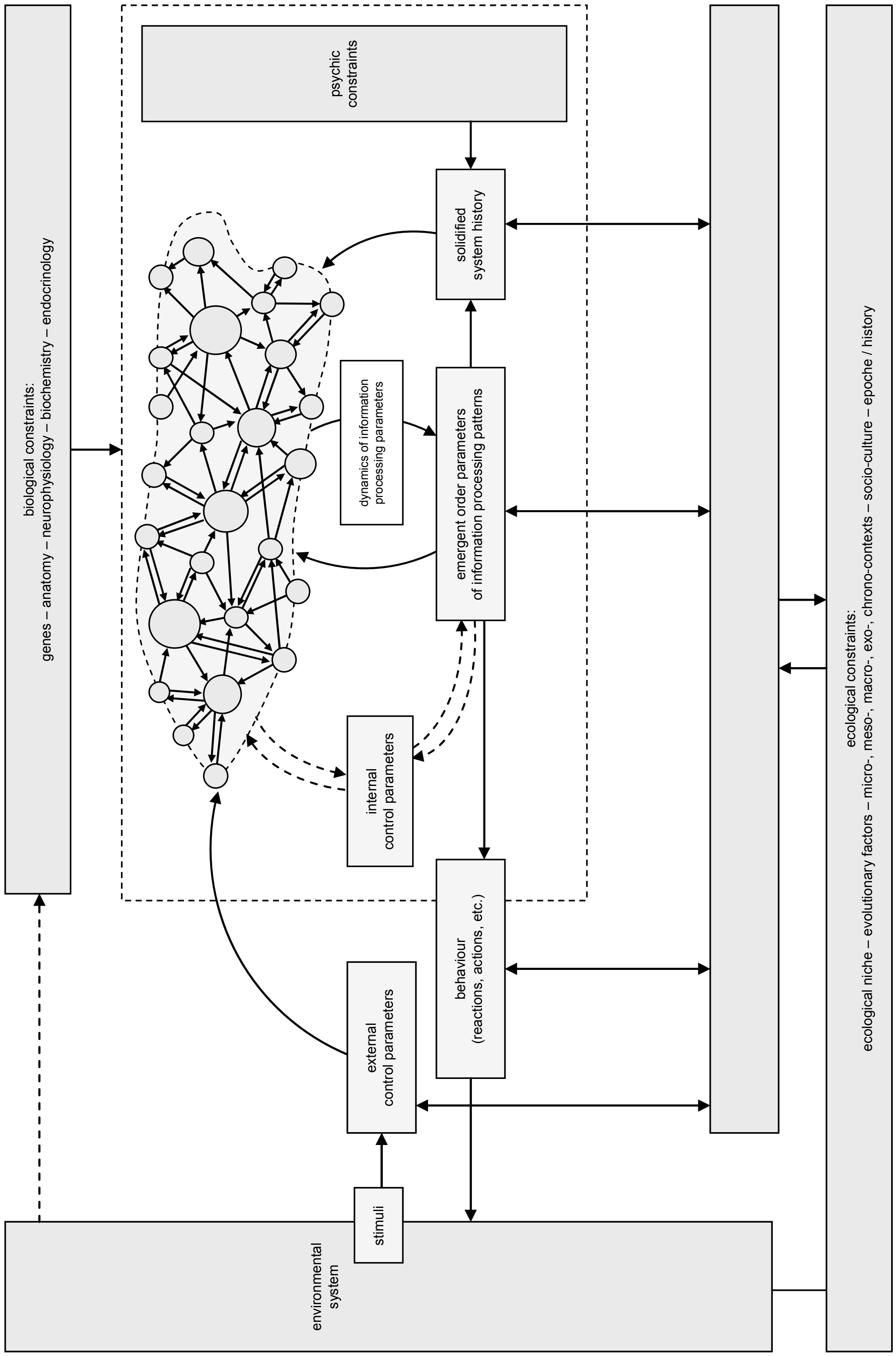


Figure 4. A systemic-synergetic conceptualisation of personality

Heiden, 1997; Ciompi, 1997; Haken and Schiepek, 2006; Kelso, 1995; Schiepek, 1999; Schiepek and Strunk, 1994).

Basic description of personality qualities in a systemic-synergetic conceptualisation:

- The personality system constitutes a wide-spreading bio-psycho-environmental network.

- The personality system is biologically based on anatomical, neurophysiological, biochemical, and endocrinological structures, expressed by genes evolved in an evolutionary process. Together, these factors are the biological "constraint" of the the personality system: any information fluctuation and processing can only be established within a functioning biological system with unique characteristics (temperamental aspects). Biological constraints may be influenced somewhat through environmental causes (e.g., ecological niche); for instance, the neuro-physiological structures can be damaged.

- Being functionally closed but dissipative, the personality system is in permanent reciprocative interplay with its objectively existing as well as internally generated surroundings (animate and inanimate). An individual also interacts with its "subjective surroundings," that is, the surrounding it perceives through its cognitive-affective-motivational schemata (CAMS).

- A constant physical-material (by the body of the person), energetic, and informational interexchange takes place intra-, inter-, and transsystemically (person systems × ecological surroundings systems).

- An interexchange constitutes passive, reactive, evocative, active, and/or proactive behavioural connections ("links") between the individual and its surroundings. These can be expressed in verbal (words, phrases, etc.) as well as in paraverbal (voice and its qualities), nonverbal ("body language": kinesics, mimics, gestics, oculesics, etc.), and/or extraverbal (physics, clothes, hair style, status, etc.) interaction patterns.

- Both serial and parallel information processing processes with various positive and negative feedback loops can be viewed from a biophysiological-chemical (e.g., gene codes, neurotransmitters, etc.), mental-psychical (e.g., cognitive and affective information processing), or environmental-social (e.g., communication, interaction) perspective.

- Multifactoriality, multidimensionality, multidirectionality, multifunctionality, and multicausality / -determination are established within the personality system.

- Intra- and extrapsychical processes merging into each other take place due to the continual interiorisation and exteriorisation of fluctuating information.

- A systemic informational personality network is constituted with specific attractive system configurations (attractors) and order parameters which will exhibit mostly stable and coherent intraindividual behavioural patterns (that only vary within a given spectrum). Also, there are transient, momentary (fluctuating) states.

- The system configuration ("system gestalt") may possess besides periodic and stable (attractive) states also chaotic and variable-transient compounds. However, dynamical processes of self-organisation and -regulation take place and constitute a certain stability, consistency, and coherence of the system, its structures, processes, and dynamics.

- The system is more or less than the sum of all its "ingredients" as the dynamic interaction between these also has the system exhibit emergent patterns as well as some unexpected behavioural outputs (chaoticity and non-linearity).

- Short-, middle-, and long-term system configurations (as connections between different elements or domains of the personality system) can be distinguished, which all together add to the development, dynamics, stability / consistency / coherence, adaptability, variability, and plasticity or flexibility of personality.

- A specific system configuration at a given time is influenced by many internal and external factors (control parameters) such as solidified system history, preceding configurations, attractors, transient states (as quasi-attractors), situational and contextual aspects, and internal and external constraints.

To summarise the preceding remarks (see also Figure 8 for an illustration):

> The bio-psycho-environmental systemic and informational personality network, resembling the "psyche" of an individual, consists of dynamic structures and interrelated configurations as well as interacting intra- and extrapsychical informational processes (explicit and implicit) in their complex and to a certain degree varying organisation.

## A Systemic-Synergetic Disposition Model

Specific interpretation patterns of situations, arising from personal schemata, concepts, constructs, needs, expectations, cognitions, emotions, etc., could be understood as macroscopic order-parameters governing (or "enslaving") cognitive-affective attractors. All stimuli exhibited by external control parameters would be filtered to some extent by perceptional units of the personality system (being enslaved by their macroscopic orders). Then, specific cognitive-affective units would be triggered, thereby "activating" certain attractors or at least making them salient in relation to the contextual (subjectively) psychologically perceived external control parameter stimuli. These attractive "reaction norms" would produce certain motor outputs, defined as "behaviour". Behavioural variability could be understood by the concept of stable individual attractors: in reaction to internal and/or external control parameters, the excursion and pond of a cognitive-affective attractor would vary from time to time (normally only within the attractive state) and thus always constitute different kinds (morphologies and intensities) of behaviour forms, which are similar (and quite often functionally equivalent) but not identical. However, the attractor could come to a bifurcation point and then could be given up for a certain amount of time, having the system show unusual transient states (that are not mere fluctuations within the pond of an attractor) and thus exhibiting behaviour forms that are not usual for it when being in the "attractive state". This would show how consistency and inconsistency may co-exist besides each other and even emerge from each other (and also keep the idea of multiple types of consistencies): depending on the specific system and attractor time, the transient state will recur after some time into the attractive state and thus reestablish the "normal" or "regular" system behaviour again.

Of course, all of this can only take place if we presume that the system (i.e., personality) is in its basic characteristics multidimensional, non-linear, adaptive, and dissipative. In short, the concept of order parameters can provide the mediating cognitive-affective-motivational interpretation units of "triggering situations" and "reactions to triggering situations". Traits as attractors can be highly variable. A complex macro-order can be defined as the emergent pattern of situational aspects perceived through mediating cognitive-affective-motivational order parameters that interpret situations and behavioural output in relation to the context, together with the underlying dynamic information processing attractors (e.g., cognitive, affective, etc.). Figure 5 summarises all the preceding points.

## Trait-SI in a Systemic-Synergetic View on Personality and Dispositions

The question is: why study trait-SI (or even other forms of SI) in a systemic-synergetic view on personality, dispositions, and individual differences?

First, the previously outlined systemic-synergetic conceptualisations could serve very well for trait-SI concepts. Although my conceptualisations are far from being fleshed out, they might provide a fruitful ground for researchers. I invite other researchers to criticise, modify, and/or amend the concepts proposed here – in the hope that they might become some day a viable paradigm of studying SI within a dynamic personality system. Second, the methodology of systemics allows the conceptualisations to be modelled, and certain properties of a system can be simulated. However, it is essential to first conceptualise the constructs that should be modelled in systemic-synergetical terms. SI thus needs to be conceptualised systemic-synergetically *and* integrated into a systemic-synergetically conceptualised personality system. The high level of abstraction and formalisation of those models will then allow mathematisation. This in turn would yield specific predictions concerning the different models. Simulations could then be programmed to explore the properties of the models. Also, these models and simulations should always be compared to real-life empirical studies. Hence, *theory – empirical studies – modelling and simulating – practice* should be interlocked in the study of SI. Of course, all of this will take its time and an extensive load of further research on SI, but it is exciting to think of what could be achieved when adopting a systemic-synergetic view on SI.

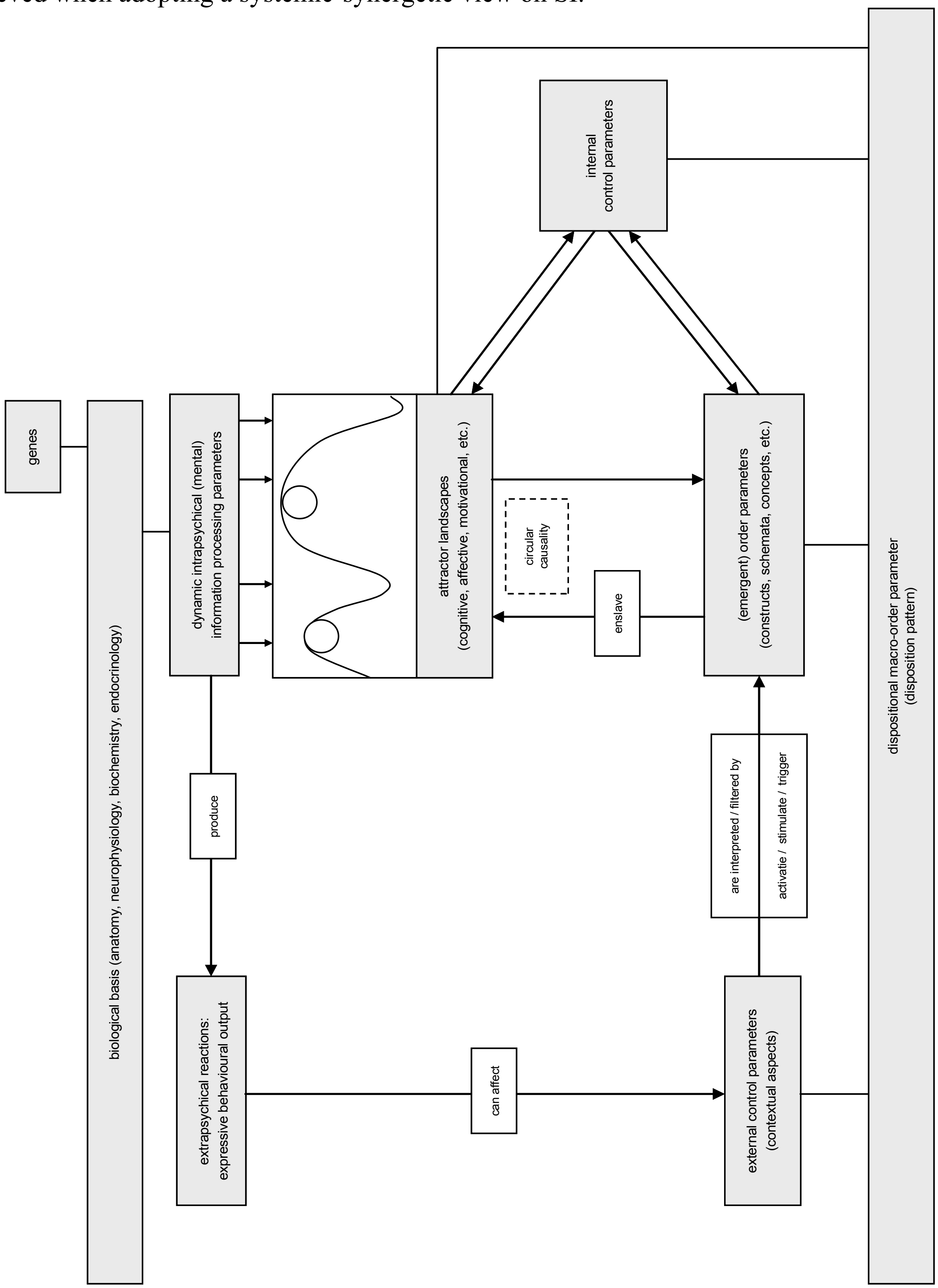


Figure 5. A systemic-synergetic conceptualisation of dispositions or traits and states

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Chapter 4

# Measuring Trait Systems Intelligence: First steps towards a Trait-SI scale (TSIS)

*John F. Rauthmann*

*This research article reports first steps towards a scale that aims at measuring systems intelligence as a trait-like construct (Trait-SI, Systems Intellect). After describing the process of item generation and the item content of the Trait-SI Scale (TSIS), psychometric properties of the scale are investigated. Students (N = 408) provided self-reports on socio-emotional skills (Riggio, 1989), self-monitoring (Laux and Renner, 2002), self-esteem (Rosenberg, 1965), and the Big Five (Schupp and Gerlitz, 2008), as well as on a German 30-item version of the TSIS in an online-study. The scale's reliability (Cronbach's alpha) and construct validity are investigated. Further, the scale's factor structure is explored. Results show good psychometric properties of the TSIS and its four retained factors. SI factors are mostly positively related to the other scales. Relationships are discussed with respect to how Trait-SI might be linked to other constructs in a nomological network. Future lines of research, especially concerning improvement of the TSIS as well as measurement of (Trait-)SI in general, are discussed.*

## Introduction

In this book (Chapter 2), I have proposed Trait Systems Intelligence, or systems intellect, as opposed to Ability Systems Intelligence. Trait-SI refers to enduring mental and behavioral characteristics that individuals would attribute themselves, whereas Ability-SI refers to the abilities in the SI domain. Ability-SI is hard to capture with self-report data (Q-data), but Trait-SI can very well be measured with self-reports of people, and this chapter provides first steps towards a reliable and valid measure of Trait-SI.

First, theoretical assumptions underlying the item content are discussed, and then empirical findings concerning basic psychometric properties (e.g., descriptive statistics, item statistics, internal consistency, scale structure, etc.) are presented. The preliminary and yet to be improved *Trait-SI Scale (TSIS)* will also be linked to other psychological constructs (social and emotional intelligence, self-monitoring, self-esteem, Big Five). Finally, suggestions for improvements of the TSIS are given, and limitations of the study and its findings are discussed.

## Theoretical Background

Regardless whether a nomothetic or idiographic (or even "idiothetic") approach is used, there are commonly three ways to measure a certain phenomenon or construct (cf. Cattell and Kline, 1977; see Table 1): *L-data* ("Life") and B-data ("Behaviour"), *Q-Data* ("Questionnaire"), and *T-data* ("Test").

L-data refers to any information obtained from or about the life of an individual (e.g., letters, emails, school grades, curriculum vitae, observed behaviour patterns, etc.) and is gathered by "external" information. A subgroup of L-data is B-data which refers to any data that is concerned with behaviour of a target individual. Q-data is any self-evaluation data gained from (standardised) questionnaires and thus taps into internal or introspectional information. T-data refers to data gained from standardised testing situations (e.g., experiments) or when obtaining objectively quantifiable data (opposed to interview data) in performance tasks.

A certain type of data or a certain assessment method should not be a priori favoured; rather, the three types have each their advantages and shortcomings and can be useful or inconvenient for certain research aims – hence, they should be treated as equal. Thus, the researcher will have to decide which kind of data he or she wants or needs to assess, and which suits best for his or her study, questions, and hypotheses.

Q-data will probably work best for Need- and Trait-SI, but most certainly not for Ability-SI as self-evaluations of abilities do not tend to be very accurate.[14]

Table 1. Overview of different types of data

| Type | Data | Examples | Best for |
|---|---|---|---|
| L-data | assessment through others | – peer-ratings<br>– behavioural observation (B-data)<br>– videotaping and audio recording<br>– autobiography, CV, handwritings, etc. | Trait-SI<br>Ability-SI<br>Competence-SI<br>(SI skills) |
| Q-data | subjective self-report and self-evaluation | questionnaires | Trait-SI |
| T-data | objectives measures | – physiological tests<br>– intelligence tests<br>– performance tests | Ability-SI |

[14] This is another point why we should at least distinguish Ability-SI and Trait-SI. "Systems Intelligence" has been conceptualised both as a disposition or trait *and* an ability. However, these two conceptualisations have different implications for assessment and for the research or diagnostic methods used. Usually, abilities do not correlate highly with self-evaluations of one's abilities, suggesting that we are not measuring the same constructs, but (at best) rather different aspects of it.

## The Present Study

The present study aimed at assessing the psychometric properties (reliability and validity) of the TSIS items and scales. Reliability in the sense of internal consistency will be indexed by Cronbach's alpha. Validity will be assessed in terms of construct validity by embedding Trait-SI into a nomological network. For this purpose, a priori hypotheses on the associations between Trait-SI and other (related) constructs (socio-emotional skills, acquisitive self-monitoring, self-esteem, Big Five) were generated.

Specifically, all constructs should show positive relationships with Trait-SI. Systems intelligent individuals should be able to act intelligently also in interpersonal systems which would make them socio-emotionally intelligent. They may possess heightened levels of perceptional sensitivity to others' and also own states. This includes thoughts, feelings, desires, and behaviours. Also, systems intelligent people would need to adapt to varying circumstances within complex and dynamic systems, and if these are interpersonal or social in nature, then there should be tendencies to impression management (and lower behavioural consistency given that situational or contextual circumstances vary) in the sense of altering one's demeanour in a situation-appropriate manner to maximise (social) adaptivity. Being efficient and productive in systems should come along with self-efficacy and self-esteem (whereas it is not specified whether Trait-SI breeds self-esteem or vice versa). In terms of central personality traits, systems intelligent individuals should be rather emotionally stable (although possessing a certain sensitivity), outgoing and communicative (Extraversion), open-minded (Openness for experiences, Intellect, Culture, Fantasy), socially adjusted and warm (Agreeableness), as well as productive and persistent (Conscientiousness).

## Item Generation

### Item content of a trait-SI scale

Systems intelligence as the "behavioural intelligence of human agents in systemic environments" (Luoma, Hämäläinen, and Saarinen, 2008, p. 757) is a heterogeneous construct and comprises different levels (see Table 2): there are perceptional (perceiving oneself and reciprocal influences in systems), cognitive and meta-cognitive (thinking and reflecting within systems), emotional and motivational (intuitively guided actions, empathical experiences, motivation to persevere and exact productive action patterns, etc.), and behavioural (productive behaviours) components. An SI-scale should therefore be able to account for all these components and capture core elements of what is referred to as systems intelligent thinking and acting. Of course, one needs to take into account that the scale might turn out heterogeneous due to the theoretical assumptions of very different SI components although there should be a positive manifold among the factors of the scale as they ought to be tied together by an underlying super-factor, (global or general) Trait-SI.

### Item generation

Based on the five stages of SI (Hämäläinen and Saarinen, 2007, p. 50) and other descriptions of what SI might comprise (Hämäläinen and Saarinen, 2004, 2008), preliminary items were generated based solely on theoretical grounds. Specifically, there were three core areas of SI into which ten items each were fitted (see also Table 2): *perception*, *cognition*, and *action*. Due to the heterogeneity of the item content and also its overlap, no specific factor structure was expected except that there should be lower-order and hierarchically higher factors.

Table 2. Different core components of systems intelligence

| |
|---|
| Perception-SI: *seeing oneself in the system* |
| – seeing oneself, one's roles, and one's behaviour in a system<br>– seeing through the eyes of others<br>– contextual awareness |
| Cognition-SI: *thinking systems intelligently* |
| – identifying and envisioning productive ways of behaviour for oneself in a system<br>– self- and meta-reflection<br>– deep thoughts |
| Action-SI: *managing and sustaining systems intelligent behaviour* |
| – exercising productive ways of behaviour in a system<br>– continuing and fostering systems intelligent behaviour in the long run |

As there would be too much overlap in item content between SI and forms of leadership, the fifth dimension (leadership with systems intelligence) was omitted. It could be expected that the fifth dimension of SI is highly similar to transformational leadership and self-leadership. Also, the third (managing systems intelligence) and fourth dimension (sustaining systems intelligence) were both slightly modified and combined to one dimension (action). The second (thinking about systems intelligence) and first dimension (seeing oneself in the system) were left as separate dimensions, but were slightly modified and now comprise some additional aspects.

Answers should be given on a 5-point Likert scale ranging from "0 – I totally disagree" to "4 – I totally agree". Some items need to be reversed. Items can be found in Table 4 and Appendix B.

In particular, descriptions such as "I like . . ." or "I am motivated / try to . . ." were avoided as they would rather tap into need-like constructs. The measure is not designed to assess Need-SI nor will it account for Ability-SI. However, Trait-SI and Style-SI are probably confounded here. This scale can at no means be considered a valid and reliable way of assessing Ability-SI. It only aims at capturing some important aspects of self-perceived trait-like SI. It will assess self-evaluations of SI (being a measure of Trait-SI). Future research will have to demonstrate what the scale actually measures. There has got to be an extensive and rigorous validation process of the scale to make it useful for further research in the field of SI.

## Methods

***Procedure.*** Participants completed all scales online on a platform for online-studies founded by the author. The TSIS was administered intermingled with many other scales (some of which are not relevant to the present study and are thus not reported here). On average, participants took 30 – 40 minutes for the entire study.

***Participants.*** Scales were adminitered online to *N* = 408 students from the University of Innsbruck. Their native language was mostly German, so German versions of all scales were used. The participants' mean age was 22.81 years (*SD* = 4.91; median: 21 years; range: 18 – 65 years). There were 316 women (77.50%) and 93 men (22.50%) in this sample. The online-study was conducted as part of a psychology course, and participants obtained credt points for participating.

***Measures.*** Several measures were used to explore associations among Trait-SI and other constructs. The measures are listed in their order of administration in the online-study, but were interspersed with other measures too. The means, standard deviations, and internal consistencies (Cronbach's alphas) of all scales can be found in Table 6 (along with intercorrelations of the constructs).

*Social skills inventory (SSI) by Riggio (1989).* This self-report instrument, with 90 items to be answered on a five-point Likert scale from 1 (not at all like me*)* to 5 (exactly like me), is to assess basic social communication skills in non-verbal and verbal areas. The SSI consists of six subscales, *emotional expressivity* (EE; e.g., "I have been told that I have expressive eyes"), *emotional sensitivity* (ES; e.g., "I am often told that I am a sensitive, understanding person"), *emotional control* (EC; e.g., "I am very good at maintaining a calm exterior even if I am upset"), *social expressivity* (SE; "When telling a story, I usually use a lot of gestures to help get the point across"), *social sensitivity* (SS; e.g., "I'm generally concerned about the impression I'm making on others"), and *social control* (SC; e.g., "I am usually very good at leading group discussions"). The emotional skills are associated with the non-verbal, and the social skills with the verbal domain. Expressivity skills refer to encoding (communicating, sending), sensitivity skills to decoding (receiving, interpreting), and control skills to regulating and managing emotional and/or social information. Different scales can be assessed with the SSI: Socio-emotional intelligence (SEI) as a global scale consisting of all 90 items; social intelligence (SI) consisting of all items relating to the social/verbal domain (i.e., SE + SS + SC), SE, SS, SC; emotional intelligence (EI) consisting of all items relating to the emotional/non-verbal domain (i.e., EE + ES + EC), EE, ES, EC; expressivity (E), sensitivity (S), and control (C) (incorporating social and emotional facets each). Sum scores for all possible scales were computed.

*Revised Self-Monitoring Scale by Laux and Renner (2002).* Acquisitive self-monitoring was measured with two scales: "sensitivity to behaviours of others" (labelled here as *perceptiveness*; e.g., "In conversations, I am sensitive to even the slightest change in the facial expression of the person I am conversing with") and "ability to modify self-presentation" (labelled here as *impression management*; e.g. "I have the ability to control the way I come across to people, depending on the impression I wish to give them"). Both scales contained six items each to be answered on a five-point Likert scale ranging from 0 (totally disagree) to 4 (totally agree). For further readings on self-monitoring, see, for instance, Laux and Renner (2002) as well as Snyder (1987).

*Big Five Inventory – SOEP (BFI-S) by Schupp and Gerlitz (2008).* The Big Five, *Neuroticism or Emotional Stability* (e.g., "I am someone who becomes easily anxious"), *Extraversion* (e.g., "I am someone who is communicative"), *Openness to experiences* (e.g., "I am someone who has a vivid phantasy"), *Agreeableness* (e.g., "I am someone who can forgive"), and *Conscientiousness* (e.g., "I am someone who works thoroughly"), were measured with a 15-item inventory, using three items per Big Five dimension to be answered on a seven-point Likert scale from 1 (strongly disagee – not at all like me) to 7 (strongly agree – totally like me). For further readings on the Big Five, see Costa and McCrae (1992) and also John and Srivastava (1999).

*Rosenberg's (1965) Self-Esteem Scale.* This scale aims at measuring global self-esteem with ten items in a self-report format. People are to indicate on a four-point Likert scale (coded 0 – 3) whether they strongly disagree, disagree, agree, or strongly agree with the given statements about their self-esteem (e.g., "On the whole, I am satisfied with myself"). For further readings on self-esteem and its measurement, see Rosenberg (1965) and Wylie (1974).

*Trait-SI Scale (TSIS).* This preliminary scale was developed by the author and comprised 30 items related to Trait-SI aspects (e.g., "I exercise productive ways of influence within my surroundings", "I perceive myself as part of a whole") to be answered on a five-point Likert scale ranging from 0 (strongly disagree) to 4 (strongly agree).

***Statistical analyses.*** *Reliability* of the TSIS will be evaluated by internal consistency indexed by Cronbach's alpha. For purposes of item and scale refinement, also item difficulties, item-(total-)scale correlations, and alpha-if-item deleted statistics are reported. *Validity* of the TSIS will be assessed twofold: first, its structure will be investigated by exploratory factor analyses (principal component analysis; oblique: direct-oblimin rotation with δ = 0) and Horn's parallel analysis (Horn, 1965) to evaluate the number of factors to be retained. Second, bivariate zero-order Pearson correlations will be used to explore the interrelationships of the TSIS scales (retained factors, global factor) with other scales (socio-emotional skills, acquisitive self-monitoring scales, self-esteem, Big Five factors). The presented results on associations can be interpreted as indications of construct validity.

## Results

***Descriptive and item statistics.*** Means, standard deviations, skewnesses, kurtoses, minimum and maximum values, dfficulties ($P_i$)[15], and item-(total-)scale correlations can be found in Table 3. The interested reader and researcher aiming at revising the TSIS might want to compare the items with each other.

***Internal consistency.*** The global Trait-SI score obtained α = .89, which is very good considering the heterogeneity of the item content. Cronbach's alpha could also not be optimized by excluding items (see Table 3). Even in the retained factors of the scale (see below) no item had to be excluded (see Table 4).

[15] Formula used: $P_i = \frac{M}{4} \cdot 100$. Values around 50 are deemed as opimal.

***Factor structure.*** To investigate the factor structure, an exploratory factor analysis (principal components analysis; direct-oblimin rotation with $\delta = 0$, due to hypothesized unorthogonality of factors) was conducted. An initial solution yielded a seven-factor structure that accounted for 57.03% of variance. As Kaiser's rule to retain factors that show eigenvalues above one (cf. Kaiser, 1970) tends to overestimate the number of factors to be retained (e.g., Zwick and Velicer, 1986) and Cattell's scree-plot turns out ambiguous at times, Horn's parallel analysis (1965) was performed (which, however, still slightly overestimates the number of retained factors; see Glorfeld, 1995). By comparing the eigenvalues of factors retained from the original correlation matrix (of items) and the random ones from Horn's parallel analysis (number of variables: 30; number of participants: 408; number of replications: 1,000), results indicate that four factors (accounting for 46.31% of variance) should be retained (see Table 4). Underestimating the number of factors to be retained generally leads to more problems than overestimating factor numbers although this also comes along with a set of problems (cf. Mumford, Ferron, Hines, Hogarty, and Kromrey, 2003).

The four retained factors are labelled *"effective systems handling"* (12 items), *"systemic reflection"* (6 items), *"holistic systems perception"* (5 items), and *"systemic perspective-taking"* (7 items). Due to the positive manifold of SI factors, a higher-order structure was postulated and secondary (exploratory) factor anlysis was conducted. A general factor, accounting for 53.51% of total variance, was extracted (factor loadings: systemic perspective taking: .81; effective systems handling: .80; holistic systems perception: .71; systemic reflection: .58). This g-factor can be interpreted as the general Trait-SI factor underlying the four SI factors. It is virtually identical with the total score obtained from all TSIS items. Thus, the TSIS is able to capture a broad, more complex, and abstract general Trait-SI factor (SI global factor) as well as more specified lower-order factors.

Table 3 A and B. Item statistics of the TSIS

| A | ***M*** | ***SD*** | Skewness | Kurtosis |
|---|---|---|---|---|
| I perceive myself as part of a whole. | 2.56 | 0.99 | –0.34 | –0.52 |
| I am usually aware of my surroundings and its influences on me. | 2.92 | 0.70 | –0.64 | 1.14 |
| I have an intuitive feeling for unspoken things. | 3.02 | 0.80 | –0.73 | 0.68 |
| I am usually not quite aware of the impact of my actions on my surroundings. | 2.65 | 0.92 | –0.79 | 0.50 |
| I feel as part of a bigger system. | 2.31 | 1.04 | –0.16 | –0.56 |
| I observe my own interdependence within my surroundings. | 2.52 | 0.91 | –0.16 | –0.42 |
| I have difficulties seeing things from different perspectives. | 3.18 | 0.81 | –0.96 | 1.12 |
| I am very well aware that I live and interact within a complex and dynamic system. | 2.75 | 0.91 | –0.43 | –0.12 |
| I can easily adopt the perspective of other people and "feel" what they are thinking and feeling. | 3.04 | 0.85 | –0.95 | 1.19 |
| I perceive myself as part of a whole, the influence of the whole upon myself, as well as my own influence upon the whole. | 2.47 | 0.96 | –0.31 | –0.23 |
| I would not describe my thinking as "holistic" and "intuitive". | 2.69 | 0.96 | –0.37 | –0.49 |

| | | | | |
|---|---|---|---|---|
| I often ponder on my thoughts, feelings, intentions, and actions. | 3.35 | 0.72 | –0.96 | 0.68 |
| I would describe my thinking as quite “complex” and “interwoven”. | 2.80 | 0.97 | –0.55 | –0.35 |
| I usually have no problems dealing with difficult and complex problems when going them through step by step in my mind. | 2.60 | 0.95 | –0.33 | –0.51 |
| I am not a very self-reflexive and thoughtful person. | 3.22 | 1.06 | –1.5 | 1.55 |
| I often ponder on others’ thoughts, feelings, intentions, and actions. | 3.20 | 0.77 | –0.90 | 1.09 |
| I often think about my role in my surroundings. | 2.96 | 0.88 | –0.76 | 0.57 |
| I envision and identify productive ways of behaviour in my mind if confronted with complex problems. | 2.60 | 0.84 | –0.16 | –0.15 |
| My thinking is very action-oriented. | 2.25 | 0.81 | 0.13 | -0.14 |
| I am a very reflexive person. | 2.89 | 0.86 | –0.38 | –0.32 |
| I am able to manage most of my everyday activities successfully. | 3.10 | 0.79 | –0.79 | 0.68 |
| I can adapt to varying situations quite flexibly. | 2.68 | 0.83 | –0.49 | 0.27 |
| I can influence my surroundings, be they living or not. | 2.43 | 0.81 | –0.04 | 0.03 |
| When confronted with complexity, I persevere until I have found a productive solution. | 2.71 | 0.87 | –0.50 | 0.09 |
| I exercise productive ways of influence within my surroundings. | 2.51 | 0.78 | –0.06 | 0.23 |
| I have difficulties adjusting my thoughts, feelings, and actions to my surroundings and situations. | 2.80 | 0.77 | –0.69 | 1.07 |
| I usually cannot influence much in my surroundings. | 2.68 | 0.84 | –0.39 | –0.22 |
| I tend to just do things right. | 2.24 | 0.79 | –0.16 | –0.13 |
| I do not give up until I have achieved my goal. | 2.63 | 0.89 | –0.61 | 0.40 |
| I sometimes have the feeling that there is not much what I can influence by my own actions. | 2.61 | 0.89 | –0.33 | –0.23 |

| B | Range (min. – max.) | $P_i$ | Corrected Item-Total correlation | Cronbach's α if item deleted |
|---|---|---|---|---|
| I perceive myself as part of a whole. | 0 – 4 | 64.00 | .437 | .882 |
| I am usually aware of my surroundings and its influences on me. | 0 – 4 | 73.00 | .525 | .880 |
| I have an intuitive feeling for unspoken things. | 0 – 4 | 75.50 | .433 | .882 |
| I am usually not quite aware of the impact of my actions on my surroundings. | 0 – 4 | 66.25 | .229 | .886 |
| I feel as part of a bigger system. | 0 – 4 | 57.75 | .436 | .882 |
| I observe my own interdependence within my surroundings. | 0 – 4 | 63.00 | .440 | .882 |
| I have difficulties seeing things from different perspectives. | 0 – 4 | 79.50 | .451 | .882 |
| I am very well aware that I live and interact within a complex and dynamic system. | 0 – 4 | 68.75 | .588 | .878 |

| | | | | |
|---|---|---|---|---|
| I can easily adopt the perspective of other people and "feel" what they are thinking and feeling. | 0 – 4 | 76.00 | .414 | .882 |
| I perceive myself as part of a whole, the influence of the whole upon myself, as well as my own influence upon the whole. | 0 – 4 | 61.75 | .607 | .878 |
| I would not describe my thinking as "holistic" and "intuitive". | 0 – 4 | 67.25 | .419 | .882 |
| I often ponder on my thoughts, feelings, intentions, and actions. | 1 – 4 | 83.75 | .393 | .883 |
| I would describe my thinking as quite "complex" and "interwoven". | 0 – 4 | 70.00 | .274 | .886 |
| I usually have no problems dealing with difficult and complex problems when going them through step by step in my mind. | 0 – 4 | 65.00 | .424 | .882 |
| I am not a very self-reflexive and thoughtful person. | 0 – 4 | 80.50 | .221 | .887 |
| I often ponder on others' thoughts, feelings, intentions, and actions. | 0 – 4 | 80.00 | .283 | .885 |
| I often think about my role in my surroundings. | 0 – 4 | 74.00 | .341 | .884 |
| I envision and identify productive ways of behaviour in my mind if confronted with complex problems. | 0 – 4 | 65.00 | .527 | .880 |
| My thinking is very action-oriented. | 0 – 4 | 56.25 | .251 | .885 |
| I am a very reflexive person. | 0 – 4 | 72.25 | .408 | .882 |
| I am able to manage most of my everyday activities successfully. | 0 – 4 | 77.50 | .468 | .881 |
| I can adapt to varying situations quite flexibly. | 0 – 4 | 67.00 | .471 | .881 |
| I can influence my surroundings, be they living or not. | 0 – 4 | 60.75 | .545 | .880 |
| When confronted with complexity, I persevere until I have found a productive solution. | 0 – 4 | 67.75 | .495 | .880 |
| I exercise productive ways of influence within my surroundings. | 0 – 4 | 62.75 | .586 | .879 |
| I have difficulties adjusting my thoughts, feelings, and actions to my surroundings and situations. | 0 – 4 | 70.00 | .370 | .883 |
| I usually cannot influence much in my surroundings. | 0 – 4 | 67.00 | .509 | .880 |
| I tend to just do things right. | 0 – 4 | 56.00 | .466 | .881 |
| I do not give up until I have achieved my goal. | 0 – 4 | 65.75 | .420 | .882 |
| I sometimes have the feeling that there is not much what I can influence by my own actions. | 0 – 4 | 65.25 | .480 | .881 |

*Note.* Standard Error of Kurtosis = 0.241; Standard Error of Skewness = 0.121.

Table 4. Item-scale correlations and Cronbach's alphas if item deleted for each Trait-SI factor

| | Corrected item-scale correlation | Cronbach's alpha if item deleted |
|---|---|---|
| ***Effective systems handling* (α = .85)** | | |
| When confronted with complexity, I persevere until I have found a productive solution. | .597 | .828 |
| I do not give up until I have achieved my goal. | .503 | .836 |
| I exercise productive ways of influence within my surroundings. | .640 | .826 |
| I am able to manage most of my everyday activities successfully. | .558 | .832 |
| I can influence my surroundings, be they living or not. | .581 | .830 |
| I usually have no problems dealing with difficult and complex problems when going them through step by step in my mind. | .527 | .834 |
| I tend to just do things right. | .498 | .836 |
| I usually cannot influence much in my surroundings. | .559 | .831 |
| My thinking is very action-oriented. | .295 | .850 |
| I sometimes have the feeling that there is not much what I can influence by my own actions. | .486 | .837 |
| I can adapt to varying situations quite flexibly. | .468 | .838 |
| I envision and identify productive ways of behaviour in my mind if confronted with complex problems. | .466 | .838 |
| ***Systemic reflection* (α = .72)** | | |
| I often ponder on my thoughts, feelings, intentions, and actions. | .606 | .652 |
| I would describe my thinking as quite "complex" and "interwoven". | .476 | .680 |
| I am not a very self-reflexive and thoughtful person. | .254 | .758 |
| I often ponder on others' thoughts, feelings, intentions, and actions. | .475 | .682 |
| I often think about my role in my surroundings. | .479 | .679 |
| I am a very reflexive person. | .550 | .658 |
| ***Holistic systems perception* (α = .86)** | | |
| I perceive myself as part of a whole, the influence of the whole upon myself, as well as my own influence upon the whole. | .766 | .809 |
| I am very well aware that I live and interact within a complex and dynamic system. | .616 | .847 |
| I observe my own interdependence within my surroundings. | .550 | .862 |
| I feel as part of a bigger system. | .748 | .813 |
| I perceive myself as part of a whole. | .718 | .821 |
| ***Systemic flexibility* (α = .69)** | | |
| I have difficulties seeing things from different perspectives. | .480 | .640 |
| I can easily adopt the perspective of other people and "feel" what they are thinking and feeling. | .493 | .636 |
| I have difficulties adjusting my thoughts, feelings, and actions to my surroundings and situations. | .360 | .671 |
| I would not describe my thinking as "holistic" and "intuitive". | .361 | .675 |
| I am usually aware of my surroundings and its influences on me. | .474 | .647 |
| I have an intuitive feeling for unspoken things. | .428 | .654 |
| I am usually not quite aware of the impact of my actions on my surroundings. | .272 | .699 |

Table 5. Factor structure of the TSIS

| | **Factors** | | | | ***h***$^2$ |
|---|---|---|---|---|---|
| | **I** | **II** | **III** | **IV** | |
| ***Effective systems handling*** | | | | | |
| When confronted with complexity, I persevere until I have found a productive solution. | **.77** | .14 | –.08 | –.08 | .573 |
| I do not give up until I have achieved my goal. | **.70** | .02 | .03 | –.14 | .458 |
| I exercise productive ways of influence within my surroundings. | **.67** | .06 | .21 | –.06 | .568 |
| I am able to manage most of my everyday activities successfully. | **.65** | –.06 | –.07 | .14 | .460 |
| I usually have no problems dealing with difficult and complex problems when going them through step by step in my mind. | **.62** | .05 | –.22 | .21 | .467 |
| I can influence my surroundings, be they living or not. | **.52** | .03 | .09 | .22 | .443 |
| I tend to just do things right. | **.49** | –.08 | .13 | .14 | .361 |
| I usually cannot influence much in my surroundings. | **.46** | –.20 | .15 | .33 | .485 |
| My thinking is very action-oriented. | **.46** | .09 | .06 | –.21 | .217 |
| I sometimes have the feeling that there is not much what I can influence by my own actions. | **.40** | –.16 | .24 | .21 | .393 |
| I envision and identify productive ways of behaviour in my mind if confronted with complex problems. | **.40** | .37 | .07 | .10 | .415 |
| I can adapt to varying situations quite flexibly. | **.40** | –.03 | .03 | **.34** | .368 |
| ***Systemic reflection*** | | | | | |
| I often ponder on my thoughts, feelings, intentions, and actions. | .08 | **.72** | .07 | –.02 | .558 |
| I would describe my thinking as quite “complex” and “interwoven”. | .13 | **.68** | –.11 | –.02 | .476 |
| I am a very reflexive person. | .13 | **.67** | –.02 | .09 | .521 |
| I often think about my role in my surroundings. | .00 | **.67** | .19 | –.08 | .496 |
| I often ponder on others’ thoughts, feelings, intentions, and actions. | –.14 | **.66** | –.01 | .20 | .495 |
| I am not a very self-reflexive and thoughtful person. | –.06 | **.27** | .07 | .19 | .136 |
| ***Holistic systems perception*** | | | | | |
| I feel as part of a bigger system. | –.01 | –.04 | **.89** | –.11 | .748 |
| I perceive myself as part of a whole. | –.02 | –.09 | **.87** | –.05 | .726 |
| I perceive myself as part of a whole, the influence of the whole upon myself, as well as my own influence upon the whole. | .05 | .03 | **.80** | .13 | .737 |
| I observe my own interdependence within my surroundings. | .03 | .17 | **.67** | –.07 | .495 |
| I am very well aware that I live and interact within a complex and dynamic system. | .07 | .21 | **.62** | .12 | .564 |
| ***Systemic flexibility*** | | | | | |
| I can easily adopt the perspective of other people and “feel” what they are thinking and feeling. | .02 | .18 | –.11 | **.68** | .514 |
| I have difficulties seeing things from different perspectives. | –.01 | .07 | .07 | **.67** | .488 |
| I have difficulties adjusting my thoughts, feelings, and actions to my surroundings and situations. | .21 | –.26 | .08 | **.51** | .408 |
| I have an intuitive feeling for unspoken things. | .02 | .21 | .09 | **.49** | .366 |
| I am usually aware of my surroundings and its influences on me. | .10 | .03 | .28 | **.48** | .432 |
| I am usually not quite aware of the impact of my actions on my surroundings. | .01 | .09 | –.08 | **.42** | .193 |
| I would not describe my thinking as “holistic” and “intuitive”. | .00 | –.02 | **.36** | **.38** | .333 |
| Eigenvalues | 7.40 | 2.58 | 2.34 | 1.58 | |
| % of variance | 24.66 | 8.59 | 7.80 | 5.25 | |

*Note.* $N$ = 408. Extraction Method: Principal Component Analysis. Rotation Method: Direct-Oblimin ($\delta = 0$) with Kaiser Normalization. When components are correlated, sums of squared loadings cannot be added to obtain a total variance. Highest factor loadings on a factor are indicated bold. $h^2$ = communalities. Interpretation of factors: I = Effective systems handling; II = Systemic reflection; III = Holistic systems perception; IV = Systemic flexibility. Kaiser-Meyer-Olkin Measure of Sampling Adequacy = .882 (meritorious: .80, marvellous: .90; cf. Dziuban and Shirky, 1974); Bartlett’s Test of Sphericity: Approx. $\chi^2(435) = 4{,}213.27$, $p < .001$.

***Intercorrelations.*** All four factors of Trait-SI were moderately positively intercorrelated ($\bar{r}$ = .38, range: *r*s = .24 – .56). The four SI factors and the SI global factor were also correlated with socio-emotional skills, acquisitive self-monitoring, self-esteem, and the Big Five (see Table 6) to further investigate which (psychological) meaning each SI factor might have.

In general, there were positive association patterns among *socio-emotional skills* and SI factors, with the highest correlations mostly for effective systems handling. Only social sensitivity was negatively correlated with SI factors. The global SI score even correlated at $r$ = .53 ($p$ < .001) with socio-emotional intelligence (the global score from all social and emotional skills). Further, emotional sensitivity (facet score) and systemic perspective-taking ($r$ = .51, $p$ < .001), control (domain score) and effective systems handling ($r$ = .51, $p$ < .001), emotional intelligence (score from all emotional facets) and global SI ($r$ = .53, $p$ < .001), emotional intelligence and effective systems handling ($r$ = .53, $p$ < .001), and socio-emotional intelligence ($r$ = .51, $p$ < .001) and effective systems handling reached significant correlation coefficients at $r$ > .50. Generally, the factor systemic reflection correlated the least with socio-emotional skills; from the socio-emotional skills facet scales, it was only positively associated with the sensitivity scales, emotional sensitivity ($r$ = .31, $p$ < .001) and social sensitivity ($r$ = .25, $p$ < .001).

There were largely significant positive relationships between *acquisitive self-monitoring* and the SI factors. Highest correlations were found for global SI and the perceptiveness-factor ($r$ = .43, $p$ < .001), global SI and impression management ($r$ = .48, $p$ < .001), effective systems handling and the perceptiveness-factor ($r$ = .51, $p$ < .001), and systemic flexibility and impression management ($r$ = .54, $p$ < .001). The lowest (and only marginally significant) correlation was found for systemic reflection and the perceptiveness-factor ($r$ = .08, $p$ = .09).

Nearly all correlations of SI factors and *self-esteem* turned out positively significant, except for the association with systemic reflection. Effective systems handling even showed a correlation of $r$ = .49 ($p$ < .001) with self-esteem.

From correlations with the *Big Five*, Emotional Stability (reversed Neuroticism) and Extraversion showed highest associations with effective systems handling ($r$ = .42 and $r$ = .41, respectively, *p*s < .001). The only exception from the positive association pattern among Big Five and SI factors was systemic reflection: it correlated negatively with Emotional Stability ($r$ = –.11, $p$ < .05) and non-significantly with Extraversion and Conscientiousness ($r$ = .05 and $r$ = .07, respectively, *p*s > .10). Further, it is noteworthy to mention that Agreeableness shows generally lower correlations with SI factors. The global SI factor shows highest associations with Extraversion and Openness to experiences ($r$ = .37 and $r$ = .36, respectively, *p*s < .001), the two most agentic traits of the Big Five.

## Discussion

***Summary of results.*** In general, the TSIS shows good psychometric properties which is reflected in good internal consistencies, a sensible factor structure, and associations with other constructs as were hypothesized. Four SI factors (effective systems handling, systemic reflection, holistic systems perception, systemic perspective-taking) were retained from the TSIS with a general or global SI factor hierarchically above these. In particular, SI factors were positively associated with socio-emotional skills, (acquisitive) self-monitoring, self-esteem, and the Big Five. The only factor showing at times divergent (i.e., inverse) and even non-significant patterns was systemic reflection. The factor showing strongest associations was effective systems handling.

***Interpretation of results.*** The results are interpreted with respect to the factor structure obatinef from the TSIS as well as the associations the retained factors show with other, theoretically related constructs.

*Factor structure.* Four factors were retained from the 30 items of the TSIS.

The first factor, *effective systems handling*, refers to efficient and productive ways of acting within complex and dynamic systems and problems. Individuals high in this factor exert positive and effective control within systems while remaining flexible and systems-oriented. Should hindrances occur, they persevere and seek action-oriented solutions. This factor is related to the action- or behavior-component of SI (which would also be a core factor in systems intelligent leadership).

The second factor, *systemic reflection*, refers to the tendency to reflect upon oneself *and* others concerning thoughts, feelings, intentions, and behaviors. Individuals high on this factor should be deep in thinking, very reflective, but also very sensitive to their surroundings. This factor relates to the thought- or cognition-component of SI.

The third factor, *holistic systems perception*, refers to the tendency to perceive oneself within a complex system, one's actions within this system, but also the feedbacks from this system. People high in this factor have perceptional and thought patterns referring to persons and environments "working together" as one whole. Their perception can be described as systemic or holistic. This factor reflects both a perceptional and attitude or opinion factor (e.g., one has the opinion that he or she acts within a complex system involving feedback processes).

The fourth factor, *systemic flexibility*, refers mostly to a factor of perspective-taking, empathy, flexibility, plasticity, and adaptivity. People high in this factor should be able to adapt sucessfully to different situations and also adopt views and opinions different from their own, which should make them not only cognitively but also behaviourally more flexible. Further, individuals might also employ a great deal of intuition. This factor relates to a cognitive and behavioral competence of taking different perspectives within systems.

In addition, the study showed that the four retained factors are tied together by an underlying super-factor, which could be tentatively labelled the g-factor of Trait-SI. Thus, the TSIS gives us the opportunity of studying Trait-SI both as a global construct and as differentiated subconstructs.

Table 6. Bivariate zero-order (inter-)correlations of SI scales with other constructs

| | *M* | *SD* | α | SI (g) | ESH | SR | HSP | SF |
|---|---|---|---|---|---|---|---|---|
| ***Systems intellect*** | | | | | | | | |
| Systems intellect (global) | 2.75 | 0.42 | .89 | – | | | | |
| Effective systems handling | 2.59 | 0.51 | .85 | – | – | | | |
| Systemic reflection | 3.07 | 0.57 | .72 | – | .28*** | – | | |
| Holistic systems perception | 2.52 | 0.77 | .86 | – | .43*** | .24*** | – | |
| Systemic flexibility | 2.90 | 0.50 | .69 | – | .56*** | .33*** | .40*** | – |
| ***Socio-emotional skills*** | | | | | | | | |
| Emotional expressivity | 48.32 | 8.19 | .76 | .25*** | .30*** | –.00 | .20*** | .16** |
| Emotional sensitivity | 53.44 | 6.98 | .76 | .48*** | .38*** | .31*** | .22*** | .51*** |
| Emotional control | 44.68 | 8.29 | .80 | .17** | .22*** | .07 | –.03 | .18*** |
| Social expressivity | 49.58 | 9.93 | .88 | .41*** | .43*** | .08 | .32*** | .30*** |
| Social sensitivity | 50.20 | 9.08 | .84 | –.10* | –.26*** | .25*** | –.05 | –.11* |
| Social control | 52.77 | 8.31 | .80 | .47*** | .56*** | .03 | .27*** | .39*** |
| Expressivity | 97.89 | 16.53 | .89 | .37*** | .40*** | .04 | .29*** | .26*** |
| Sensitivity | 103.64 | 12.15 | .81 | .20*** | .03 | .36*** | .09 | .22*** |
| Control | 97.45 | 12.69 | .81 | .42*** | .51*** | .06 | .16** | .37*** |
| Emotional intelligence | 146.44 | 12.95 | .71 | .53*** | .53*** | .21*** | .23*** | .49*** |
| Social intelligence | 152.55 | 16.82 | .83 | .42*** | .39*** | .19*** | .30*** | .31*** |
| Socio-emotional intelligence | 298.99 | 26.08 | .86 | .53** | .51*** | .23*** | .31*** | .45*** |
| ***Self-monitoring (acquisitive)*** | | | | | | | | |
| Perceptiveness | 2.48 | 0.70 | .88 | .43*** | .51*** | .08† | .18*** | .36*** |
| Impression management | 2.69 | 0.59 | .80 | .48*** | .39*** | .28*** | .21*** | .54*** |
| ***Self-esteem*** | 2.26 | 0.54 | .90 | .40*** | .49*** | –.03 | .26*** | .33*** |
| ***Big Five*** | | | | | | | | |
| Emotional stability | 3.64 | 1.23 | .71 | .29*** | .42*** | –.11* | .15** | .26*** |
| Extraversion | 4.97 | 1.26 | .81 | .37*** | .41*** | .05 | .28*** | .26*** |
| Openness to experiences | 5.25 | 1.10 | .68 | .36*** | .31*** | .22*** | .21*** | .30*** |
| Agreeableness | 5.39 | 0.94 | .52 | .22*** | .11* | .15** | .13** | .29*** |
| Conscientiousness | 4.88 | 1.12 | .69 | .34*** | .38*** | .07 | .25*** | .20*** |

*Note.* $N = 408$.
SI (g) = global systems intelligence score; ESH = Effective systems handling; SR = Systemic reflection; HSP = Holistic systems perception; SF = Systemic flexibility.
*** $p < .001$, ** $p < .01$, * $p < .05$, † $p < .10$.

*Intercorrelations.* As hypothesized, most associations turned out (significantly) positive. Particularly, high correlations emerged for socio-emotional intelligence and self-monitoring. The pattern of findings points towards the positive nature of SI: individuals scoring high on Trait-SI can be expected to be socially and emotionally intelligent, self-confident, flexible, stable, outgoing, open-minded, warm, and persistent.

One notable exception to the general pattern of findings (i.e., significantly positive correlations) is the correlations of the SI factor systemic reflection: they were one of the smallest, some were not even significant, and systemic reflection showed a negative association with Emotional Stability (whereas the other factors showed positive associations) and a positive one with social sensitivity (whereas the other factors showed negative associations). The latter findings can be explained by the nature of systemic reflection: reflecting upon oneself and others in complex systems gives rise to not only thoughtful but possibly also ruminative and even depressive (or dysphoric) moods (which is associated with Neuroticism as a domain of negative affect). Further, Neuroticism can be associated with sociometer theory (Leary and Baumeister, 2000) which posits that people show individual tendencies to detecting cues of inclusion (acceptance) and exclusion (rejection) which in turn determines their self-esteem (Penke and Denissen, 2008). People with a more sensitive sociometer are also more neurotic, sensitive to social cues (especially negative ones), and ponder on interpersonal problems (see, e.g., Denissen and Penke, 2008). Therefore, it is plausible that systemic reflection is associated with social sensitivity and Neuroticism. This is corroborated by the finding that it is not associated with self-esteem (and even shows a negative tendency, albeit small). Further, systemic reflection correlates the least with the other SI factors and also loads the least on the global Trait-SI factor. These findings seem to shed light on more negative aspects of systems intelligent people: even though they might be sensitive to themselves and surroudings and know what (is right) to do (i.e., they have high competencies in taking actions in systems), especially the sensitivity- and reflectivity-parts could be hindrances at some time (e.g., it may be better at times to not be too sensitive or perceptive as well as to not think so much about things and take them too seriously). However, there are two upsides that ought not to be forgotten: first, the self-concept, self-efficacy, and general self-esteem may buffer negative states and moods and thus counteract depressogenic symptomatology. Second, even if there are ruminative states that consume one's attention, thoughts, and time, this is actually indicative of solving complex analytical problems and serves an adaptive purpose (see Andrews and Thomson, 2009; see, however, also Lyubomirsky and Tkach, 2003).

***Merits and limitations.*** The merit of this article lies in proposing a preliminary Trait-SI scale along with assessing basic psychometric criteria of the items and scale(s). First steps have been taken in developing a scale that can validly and reliably assess individual differences in Trait-SI. Other researchers could use the scale in their research and possibly revise and refine the items and scales (or at least adjust them to their needs). However, there are also certain limitations that should be briefly addressed.

One limitation of the findings is the sample used. First, there was a female overrepresentation (77.50%). Even though it is unlikely that females systematically differ in their SI skills and traits,[16] future studies should seek to balance out the sex ratio. Second, all participants were students and thus had higher education levels which could have led to higher levels of SI-related traits (e.g., more and deeper reflection tendencies, striving to think holistically, etc.). Third, mostly adolescents were in the sample which restricts generalisability to other age classes. Fourth, all participants were native speakers of German, and so the TSIS and all other scales were administered in German versions. This may limit the findings on the TSIS. Future studies ought to use the English items[17] and replicate findings from this study. A further limitation is the reliance on self-reports and cross-sectional data. Due to the latter, no causal inferences can be made and associations cannot be sufficiently interpreted. The effects and interactions of the variables remain thus unclear. This limits our view to a structural rather than a process-oriented and dynamic one. Longitudinal data would be needed to gain insight into causality and dynamics. Self-reports should be complemented by peer-ratings and (observed) behavioural data in future studies. Also, multitrait-multimethod analyses should be employed. Another limitation concerns social desirability of answering. Most traits were genuinely positive traits (e.g., self-esteem, emotional stability) and correlations might be inflated due to a socially desirable response style. Further, the TSIS might not have any predictive and incremental abilities. No SI-related criteria were sampled and thus the predictive validity of the TSIS remains unclear as of yet. The scale's applicability will have to be tested in future research and under other circumstances. Moreover, the scale's content and face validity was not assessed. Face validity is not that important in the case of the TSIS, but content validity is, especially because there are no other scales that could be used to assess construct validity in terms of convergent (and discriminant) validity. Therefore, experts in SI should rate the proposed items according to their respective levels of capturing SI-relevant aspects.[18]

***Prospects: future lines of research.*** Future research should be especially concerned with maximising content validity, revising, and validating the TSIS. In general, not only should self-ratings but also peer-ratings (with different levels of acquaintanceship) be sampled. Further, the factor structure of the TSIS ought to be replicated and confirmatory factor analyses employed (as opposed to the exploratory factor analyses conducted in this study). Moreover, test-retest reliability needs to be assessed for the scale in order to ensure that a stable trait (i.e., enduring characteristics) is measured. Additionally, the scale should be integrated into a wider nomological network of (theoretically) related constructs. The present

[16] Indeed, Mann-Whitney *U*s turned out non-signficant. No sex differences were found for the four SI factors and the global Trait-SI factors.

[17] The English items proposed are suggestions from the author; they have not (yet) been derived by the usual translation–backtranslation process.

[18] Lawshe (1975) proposed following method: a panel of subject matter experts (i.e., experts in SI) should examine the items and indicate whether they are "essential", "useful (but not essential)", or "not necessary". The *content validity ratio* (CVR) is calculated to indicate whether each item is pertinent to content validity or not:

$$CVR = \frac{n_e - \frac{N}{2}}{N - 1}$$

$n_e$ = absolute number of times which an item is rated "essential"; $N$ = absolute number of raters

CVR values range from +1 to –1. Positive values and such closer to +1 indicate that experts are in agreement that the item should be deemed as essential to content validity. A mean CVR across items as an indicator of overall content validity can also be computed.

study only used a small selection of possibly related constructs (and also measured each construct only with one instrument). Possibly, also latent state-trait models and multitrait-multimethod analyses could be used in the future. A further concern will be to establish criterion validity of the TSIS as the scale(s) should be able to "predict" SI-related real-life criteria (from the past, at the present, and in the future). Another area of investigation would be whether SI structures (and the constructs themselves) differ according to socio-demographic variables (sex, age, education, nationality, etc.) and whether there are cultural differences. Specifically, future research should focus on identifying (a) behavioural criteria of (Trait-)SI that can be observed and coded by raters (in order to show associations between behavioural scores and the TSIS) and (b) critical real-life outcomes (criteria) for (Trait-)SI. This will also help improve the scale.

## Conclusion

The present article proposed a preliminary Trait-SI Scale (TSIS) to assess trait-aspects of SI. Thus, first steps towards measuring individual differences in SI in a psychometric sense were made. Self-reports might capture some trait-related aspects of SI, but the proposed scale should be under close and rigorous scrutiny in future empirical studies. Not only should basic psychometric criteria be met, but also should self- and peer-ratings as well as behaviour observations be employed to study the properties of the items and scale(s) more closely.

It is my hope that other researchers in the filed of SI find this article, its statistics, and the items of the TSIS useful for their own research and even strive to revise and improve the scale. Hopefully, a valid and reliable scale of Trait-SI will emerge that will be capable of quickly and easily assessing individual levels of Trait-SI.

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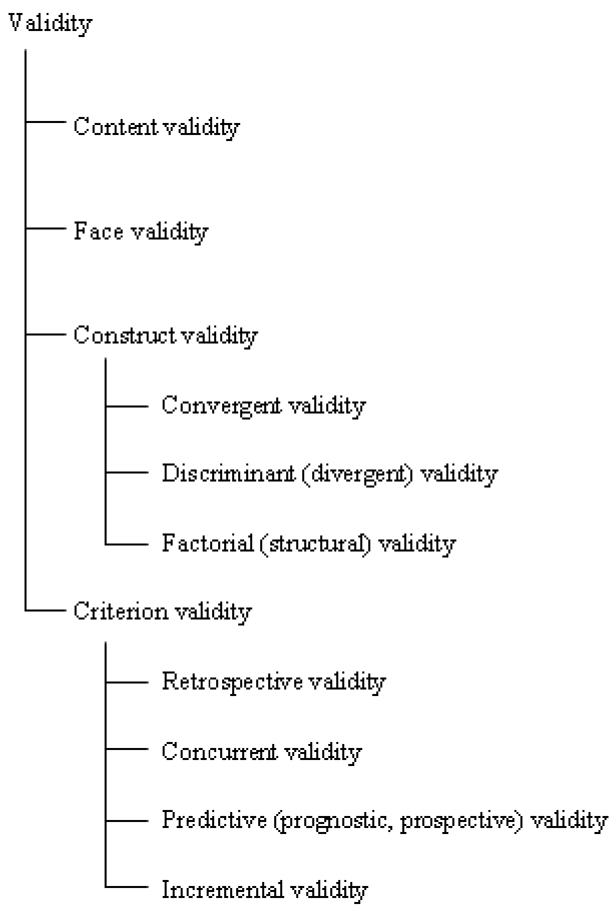
## Appendix A. Overview and Explanation of Basic Psychometric Criteria




### Psychometric criteria

Different psychometric criteria will have to be assessed for the preliminary Trait-SI scale. In the following, different “traditional” criteria of *validity* and *reliability*, which the Trait-SI scale should meet, are briefly outlined.

### Validity

*Validity* refers to the extent to which the construct that should be measured by a certain measure is actually measured by this measure. This means that a scale aiming at measuring Trait-SI should indeed capture Trait-SI (or at least essential or constituting parts of it) and not measure (self-reported) intelligence or socio-emotional competences. The proposed scale is solely theoretically generated, and its validity needs to be evaluated in future empirical studies.

### *Content validity*

*Content validity* refers to the extent to which a measure or rather its item content represents the construct that should be measured. Although this form of validity is not too often quantified, expert ratings can be used to evaluate whether the items are useful or not for a certain construct.

### *Face validity*

*Face validity* refers to the ability of a measure to at least *appear* to superficially measure a certain construct (whether it may do this in fact or not). Face validity can be assessed by asking non-expert subjects (lay persons) whether the items account for SI aspects after giving them an introduction on what SI is and how it is mentally and behaviourally manifested. Of course, face validity is not essential in all measures, and some constructs might even provoke social desirability through their face validity.

### *Construct validity: convergent and discriminant (divergent) validity*

*Convergent validity* refers to the extent to which one construct is similar to another theoretically near construct (within a nomological network). This is often used to show that one particular construct can be assessed by several measures that claim to measure that same construct. *Discriminant validity* refers to the extent of which one construct is *not* similar to certain other constructs (and should be lower than convergent correlations). Both forms of validity can be assessed in multitrait-multimethod analyses (Campbell and Fiske, 1959). In the future, also Gardner's multiple intelligences could be correlated with SI (if valid and reliable tests can be found)[19]. Yet, convergent validity cannot be clearly assessed as there are so far no valid and reliable scales to measure Trait-SI. However, one could find scales measuring certain constructs that are highly similar to sub-scales of the global SI or its subcomponents and explore correlations.

### *Construct validity: factorial (structure) validity*

We should think about the structure of a scale that we expect: do we expect orthogonal or interrelated factors? Do we expect higher-order factors? Do we expect a hierarchical structure? Do we expect a circumplex? Why do or *should* we expect certain SI structures? These are questions that both theorisation *and* sound research ought to address. After excluding items that show poor content validity (they need not necessarily have high face validity, though), it might be advisable to reexamine the factorial structure of the TSIS. Also, it will be interesting to see *which* and *how much items* load on *which* and *how much extracted factors*. Further, the factor structure of the TSIS needs to be replicated in different samples. Future empirical studies should address these issues with both exploratory *and* confirmatory factor analyses.

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[19] We need to be careful when "mixing" abilities with traits here: The intelligences should be assessed as both abilities *and* traits (cf. Ability-, Integrative, and Mixed-Models) and then convergent and discriminant correlations can be computed.

### *Criterion validity: retrospective, concurrent, and predictive/prospective/prognostic validity*

*Criterion validity* refers to the extent to which the measured construct (predictor) can predict construct-related real-life phenomena or outcomes (criteria) either from the past (retrospective), at the moment (concurrent), or in the future (predictive, prognostic, prospective). The TSIS should especially be analysed concerning its criterion validity. For this, however, suitable indicators or criteria for (Trait-)SI need to be found. Future research should hence focus on *investigating SI-related criteria* (be they set in the past, present, or future), *evaluating their specific relevance to certain aspects of (Trait-)SI*, and eventually *assessing the criterion validity of the scale*.

### *Incrementanl validity*

The most interesting "test" for SI will be its *incremental validity*: can Trait-SI predict relevant or critical real-life criteria when controlling socio-demographic variables (sex, age, education, socio-economic status, nationality, culture, etc.) *and* person variables (personality factors, intelligence, other forms of "intelligence", etc.)? Should the scale not perform well on incremental validity, then this does not necessarily mean that SI should not be treated as a distinct construct; it might also be due to unsatisfactory item generation and poor operationalisation. However, should the scale perform well on incremental validity, then this is no guarantee that (Trait-)SI is actually measured – the scale measures something that is able to predict certain criteria above the controlled variables (but what exactly is measured and why it contributes an incremental portion to predictive variance remains unclear). Therefore, we ought to maximise content and construct validity for the SI scale *before* aiming at incremental validity or else findings will not be interpretable that easily. Additionally, (Trait-)SI should be integrated into a *nomological network*.

## Reliability

*Reliability* refers to the extent of how consistently a construct is measured by a certain measure. This means that measures of long-term stable tendencies such as traits should have a high reliability: a person should not be very systems intelligent in week 1 and then not in week 2 or vice versa. This is referred to as test-retest reliability. However, reliability can also be assessed in other ways (e.g., by internal consistency).

### *Internal consistency*

*Internal consistency* of a scale can be indexed by Cronbach's alpha (Cronbach, 1951; see also Cortina, 1993; Schmitt, 1996) with a range from .00 to theoretically 1.00 (which is practically never achieved, though). Cronbach's alpha should not be mistaken as an index for dimensionality: a high alpha does not necessarily mean that the scale is unidimensional. Dimensionality should be investigated via factor analyses. Cronbach's alpha taps the consistency or homogeneity of a scale: if there are strong intercorrelations among items (which indicate that they are somehow tied together), then the scale, resulting from these items, can be expected to be homogeneous and show a high alpha.

### *Test-retest reliability*

*Test-retest reliability* concerns stability, that is when administering the measure of a certain construct at two (or more) times apart and correlating the obtained scores, then there should be high correlations suggesting a certain stability of the measurement and construct (if we are assessing a trait). This type of reliability is very important for Trait-SI as it should be a stable construct. Under the presumption that there are minimal variations in Trait-SI over time, test-retest correlations should be quite high or else the measure might capture more state-related aspects of SI. Cases of SI-training can be particularly problematic here: people might be able to train and further their SI to some extent but this refers mostly to Ability-SI. The relationships between ability- and Trait-SI have yet to be explored and it will be interesting to see whether an increase in Ability-SI is also accompanied by an increase in Trait-SI (i.e., the person's values, self-descriptions, and traits have changed in some way)[20]. Then, test-retest reliability can be lower, indicating that a change has occurred.

[20] Also, it would be interesting to investigate if one or both (ability-SI, trait-SI) can decrease and how and why this may be the case.

# Appendix B.

| English Items | German items (used in the study) | Codings |
|---|---|---|
| *I perceive myself as part of a whole.* | Ich nehme mich als Teil eines Ganzen wahr. | + |
| *I am usually aware of my surroundings and its influences on me.* | Ich bin mir meistens über meine Umgebung und dessen Einflüsse auf mich bewusst. | + |
| *I have an intuitive feeling for unspoken things.* | Ich habe ein intuitives Gefühl für unausgesprochene Dinge. | + |
| *I am usually not quite aware of the impact of my actions on my surroundings.* | Meistens bin ich mir nicht bewusst, welche Auswirkungen meine Handlungen auf meine Umgebung haben. | – |
| *I feel as part of a bigger system.* | Ich empfinde mich als Teil eines größeren Systems. | + |
| *I observe my own interdependence within my surroundings.* | Ich beobachte eine wechselseitige Abhängigkeit von mir und meiner Umgebung. | + |
| *I have difficulties seeing things from different perspectives.* | Ich tue mich schwer, Dinge aus einer anderen Perspektive zu betrachten. | – |
| *I am very well aware that I live and interact within a complex and dynamic system.* | Ich bin mir voll bewusst, dass ich in einem komplexen und dynamischen System interagiere. | + |
| *I can easily adopt the perspective of other people and "feel" what they are thinking and feeling.* | Ich kann leicht die Perspektive anderer einnehmen und fühlen, was sie denken und fühlen. | + |
| *I perceive myself as part of a whole, the influence of the whole upon myself, as well as my own influence upon the whole.* | Ich nehme mich selbst als Teil eines Ganzen, den Einfluss des Ganzen auf mich sowie meinen Einfluss auf das Ganze wahr. | + |
| *I would not describe my thinking as "holistic" and "intuitive".* | Ich würde mein Denken nicht als „holistisch“ (ganzheitlich) und „intuitiv“ beschreiben. | – |
| *I often ponder on my thoughts, feelings, intentions, and actions.* | Ich denke oft über meine Gedanken, Gefühle, Absichten und Handlungen nach. | + |
| *I would describe my thinking as quite "complex" and "interwoven".* | Ich würde mein Denken als ziemlich „komplex“ und „verwoben“ beschreiben. | + |
| *I usually have no problems dealing with difficult and complex problems when going them through step by step in my mind.* | Ich habe normalerweise keine Schwierigkeiten mit komplexen und schweren Problemen, wenn ich diese in meinem Geist Stück für Stück durchgehe. | + |

| | | |
|---|---|---|
| *I am not a very self-reflexive and thoughtful person.* | Ich bin keine sehr selbst-reflexive und nachdenkliche Person. | – |
| *I often ponder on others' thoughts, feelings, intentions, and actions.* | Ich denke oft über Gedanken, Gefühle, Absichten und Handlungen anderer nach. | + |
| *I often think about my role in my surroundings.* | Ich denke oft über meine eigene Rolle in meiner Umgebung nach. | + |
| *I envision and identify productive ways of behaviour in my mind if confronted with complex problems.* | Im Geist vergegenwärtige ich mir und identifiziere produktive Verhaltensweisen, wenn ich mit einem komplexen Problem konfrontiert bin. | + |
| *My thinking is very action-oriented.* | Mein Denken ist sehr handlungsorientiert. | + |
| *I am a very reflexive person.* | Ich bin eine sehr reflexive Person. | + |
| *I am able to manage most of my everyday activities successfully.* | Ich bin der Lage, die meisten meiner alltäglichen Anforderungen erfolgreich zu meistern. | + |
| *I can adapt to varying situations quite flexibly.* | Ich kann mich sich ändernden Umgebungsbedingungen sehr flexibel anpassen. | + |
| *I can influence my surroundings, be they living or not.* | Ich kann meine belebte und unbelebte Umwelt beeinflussen. | + |
| *When confronted with complexity, I persevere until I have found a productive solution.* | Wenn ich mit komplexen Dingen konfrontiert bin, dann bemühe ich mich beharrlich, bis ich eine produktive Lösung dafür gefunden habe. | + |
| *I exercise productive ways of influence within my surroundings.* | Ich übe einen produktiven Einfluss innerhalb meiner Umgebung aus. | + |
| *I have difficulties adjusting my thoughts, feelings, and actions to my surroundings and situations.* | Ich habe Schwierigkeiten, meine Gedanken, Gefühle und Handlungen meiner Umgebung sowie Situationen anzupassen. | – |
| *I usually cannot influence much in my surroundings.* | Meistens kann ich nicht viel in meiner Umgebung beeinflussen. | – |
| *I tend to just do things right.* | Ich habe die Tendenz, Dinge „einfach richtig“ zu machen. | + |
| *I do not give up until I have achieved my goal.* | Ich gebe nicht auf, ehe ich mein Ziel erreicht habe. | + |
| *I sometimes have the feeling that there is not much what I can influence by my own actions.* | Ich habe manchmal das Gefühl, dass es nicht vieles gibt, was ich durch meine eigenen Handlungen beeinflussen kann. | – |

| English Items | Item content | SI concept | References |
|---|---|---|---|
| *I perceive myself as part of a whole.* | attitude<br>self-description | Whole is more important than parts.<br>In our culture the human conceptual system emphasizes linear thinking, isolating thinking and seeing separate units rather than seeing wholes. Our perception mechanisms exhibit a similar tendency. | Saarinen and Hämäläinen (2007, p. 52/53) |
| *I am usually aware of my surroundings and its influences on me.* | situational awareness | In our culture the human conceptual system emphasizes linear thinking, isolating thinking and seeing separate units rather than seeing wholes.<br>Our perception mechanisms exhibit a similar tendency. | Saarinen and Hämäläinen (2007, p. 53) |
| *I have an intuitive feeling for unspoken things.* | intuition<br>description | The behaviour of people often reflects their best guess of rational behaviour but that guess can be completely erroneous. | Saarinen and Hämäläinen (2007, p. 53) |
| *I am usually not quite aware of the impact of my actions on my surroundings.* | self-monitoring<br>description | Human beings perceive themselves as independent individuals, yet they most often are encompassed in systems.<br>In most systems, each subject separately reacts to the system without seeing the cumulative overall effect of the reactive behaviours on the others. Our perception mechanisms exhibit a similar tendency. | Saarinen and Hämäläinen (2007, p. 53) |
| *I feel as part of a bigger system.* | attitude | Whole is more important than parts. | Saarinen and Hämäläinen (2007, p. 52) |
| *I observe my own interdependence within my surroundings.* | self-monitoring<br>description | Systems approach looks beyond isolated linear cause-and-effect chains for interconnections and interrelations. | Saarinen and Hämäläinen (2007, p. 52) |
| *I have difficulties seeing things from different perspectives.* | empathy<br>social competences | Systems approach starts when you perceive the world through the eyes of another person. | Saarinen and Hämäläinen (2007, p. 52) |
| *I am very well aware that I live and interact within a complex and dynamic system.* | attitude<br>description | Systems approach looks beyond isolated linear cause-and-effect chains for interconnections and interrelations. | Saarinen and Hämäläinen (2007, p. 52) |
| *I can easily adopt the perspective of other people and "feel" what they are thinking and feeling.* | empathy<br>emotional intelligence | Systems approach starts when you perceive the world through the eyes of another person. | Saarinen and Hämäläinen (2007, p. 52) |

| | | | |
|---|---|---|---|
| *I perceive myself as part of a whole, the influence of the whole upon myself, as well as my own influence upon the whole.* | attitudes<br>self-description | In most systems, each subject separately reacts to the system without seeing the cumulative overall effect of the reactive behaviours on the others. Our perception mechanisms exhibit a similar tendency.<br>"Part" and "Whole" are relative abstractions that are always subject to potential redefinition by changing the perspective. | Saarinen and Hämäläinen (2007, p. 52/53) |
| *I would not describe my thinking as "holistic" and "intuitive".* | thinking style | Whole is more important than parts.<br>In our culture the human conceptual system emphasizes linear thinking, isolating thinking and seeing separate units rather than seeing wholes. Our perception mechanisms exhibit a similar tendency. | Saarinen and Hämäläinen (2007, p. 52/53) |
| *I often ponder on my thoughts, feelings, intentions, and actions.* | reflection<br>meta-cognition | In our culture the human conceptual system emphasizes linear thinking, isolating thinking and seeing separate units rather than seeing wholes. Our perception mechanisms exhibit a similar tendency.<br>Systems approach looks beyond isolated linear cause-and-effect chains for interconnections and interrelations. | Saarinen and Hämäläinen (2007, p. 52/53) |
| *I would describe my thinking as quite "complex" and "interwoven".* | thinking style | In our culture the human conceptual system emphasizes linear thinking, isolating thinking and seeing separate units rather than seeing wholes. | Saarinen and Hämäläinen (2007, p. 53) |
| *I usually have no problems dealing with difficult and complex problems when going them through step by step in my mind.* | complex problem solving | Human agents can influence entire systems. | Saarinen and Hämäläinen (2007, p. 52) |
| *I am not a very self-reflexive and thoughtful person.* | reflection (trait) | Systems approach looks beyond isolated linear cause-and-effect chains for interconnections and interrelations. | Saarinen and Hämäläinen (2007, p. 52) |
| *I often ponder on others' thoughts, feelings, intentions, and actions.* | reflection<br>meta-cognition | In our culture the human conceptual system emphasizes linear thinking, isolating thinking and seeing separate units rather than seeing wholes. | Saarinen and Hämäläinen (2007, p. 53) |
| *I often think about my role in my surroundings.* | reflection<br>meta-cognition | In our culture the human conceptual system emphasizes linear thinking, isolating thinking and seeing separate units rather than seeing wholes. | Saarinen and Hämäläinen (2007, p. 53) |
| *I envision and identify productive ways of behaviour in my mind if confronted with complex problems.* | visualising<br>complex problem solving | Much of the time, people display behaviours they would change if they only could see the bigger picture of the setting they are in.<br>A system can make people act in some undesirable ways but as people act in such ways, they maintain the system and its influence upon | Saarinen and Hämäläinen (2007, p. 53) |

| | | | |
|---|---|---|---|
| | | the others, partly causing the system of undesirable behaviours to regenerate itself.<br>In most systems, each subject separately reacts to the system without seeing the cumulative overall effect of the reactive behaviours on the others. | |
| *My thinking is very action-oriented.* | thinking style | Beliefs regarding structures produce behaviour. | Saarinen and Hämäläinen (2007, p. 53) |
| *I am a very reflexive person.* | reflection (trait) | Systems approach looks beyond isolated linear cause-and-effect chains for interconnections and interrelations. | Saarinen and Hämäläinen (2007, p. 52) |
| *I am able to manage most of my everyday activities successfully.* | successful intelligence behaviour description | Human agents can influence entire systems.<br>There does not need to be an external reason for the particulars of a system, yet people in the system can feel helpless regarding their possibilities of changing the system. | Saarinen and Hämäläinen (2007, p. 53) |
| *I can adapt to varying situations quite flexibly.* | situational adaptability flexibility | There does not need to be an external reason for the particulars of a system, yet people in the system can feel helpless regarding their possibilities of changing the system. | Saarinen and Hämäläinen (2007, p. 53) |
| *I can influence my surroundings, be they living or not.* | social / emotional intelligence behaviour description | Human agents can influence entire systems.<br>There does not need to be an external reason for the particulars of a system, yet people in the system can feel helpless regarding their possibilities of changing the system. | Saarinen and Hämäläinen (2007, p. 53) |
| *When confronted with complexity, I persevere until I have found a productive solution.* | perseverance conscientiousness (trait) | There does not need to be an external reason for the particulars of a system, yet people in the system can feel helpless regarding their possibilities of changing the system. | Saarinen and Hämäläinen (2007) |
| *I exercise productive ways of influence within my surroundings.* | social / emotional intelligence behaviour description | Human agents can influence entire systems. | Saarinen and Hämäläinen (2007, p. 53) |
| *I have difficulties adjusting my thoughts, feelings, and actions to my surroundings and situations.* | social / emotional intelligence | Much of the time, people display behaviours they would change if they only could see the bigger picture of the setting they are in.<br>Systems approach starts when you perceive the world through the eyes of another person. | Saarinen and Hämäläinen (2007, p. 52/53) |
| *I usually cannot influence much in my surroundings.* | social / emotional intelligence behaviour description | There does not need to be an external reason for the particulars of a system, yet people in the system can feel helpless regarding their possibilities of changing the system. | Saarinen and Hämäläinen (2007, p. 53) |

| | | | |
|---|---|---|---|
| *I tend to just do things right.* | (behavioural) intuition<br>behaviour description | The behaviour of people often reflects their best guess of rational behaviour but that guessan be completely erroneous. | Saarinen and Hämäläinen (2007, p. 53) |
| *I do not give up until I have achieved my goal.* | perseverance<br>conscientiousness<br>goal achievement | Human agents can influence entire systems. | Saarinen and Hämäläinen (2007, p. 53) |
| *I sometimes have the feeling that there is not much what I can influence by my own actions.* | social / emotional intelligence<br>(learned) helplessness | There does not need to be an external reason for the particulars of a system, yet people in the system can feel helpless regarding their possibilities of changing the system. | Saarinen and Hämäläinen (2007, p. 53) |

Chapter 5

# The Social System of Systems Intelligence – A Study Based on Search Engine Method

*Kalevi Kilkki*

*This essay offers an preliminary study on systems intelligence as a social system based on four cornerstones: writings using the terminology of systems intelligence, search engines, models to describe the behavior of social phenomena, and a theory of social systems. As a result we provide an illustration of systems intelligence field as a network of key persons. The main conclusion is that the most promising area for systems intelligence as social system is to systematically apply positive psychology to develop organizational management and to solve our everyday problems.*

## Introduction

The social system of systems intelligence is an ambitious topic, particularly for a person without any formal studies in sociology. Moreover, systems intelligence is a novel area of science and, hence, the development of its social structures is in early phase. It is even possible to argue that there is not yet any social system of systems intelligence.

The approach of this study is based on four cornerstones: first, the literature that has used concept of systems intelligence, second, search engines, third, models to describe the behavior of social phenomena, and forth, a theory of social systems. As a result we may be able to say something novel about the development of systems intelligence as a social system.

As to the social systems this essay relies on the grand theory developed by Niklas Luhmann (Luhmann 1995). One of the main statements of Luhmann is that social systems are systems of *communication*; even the mental processes of persons participating the communication process are excluded. Another key concept is *environment* that is, from the perspective of any social system, immensely complex. Other relevant terms are *autopoiesis* and *binary code*. All these concepts are relevant for any social system, including systems intelligence as a social system.

A central assumption of this essay is that the term "systems intelligence" defines the limit of the social system of systems intelligence. Because any social system is communication (in Luhmann's theory) we can observe the social system by observing the communication that somehow includes the term *systems intelligence*. Thus if the term "systems intelligence" is observed often enough, we may justifiably argue that the corresponding communication is part of the social system of systems intelligence. Note particularly that in this phase of analysis we do not need to assume any coherent group of people that intentionally have formed a society of systems intelligence. However, for the autopoiesis of the social system (or for the survival of the concept), a formal society is obviously useful, or maybe even necessary.

The paper is organized as follows. First we introduce the technical method applied in the paper called search engine method. The method is used to derive the list of most important systems intelligence names. The names are then located into a systems intelligence map based on the information about which names most often occur with each other. The map reveals seven subfields of systems intelligence. Moreover, the names are classified based on their emotional flavor that describes how often emotional concepts appear together with the name. In order to assess the future of systems intelligence we draw another map that includes only those persons that supposedly are still active and thus are able to contribute to the creation and development of the social system of systems intelligence. Finally, we provide some preliminary thoughts about the most promising future directions for the whole endeavour of systems intelligence.

## Search Engine Method

The starting point of our analysis is that the social system of systems intelligence consists of communication that regularly uses the phrase of systems intelligence. Therefore, we can just observe any communication both in formal scientific papers and in any other communication media. Fortunately, nowadays this kind of research is quite straightforward thanks to powerful search engines, like Google, Yahoo, and Live Search. There is no lack of numerical information about any subject. Still we need to be careful with the interpretation of the numbers.

I have applied a similar method to generate long tail distributions (Kilkki 2007), for instance, to describe distribution the most popular string of characters in the Internet: www, the, in, to, and, a, by, home, of, for, com, on, 1, etc. (etc is 446$^{th}$ on the list). The study also revealed some problems related to the number of results given by different search engines (see figure 11 in Kilkki, 2007).

The search engine method adopted in this essay is the following. First we recognize a number of names that are somehow linked with systems intelligence. Note again that the persons themselves are excluded from the social system, while the names of the persons, of course, appear in the communication process related to systems intelligence (even when the person had not ever himself used the concept of systems intelligence). The second phase of the analysis is to identify those names that most often appear together with the concept of systems intelligence. The process is quite simple except that we need to have some insight about the potential names. Once again, the web provides several useful sites that give an overview about the topic and a lot of relevant names as well. In this process the primary source has been the Wikipedia pages about systems intelligence, systems thinking, Systems Theory, and Cybernetics.

With the list of potential systems intelligence names we can start to use search engines and observe how many results we get with each name. For instance, a search “Peter Senge” “systems intelligence” produces 426 results in Google, 458 results in Yahoo, and 160 results in Live Search. Note particularly that both the whole name and systems intelligence shall be in quotation marks. Sometimes the results by different search engines significantly differ from each other, which makes it somewhat problematic to give an unambiguous definition for the importance of the name. Here we use the simple rule that systems intelligence score (SI-score) for a name is the median of the three results; for instance, the SI-score for Peter Senge is 426. The list of 38 names with SI-score of at least 50 is presented in Table 1. It is likely that some names that should appear in the list a missing. However, we can safely assume that this set of names gives a representative sample of SI-names.

Seven persons have SI-score higher than 100; we may call them the seven systems intellectuals. While only 16 out of 38 of the SI-persons are still alive, all top five SI persons are alive.

The background of SI-persons is highly varying; there are mathematicians, engineers, psychologists, biologists, etc. Many of the SI-persons have studied several sciences. For instance, Wikipedia describes Gregory Bateson as anthropologist, social scientist, linguist, semiotician, and cyberneticist. Another interesting point is that many key persons have lived extraordinary and rich life; for instance Chilean Francisco Varela spent seven years in exile in USA during Pinochet's regime, became a Tibetan Buddhist, and finally taught neuroscience at the University of Paris. We might even speculate that in order to see the world as an intelligent system one requires a kind of outsider perspective.

## Drawing the Systems Intelligence Map

The second step in the study is to define the map of the systems intelligence names by observing how often each pair of names appears on the same web pages. A similar search engine approach as earlier can be used. However, at this phase only one search engine is used, in this case Live Search provided by Microsoft. For instance, according to Live Search, "Richard Dawkins" and "Stephen Jay Gould" together gives 114000 results, whereas "Richard Dawkins" and "Mihajlo D. Mesarovic" together gives only eight results. Because of these extreme variations it is not reasonable to assess the strength of relationship between two names directly by the number of results; instead, for each person we take into account the commonness order of the other SI-names. For instance, in case of Daniel Goleman, the most common names appearing with him are Howard Gardner (18600), Mihaly Csikszentmihalyi (14100), Richard Dawkins (13500), and Peter Senge (10400).

It is apparent that most of these results do not relate in any way to the concept of systems intelligence. However, it is not possible to restrict the search to those pages that also contain phrase "systems intelligence" because there are too few pages to allow any statistically significant study. Besides, the key idea is to measure the closeness of the names in general. Figure 1 shows the systems intelligence map drawn based purely on this web-closeness information, in a way that a name is primarily situated close to the name that appears most often with the name. Unfortunately, it is hard to avoid some long connectors on a two-dimensional map. Actually, an essentially better map (in the sense that there are very few long connectors) would be obtained if it were possible to use two layers, one for theoretical field, and another one for applied field. In Figure 1 the applied part of systems intelligence is dispersed to the boundaries of the map, and particularly on the left side of the map.

Table 1. List of systems intelligence names

| Abbr. | Name | SI-score | Orig. discipline | Key concept |
|---|---|---|---|---|
| ARa | Anatol Rapoport | 74 | Psychology | Tit-For-Tat |
| ATu | Alan Turing | 80 | Mathematics | Turing machine |
| BHB | Bela H. Banathy | 103 | Linguistics | White Stag leadership |
| CFr | Charles François | 55 | Commercial sc. | Systemics |
| CSh | Claude Shannon | 53 | Engineering | Information theory |
| DBo | David Bohm | 53 | Physics | Thought as a system |
| DGo | Daniel Goleman | 120 | Psychology | Emotional intelligence |
| DMe | Donella Meadows | 76 | Enviromental sc. | Limits to growth |
| ELo | Edward Lorenz | 54 | Mathematics | Butterfly effect |
| ESa | Esa Saarinen | 1180 | Philosophy | Systems intelligence |
| FVa | Francisco Varela | 63 | Biology | Neurophenomenology |
| GBa | Gregory Bateson | 101 | Anthropology | Criteria of mind |
| GKl | George Klir | 50 | Computer sc. | Systems science |
| GWe | Gerald M. Weinberg | 57 | Psychology | Law of Twins |
| HGa | Howard Gardner | 171 | Psychology | Multiple intelligences |
| HMa | Humberto Maturana | 65 | Biology | Autopoiesis |
| HOd | Howard T. Odum | 59 | Ecology | Ecological modeling |
| HvF | Heinz von Foerster | 63 | Physics | Doomsday Equation |
| IPr | lya Prigogine | 60 | Chemistry | The End of Certainty |
| JHo | John Holland | 73 | Psychology | Six personality traits |
| JLu | Jukka Luoma | 64 | Engineering | |
| JPi | Jean Piage | 89 | Philosophy | Four development stages |
| LvB | L. von Bertalanffy | 95 | Biology | General systems theory |
| MCs | M. Csikszentmihalyi | 50 | Psychology | Flow |
| MDM | Mihajlo D. Mesarovic | 53 | Engineering | GLOBESIGHT |
| MMe | Margaret Mead | 56 | Anthropology | Primitive Societies |
| MWh | Margaret Wheatley | 50 | Management | Systems thinking |
| NLu | Niklas Luhmann | 72 | Law | Social systems |
| NWi | Norbert Wiener | 79 | Mathematics | Cybernetics |
| PCh | Peter Checkland | 59 | Management | Soft System Methodology |
| PSe | Peter Senge | 426 | Engineering | The Fifth Discipline |
| RDa | Richard Dawkins | 96 | Biology | The selfish gene |
| RPH | Raimo P. Hämäläinen | 327 | Engineering | Dynamic game theory |
| SBe | Stafford Beer | 56 | Business | POSIWID |
| SJG | Stephen Jay Gould | 54 | Biology | Punctuated equilibrium |
| TPa | Talcott Parsons | 55 | Sociology | Action theory |
| WCh | West Churchman | 97 | Philosophy | To secure improvement |
| WRA | William Ross Ashby | 61 | Psychiatry | Good regulator |

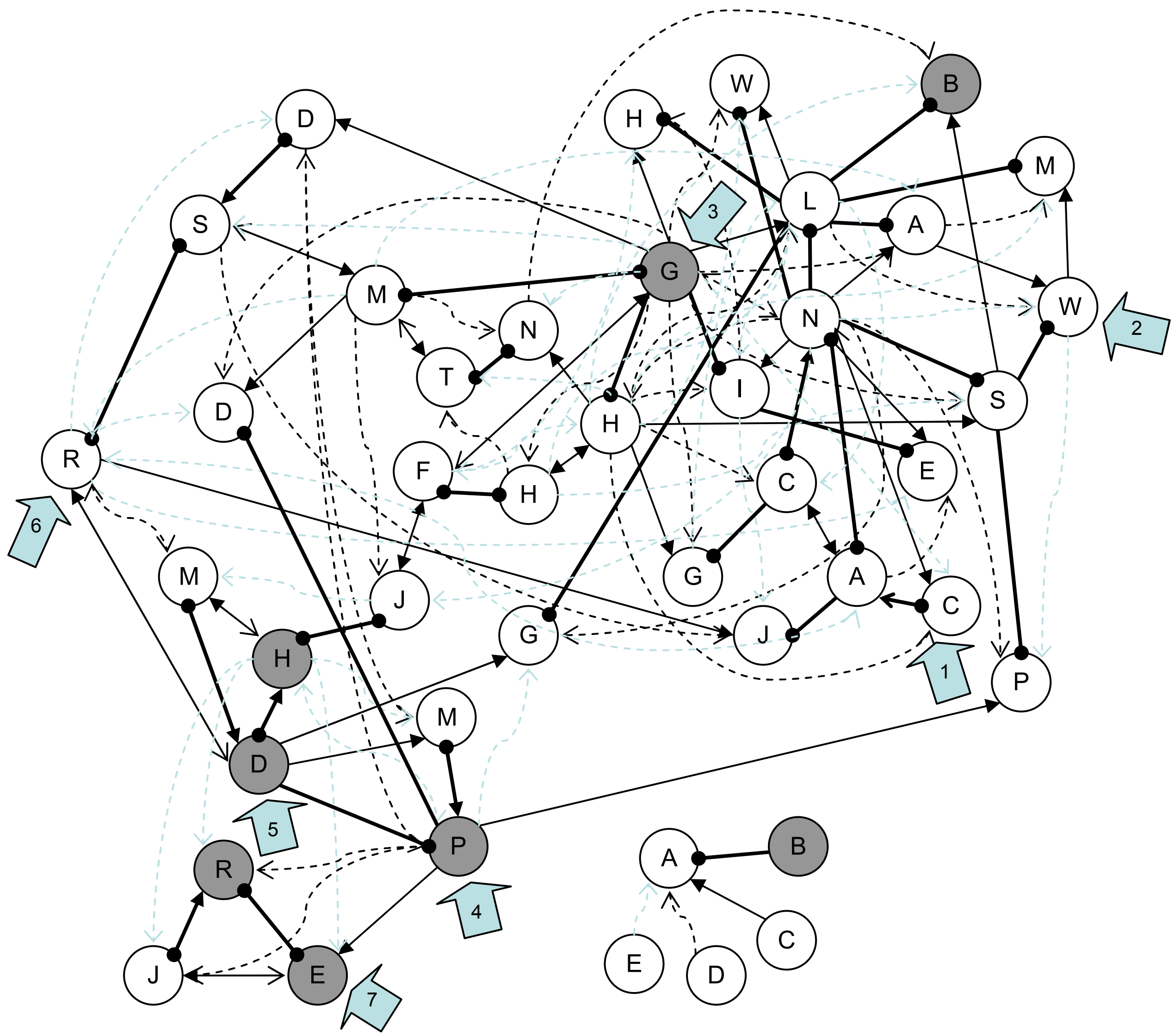


Figure 1. The map of systems intelligence. For name A, name B occurs most often with it in the web, followed by names C, D and E. B belongs to the seven systems intellectuals (SI-score > 100). Arrows with numbers indicate subfields (see list below).

We can identify several subfields with key persons as follows:

1) Mathematical basis: Claude Shannon – Norbert Wiener

2) General systems theory: C. West Churchman – Ludwig von Bertalanffy

3) Sociology: Gregory Bateson – Francisco Varela

4) Systems thinking: Peter Senge – Peter Checkland

5) Psychology: Mihaly Csikszentmihalyi – Daniel Goleman

6) Biology: Richard Dawkins – Stephen Jay Gould

7) Systems intelligence group: Esa Saarinen – Raimo P. Hämäläinen

As the Figure 1 shows there are no clear boundaries between the subfields, and some persons might even belong to several subfields. Note also that this map is very specific viewpoint defined by the concept of systems intelligence. A similar study with another concept may results in a different structure. Each subfield is just a sample of the huge area of the corresponding discipline. We may say that by using a specific concept and the search engine method, we select the highest peaks of each discipline from the specific viewpoint (here systems intelligence). Then the other step that defines the closeness of those peaks is used to draw a map across the disciplines. However, systems intelligence seems to be a specific concept in the sense that the highest peaks locate in so many diverse disciplines. Systems intelligence is a concept that has a strong creative flavor, and thus requires a multidisciplinary approach.

As to theoretical subfield, systems theory lies on a solid mathematical basis. Certainly, Claude Shannon and Alan Turing have been important for systems theory by defining the strict limits related to how information can be processed and transmitted within any system. As to the field of modern general systems theory, Lars Skyttner (1996) lists as the key persons Kenneth E. Boulding, T. Downing Bowler, C. West Churchman, Ludwig von Bertalanffy, and Joseph A. Litterer. Only Churchman and von Bertalanffy exceed the SI-score threshold of 50, Boulding was quite close with SI-score of 44, while Bowler and Litterer have quite low SI-scores. In general, it seems that most of the important contributions in these theoretical fields have made during the 20th century. Thus, it is uncertain whether we should expect any major discovery in this theoretical basis that would have a significant effect on systems intelligence – but we cannot be sure.

Sociology and biology are, of course, very active fields, although there are not any particularly young persons on our SI-list. From systems intelligence viewpoint systems thinking and psychology are most important and active fields.

## Emotional Flavor

Next we consider a key question of this paper: what kind of issues does the social system of systems intelligence consider compared to other closely related fields? The approach is, once again, based on the results obtained by search engines.

To formally analyze the difference between the fields or persons, we define emotional flavor (EF) as follows:

$$EF = \frac{(R_1 \cdot R_2 \cdot R_3 \cdot R_4)^{1/4}}{(R_1 \cdot R_2 \cdot R_3 \cdot R_4)^{1/4} + (R_5 \cdot R_6 \cdot R_7 \cdot R_8)^{1/4}}$$

where $R_i$ is the number of results given by Live Search for the search "forename surname" "ith term" (if there is no results, $R_i = 1$). The terms are

| | |
|---|---|
| (1) happiness | (5) problem |
| (2) meaning of life | (6) efficiency |
| (3) self-actualization | (7) proof |
| (4) satisfaction | (8) theory |

For instance, search "Gregory Bateson" "meaning of life" gives 830 results, and with other search results Gregory Bateson gets EF of 9.9 %. Thus, the more scientific and problem-oriented text appears in the web together with the given name, the smaller the emotional flavor. There are vast variations between the names from George Klir (EF = 1.6 %) to Daniel Goleman (EF = 22 %). Figure 2 illustrates how the EF values vary over the systems intelligence field. As could be expected, top scientist with theoretical background, like Claude Shannon, Alan Turing and Norbert Wiener have low EF, which means that theoretical concepts occur very often with their names. The average EF over the SI-persons listed in Table 1 is 7.6 %. For comparison we can take some randomly selected names (that is, names without any dominant person): EF for Thomas Jones is 3.7 % and EF for Paula Smith is 5.9 %.

The above analysis is based rather on names than persons, because we did not expect any own activity of the person, only that the name has appeared together with systems intelligence. Of course, for majority of the persons mentioned in the SI-list any activity would be impossible as they have not been alive during the relatively short existence of systems intelligence as a systematically used concept. As to the future of systems intelligence as a social system, it is obvious that some key persons will have a decisive role. Table 2 shows a list of persons that are still alive and are supposedly active; here we assume that person is still active if he or she is born 1940 or later. Of course, this crude criterion may leave out some people that still may affect the formation of systems intelligence as a systematic concept.

Particularly with the alive persons, it is very likely that several persons are missed, because the threshold for SI-score is as low as 10. On the contrary, it is quite probable that there are not many unidentified persons with SI-score above 30. In addition to the group led by Esa Saarinen, there are very few persons that are actively using the concept of systems intelligence: if the term appears 10 or 20 times in the same web pages as a name, it is only an indication that the person has potential to become active actor in the systems intelligence field.

The main difference between the two SI-maps shown in Figures 1 and 3 is that with all SI-persons (Fig. 1) there is a strong theoretically oriented area on the right side of the map whereas in case of active SI-persons (Fig. 3) there is not any clear area of theoretical persons. Although some active SI-persons have strong theoretical basis, such as Feigenbaum, Yorke and Wolfram, they are located rather on the boundaries of the SI-map. The centre of the SI-map is occupied by persons that primarily apply the SI-concept on personal development or on management problems.

Figure 3 also shows the emotional flavor of active SI-persons. The average EF over the active SI-persons listed in Table 2 is 11.6 % or about 50 % higher than the average EF of all SI-persons listed in Table 1. This significant difference also indicates that the most natural application for systems intelligence seems to be in the development of emotionally intelligent capabilities when participating in complex social systems.

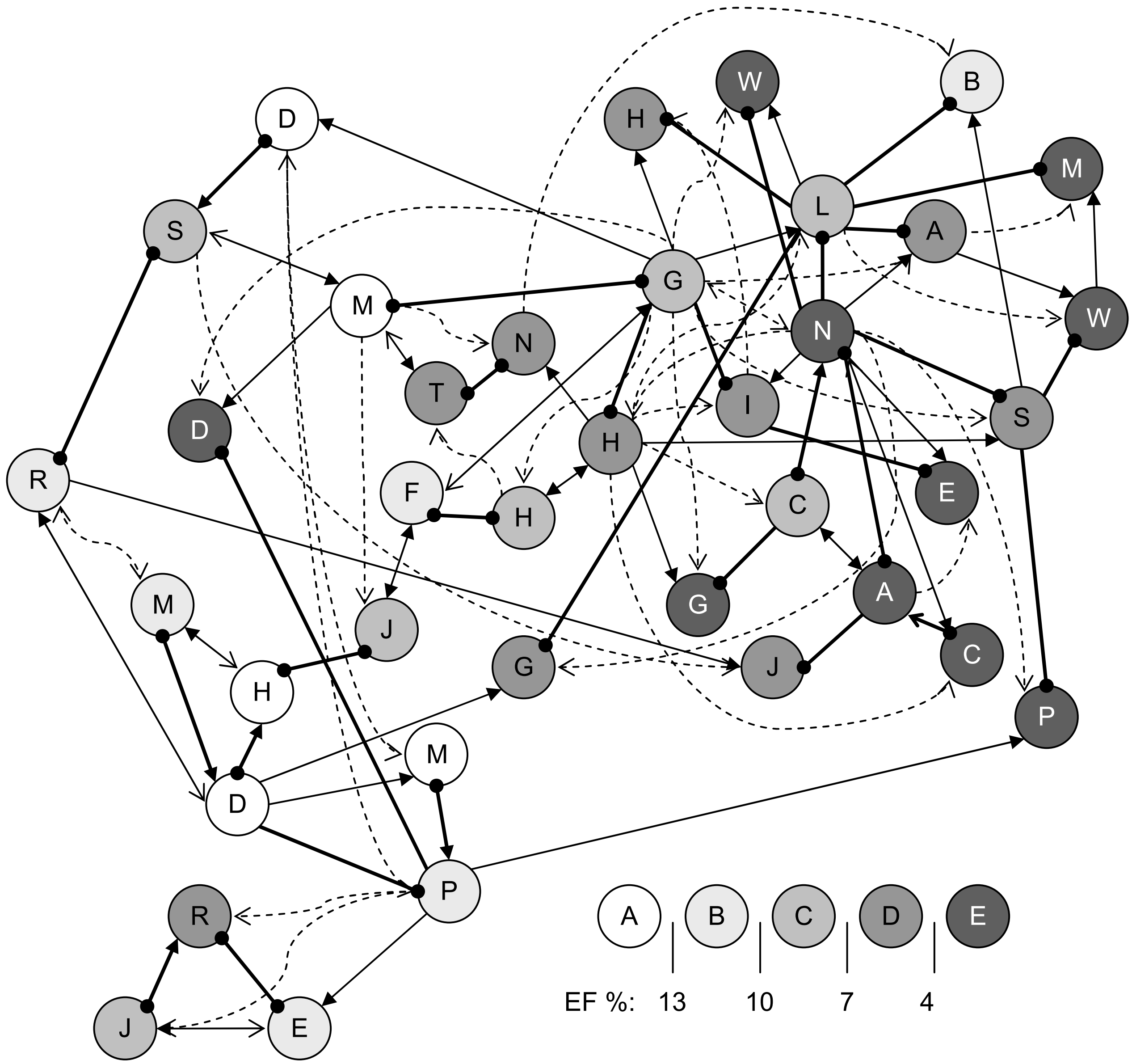


Figure 2. Emotional flavor (EF) of systems intelligence names. A: EF > 13%, B: 13% > EF > 10%, C: 10% > EF > 7%, D: 7% > EF > 4%, E: EF < 4%.

Table 2. List of active systems intelligence persons

| Abbr. | Name | SI-score | Original discipline | Key concept |
|---|---|---|---|---|
| AdB | Alain de Botton | 20 | Philosophy | How Proust can change your life |
| BKe | Bradford Keeney | 20 | Psychology | Creativity in therapy |
| BKo | Bart Kosko | 14 | Engineering | Fuzzy thinking |
| DGo | Daniel Goleman | 120 | Psychology | Emotional intelligence |
| DHa | Debora Hammond | 14 | History | Health and healing |
| DHo | Douglas Hofstadter | 26 | Physics | Strange loop |
| ESa | Esa Saarinen | 1180 | Philosophy | Systems intelligence |
| HGa | Howard Gardner | 171 | Psychology | Multiple intelligences |
| JAY | James A. Yorke | 13 | Mathematics | Chaotic systems |
| JCo | Jim Collins | 13 | Business | Built to last |
| JLu | Jukka Luoma | 64 | Engineering | |
| LSk | Lars Skyttner | 14 | Systems science | General systems theory |
| MCJ | Michael C. Jackson | 13 | Philosophy | Critical systems thinking |
| MFe | Mitchell Feigenbaum | 12 | Physics | Feigenbaum constant |
| MGl | Malcolm Gladwell | 19 | Journalism | The tipping point |
| MLo | Marcial Losada | 22 | Psychology | Meta learning model |
| MMa | Mikko Martela | 45 | Engineering | |
| MSe | Martin Seligman | 15 | Psychology | Learned helplessness |
| PHi | Pekka Himanen | 15 | Philosophy | Hacker ethic |
| PLi | Petri Lievonen | 13 | Engineering | |
| PSe | Peter Senge | 426 | Engineering | The fifth discipline |
| RCo | Randall Collins | 19 | Sociology | Interaction ritual chains |
| RDa | Richard Dawkins | 96 | Biology | The selfish gene |
| RJo | Rachel Jones | 11 | Literature | Management communication |
| RPH | Raimo P. Hämäläinen | 327 | Engineering | Dynamic game theory |
| SWo | Stephen Wolfram | 18 | Physics | Cellular automata |
| WBA | W. Brian Arthur | 12 | Economics | Increasing returns |
| YBY | Yaneer Bar-Yam | 10 | Physics | Complex systems |

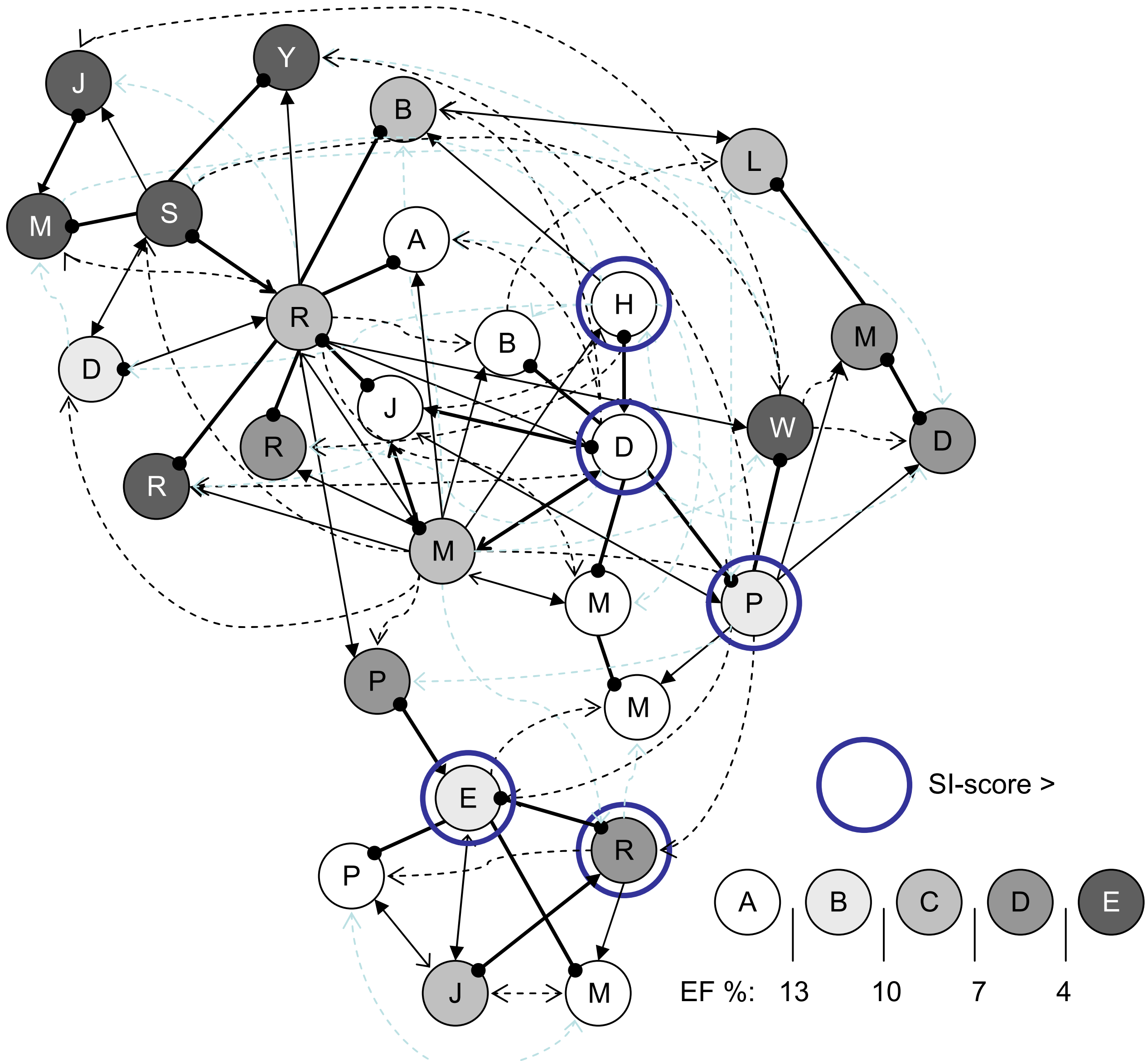


Figure 3. The systems intelligence map of active persons

## Future of Systems Intelligence

Now we can consider the major question of this essay: what will be the future of systems intelligence as a social system?

Systems intelligence as a genuine social system requires a strong enough community of active people. But then the community as a social system inevitable needs to consider and maintain its own future, or its autopoiesis. One requirement for a successful autopoiesis is that the social system is able to distinguish itself clearly enough from its environment. In case of systems intelligence, the environment includes well-established areas identified in Figure 1: mathematical theories, general systems theory, sociology, systems thinking, psychology, and biology. The most important neighbours for SI are scientific community in general, systems thinking as a more pragmatic field, and psychology as a field of personal development. For a successful autopoiesis, systems intelligence must be able first to define a clear enough difference with neighbouring fields, and secondly to form close enough relationship with those fields.

## Systems Intelligence as a Scientific Community

As to the relationship with the scientific community in general, the key question is whether systems intelligence wants to position itself inside the scientific community. Systems intelligence as a scientific discipline is quite a problematic approach, because for science the binary code, to apply Luhmann's (1995) terminology, is true/false. If systems intelligence wants to use this strict code, it has to consider very carefully what questions can be truly assessed by the true/false code. Furthermore, to gain recognition in the scientific field requires, first, publications in respected forums and, secondly, a lot of citations to those publications. As the competition in the scientific field is extremely hard, it is mandatory to carefully obey all the rules of scientific research and dissemination of results. A strictly scientific approach might lead to situation in which systems intelligence loses its strong holistic perspective and starts to concentrate to those specific issues that can be formally studied by scientifically respectable methods, for instance by means of sophisticated statistical techniques. As Esa Saarinen (2008) has expressed his way of thinking, "philosophy helps the manager in the challenge of figuring out what cannot be decided by facts and information." If something cannot be decided by facts, it is very difficult to apply a true/false code. Instead, systems intelligence shall look towards the opposite direction, to the outcomes of certain way of behaving.

Saarinen and Hämäläinen (2004) have defined systems intelligence as intelligent behavior in the context of complex systems involving interaction and feedback. What is true intelligence and what is false intelligence, anyway? Intelligent behavior implies the ability to cope with new situations and problems. In case of new situations in complex systems, it will be extremely difficult to scientifically prove that some behavior is intelligent. In many cases, the objective of systems intelligence is rather to develop skills that makes it possible for persons acting in a system to identify the uniqueness of the situation and then to cleverly act according to the achieved understanding for the benefit of the whole system. Due to the uniqueness of various situations, it will be very tricky to replicate studies and to gather material for statistical analysis. Moreover, it is extremely difficult to define whether the outcome of a separate action was beneficial or not, or what the consequences actually were (because it would be impossible to return exactly back to the same situation, to make another decision, ceteris paribus, and then to compare the consequences of those two actions).

## Systems Intelligence vs. Systems Thinking

One of the basic remarks of systems intelligence is that the reason for many observable phenomena in complex systems is in the structure of the system rather than in any separate actions. Then a natural question to be studied is how the structure of the social system influences the success of the system. Thus if systems intelligence wants to make significant scientific contributions, a promising area is to study system structures and how they can be changed by means of cleverly selected actions. However, general systems theory has already a long tradition on the theoretical part of that area. Thus in order to provide own contributions systems intelligence needs to emphasise intelligence as a research topic. Still, to take that direction seems to resemble the fundamental approach of systems thinking.

As Jones and Corner (2007) have noticed, systems intelligence has a more personal emphasis compared to systems thinking that focuses more on objective modelling. However, if we take the two key persons representing systems thinking and systems intelligence, there is no difference between the Emotional Flavors:

- Systems Thinking: Peter Senge's EF = 10.5 %, Michael C. Jackson's EF = 4.9 %

- Systems intelligence: Esa Saarinen's EF = 10.6 %, Raimo P. Hämäläinen's EF = 4.7 %

According to Michael Jackson (2003), "systems thinking is holistic rather than reductionist and, at least in the form of critical systems thinking, does everything possible to encourage creativity". In this respect systems intelligence and systems thinking visibly resemble each other. However, the main criterion for successful System Thinking seems to be the efficiency of management, at least if we consider the central books about systems thinking, written by Senge (1990) and Jackson (2003). Thus the final criterion for good systems thinking seems to be the benefit of the organization which the person is working with. In a commercial company the benefit means economical success. Consequently, the best systems thinking book gives the best advices to increase the efficiency of management in complex organizations. The endeavour of systems intelligence goes farther, both to the direction of individuals and to the direction of the whole society.

## Systems Intelligence vs. Positive Psychology

If systems intelligence goes deeply in to the area of another disciplines, like psychology or systems theory, it had to accept the methods, concepts and principles of those disciplines. General systems theory seems to be too theoretical as a sole framework for the development of systems intelligence. Although general systems theory offers a lot of valuable insight to be applied within systems intelligence, systems thinking is already a sensible approach to apply general systems theory in practical problems. The additional value of systems intelligence, compared to systems thinking, might be based on more thorough application of psychology, particularly positive psychology.

In the systems intelligence map shown in Figure 3, the key names representing psychology are Martin Seligman (EF = 29.5 %), Daniel Coleman (22.5 %), Bradford Keeney (25.0 %), and Howard Gardner (13.4 %). Furthermore, another key name from systems intelligence perspective is Barbara Fredrickson with as high EF as 32.8 % (see also Rönkkönen, 2010).

However, rather than to directly contribute to positive psychology, the scholarly role of systems intelligence might be to transmit the message of positive psychology particularly towards all managers that have to cope with complex organizations. In this sense systems intelligence comes close to the positive organizational scholarship (see Cameron et al., 2003).

## Conclusions

As a social system, it would be useful for systems intelligence to define a binary code, something similar to true/false used in scientific domain, or information/non-information applied by mass media. However, it might be that if the objective of systems intelligence is to support human flourishing, as Esa Saarinen (2008) has defined his personal ambition, it will be very difficult to define a single binary code. Niklas Luhmann (1998) stated that although most symbolic generalizations are binary coded, it is not possible to find any binary code for empassioned love. As Dustin Kidd (1999) has expressed it, love, more than any other social system, is characterized by contingency and fluidity. Human flourishing is a similar concept, evasive, and hard to formalize and compress to a binary code. But it might indeed be that a social system's autopoiesis requires binary code. Someone may even argue that a binary code will inevitably emerge when a social system grows sufficiently large.

However, I would argue that systems intelligence is as much art as it is science– art of systems, or even art of life. But how, then, can the social system of systems intelligence live in the middle area without the support of any established social structure, like science, art, or economy?

It would be useful to apply the key principles and methods of systems intelligence to systems intelligence. However, that effort is problematic if for any working inside the SI-field, for the reasons discussed by Pronin (2006) and Palonen (2010). On the other hand, it is not possible to investigate systems intelligence as a social system without intervening in the social system of systems intelligence; this is an obvious paradox. But the paradoxical nature of the effort means that we indeed need creative intelligence to sustain the endeavour of systems intelligence. An example of this kind of intelligence is presented by Ella Rönkkönen (2010) in her essay in which she applies the concept and methods of catalysts to consider the effects of positive emotions.

Therefore, a promising approach is to define systems intelligence as a framework rather than as a social system. The SI-framework makes it possible for all of us to create new insight to cope with the environment in which we live our everyday life, the extremely complex global society. The framework facilitates the transmission of insight and information between different disciplines (systems theory, psychology, sociology, etc.) and our everyday life. Persons primarily working in any other field are welcome to participate in the construction work of systems intelligence framework.

However, even the term framework per se is problematic because it does not naturally include the essential creative flavor of systems intelligence. Even more than a framework systems intelligence is a mindset that stimulates our capabilities to be aware of holistic system level phenomena and to use positive emotions to benefit both our personal life and the social systems we are living in.

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# Chapter 6

# Systems Thinking and Learning with the Systems Intelligence Perspective

*Otso Palonen*

*This article delves into the systemic dimensions of learning, particularly in the sense of non-conceptual, intuitive learning. Even though complex situations and problems may be beyond our ability to reason, we as human beings still possess intuitive tools for solving problems and learning from and of our environment. These tools, while present in every human being, are not necessarily being used to their fullest potential. Combining them with simulative learning environments may open up new vistas for learning, both for the individual and for groups.*

## Introduction

Even though the surrounding world continues to dazzle us with its complexity and ever-evolving nature, we still somehow manage to hang on. Much of our learning happens at a non-conceptual level and we realize a lot more of the underlying causal relations than would at first glance seem to be possible. Inbuilt mechanisms drive our learning and understanding, and because of that, we act intelligently even when no apparent framework to leverage with reason is available.

The question then is whether or not we should be more aware of these mechanisms and ways we can take advantage of them to further our understanding of the world and of ourselves. And if the answer is yes, how can such awareness arise other than through sheer life experience? This paper argues that simulations may prove to be useful for enhanced understanding of the world we live in and the systems we interact with.

## Systems Thinking as a Tool for Understanding the World

John D. Sterman is a leading advocate and a pioneer in the movement that is called systems dynamics. His book *Business Dynamics* (Sterman 2000) is a comprehensive work that, for many people, is bound to help them understand how complex systems work. In the book and in his article, *Learning in and about complex systems*, Sterman argues that the human capacity to understand complex systems is woefully inadequate, and much practice is needed to properly understand the various causal relationships between variables. For example, if presented with a simple causal relationship, such as the inflow to and outflow from a bathtub, most people are unable to infer correctly the behavior of the amount of water in the tub. Even when presented with a simplified explanation of the system, it still is not readily apparent how the system will behave. The problem is even more evident with real-world systems of complexity, in which it is difficult to comprehend the causal relationships or to be able to predict the system's behavior intuitively.

Sterman presents more detailed examples in the book. Car manufacturers in the USA used to offer very short term lease plans for their cars, reckoning that it would boost their sales as new cars would be perceived by customers as easier and less risky to acquire. What they did not take into account was the fact that after a certain delay, the used car market would be flooded with these almost-new vehicles and thus,  even less people would hold on to their car after the lease period expired (lowering used car prices and thus creating a positive feedback loop in which even more people would off-lease their vehicle) and even more damagingly to the car companies, cheap, good-condition used cars heavily undercut the sales of new cars, hitting the companies' profits hard. This is an example of a seemingly rational move (boosting car sales in the short term) that, due to the nature of the whole system which in the initial decision-making went unnoticed, ends up achieving just the opposite of what was desired, in this case, lowering new car sales substantially.

These examples demonstrate how oblivious we can be to the systems around us. What's even more, even if we are presented with explanations of these systems, such as causal charts, sets of equations etc. we still cannot bring ourselves to comprehend the true inner workings of the systems. As Sterman points out, we often act in an event-based manner, disregarding any possible delays. Most of the things we are adept at, such as riding a bicycle, offer instantaneous feedback of our performance and allow us to quickly change our behavior accordingly. Our brains are hardwired to learn quickly in a situation like that, and a task like riding a bicycle which would seem insurmountable given all the equations of friction, gravity, velocity and inertia that are the mathematical representation of it, is entirely doable with a little practice. Unfortunately, as delays between action and result, cause and effect are introduced, our inbuilt learning mechanisms have a much harder time of coping with them. Systems thinking is a movement that seeks to help people develop mental tools to comprehend these complex networks of intertwined causes and effects.

## The Mental Framework

Systems thinking, as a discipline, recognizes the importance of mental models. Mental models are, in the words of a leading systems thinking advocate, Barry Richmond, "selective abstractions of reality that you carry around in your head." (Richmond 1997). The whole concept of a mental model revolves around explicit knowledge:  "If you wish to employ non-rational means (like gut feel and intuition) in order to arrive at a conclusion or a decision, no mental model is needed. But, if you want to think… you can't do so without a mental model." (Richmond 1997) Mental models are constructs that are semi-reachable from consciousness in the sense that we are aware of them (at least once we've been given the idea of a mental model), but are tacit in the sense that they are not easily explicated as discussed by Sterman in "Expert knowledge elicitation to improve formal and mental models" (Sterman 1998).

Mental models are also featured prominently in the visual description of the learning process that Sterman provides in his paper "Learning in and about complex systems"; this diagram is reproduced in Figure 1.

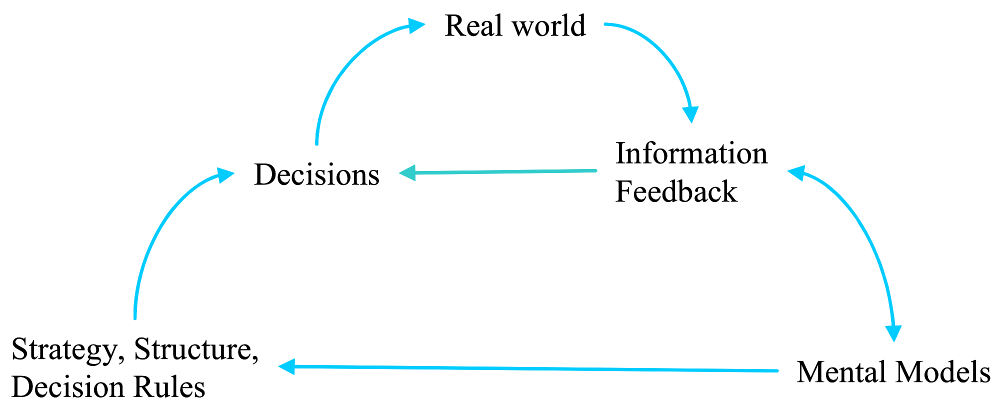


Figure 1. The learning process (Sterman 2000b)

The figure unfolds as follows. We make observations of the real world and based on those, we make decisions which in turn influence the world. This is what could be called the main loop in the chart. However, we base our actions on previous interactions with the world. These are represented in the mental models, which are our inner models of the outside world based on all previous interactions. Based on these mental models, we formulate strategies and heuristics for dealing with the real world, which in turn guide our decisions. It is important to note that the interaction between the feedback we get from the world and our mental models is two-way; new information shapes our mental models but in turn we view feedback from the world through the glasses of our existing mental models. Mental models are important to how we interact with the world. Sterman puts it thus: "on the contrary, our world is actively constructed – modeled – by our sensory and cognitive structures." (Sterman 2000b) Thus we can expect that more refined mental models result in more accurate actions, resulting in a better input/output relationship between perceptions and actions. On the other hand, even a small distortion in the mental models can change the way we perceive a phenomenon, and because it can further reinforce itself in the loop, the bias may end up as a dominant factor for the phenomenon in question. Thus even small biases can distort the mental models severely, if they are based on a narrow experience base.

If learning involves evolution of the mental models, which are the cornerstone of our conceptual understanding of the world, certain requirements for effective learning can be identified on the basis of Sterman's learning process. First of all, a large exposure to new things is necessary to form a proper mental model about them. A narrow base of experience will lead to biased views of the phenomenon in question. A major issue to consider here is the human incapability to see the stochastic nature of the world we live in, that things that work one time might not the next time, since other relevant parameters will have changed, even if the agent's actions are precisely the same. We will return to this issue later on when discussing simulation as a way to gather experience about unfamiliar situations and environments, and the effects of our actions on them.

Secondly, it is necessary to get accurate feedback in order to learn properly. If feedback is incomplete, distorted or delayed, learning is severely impaired. Like previously mentioned, the human mind is not by default conditioned to cope with noisy and delayed feedback, though the capability can be improved. A classic example of this is the Simple Beer Distribution Game (for a detailed description, see Sterman 1992), where a very simple system goes out of control simply because the players do not take deterministic delays into account while playing. Simulation can help in this as well.

The third requirement is that a person needs to have an open mind and be able to re-evaluate the existing mental models, without starting a trench war against new ideas. This might in some sense be the area in which systems intelligence can make the largest contribution. Re-examination of current mental models can be hard, but questioning them is vital to learning. This also involves contextuality of the lessons learned, because learning in one environment can also yield valuable lessons regarding other types of situations.

If all of these three criteria are met, false, biased or incomplete mental models will be exposed and corrected efficiently, and the learning process can work in a more optimal manner. However, not all learning rests on explicit mental models.

## Systems Intelligence and Non-Conceptuality

If we consider the fact that it is unadvantageous or even impossible to present all information explicitly, shouldn't we also take this into account when considering learning? Objectivization of knowledge and striving towards more explicit information is a valuable tool for codifying information, but a large part of learning happens at a non-conceptual, non-representative manner. Like Hämäläinen and Saarinen (2008) put it, "those that are 'teaching' might not even know what they are teaching, nor might they be able to point to any objectively identifiable representations of the systems structures they in fact employ, and still people learn, via a kind of 'making a lot out of a little' systems capability that Bruner identifies in children." This stands in stark contrast with Richmond's claim that "…unless a mental model changes, learning does not occur!" (Richmond 1997). If mental models are explicit, and no learning occurs without them changing, does this mean no implicit learning can occur?

Hubert Dreyfus addressed implicit knowledge in his presidential address (Dreyfus 2005) *Overcoming the Myth of the Mental: How Philosophers Can Profit from the Phenomenology of Everyday Expertise*. In the address, he takes expertise into focus and argues that through practice, a tacit form of learning occurs which eventually causes the learner to become more than competent in a given skill, and becomes an expert. However, an expert is unable to explain why he decides to act in a particular way. As Dreyfus puts it, "…the master may make moves that are entirely intuitive and contrary to any preconceived plan. In such instances, when asked why he did what he did, he may be at a loss to reconstruct a reasoned account of his actions because there is none."

Dreyfus puts forward an example in the form of lightning chess. This type of chess game involves the players making their moves very quickly (in less than a second per move), so that the whole game lasts less than two minutes. Yet, these games, when played by chess Grandmasters, are as complex as normal Master level games. Dreyfus notes, "At this speed he (the Grandmaster) must depend entirely on perception and not at all on analysis and comparison of alternatives." The Grandmaster doesn't think his moves, but rather just simply reacts to the patterns on the board. In this sense, a task as complex as playing chess can be non-conceptual. What the chess grandmaster has developed is not a complete mental model of the game, but rather a "feeling of a system" (Hämäläinen and Saarinen 2008), in this case, the feeling of the system of chess.

Another relevant example could be jazz improvisation. A jazz musician accumulates the skills needed to jam with a band during his whole playing career, and the patterns the band weaves through playing together can be complex indeed, even though there is no central guiding rules except for a few, such as the scale etc. However, the musician would be, just like the chess master, at a loss to explain why certain passages need to follow others in the song; he just knows it. Moreover, unlike in chess, where a supercomputer could find the rationale behind some move, in jazz improvisation no formal explanation can be constructed algorithmically. It's not just that the associated decision-making is non-conceptual but the whole process is non-conceptual. This is what Hämäläinen and Saarinen (2006) talk about when they say "…human activities that worked, even when there was no theory to explain why they worked, or even a recognized need for a theory."

To help comparison between the more conceptual mental models and the non-conceptual, implicit knowledge, let us call the latter "tacit models". An example of a tacit model would be the model which guides bicycle riding, or guitar playing. While obvious that there is some mental construct at work in these activities, the concept of a mental model does not fit the bill very well. First, it is almost impossible to articulate anything about the nature of tacit models, and second, they can only be acquired through personal experience. Tacit models are a sort of "feeling of a system".

To illuminate the concept of tacit models further, let us take an example of a case in which a tacit model is not strictly rational, yet effective none the less. Sterman argues in his book that model boundaries must be carefully considered so as to include all phenomena which have two-way causalities with the phenomenon to be studied, and that in constructing models it is necessary to "challenge the clouds". In *Learning in and about complex systems* Sterman recounts a story of a baseball batting champion, Wade Boggs, who always ate chicken before a game after performing particularly well after a chicken meal. As Sterman argues, of course eating chicken in itself did not further the batter's skills. But here we need to bring Sterman's own points to bear on himself and "challenge a cloud" by asking whether or not the mental state and constructs of the batsman can be left out from his system of batting? Even though in "the scientific worldview" there is no causal relationship between eating chicken and batting well, if eating chicken serves as a lucky charm which makes the batter believe in himself (even if this is completely irrational) and thus makes him perform better, shouldn't we view eating chicken a completely rational choice – indeed, the *right* choice?

Surely the system that determines a person's batting prowess incorporates both physical and mental elements, and neither should be neglected. Of course, attuning one self to batting by eating chicken can be seen as superstitious, but it if works and enables the batter to perform well, it doesn't seem prudent, wise or productive to judge such a form of objectively ill-founded action too harshly. Of course, if the batter was able to see this superstition for what it is, and be able to attune himself to the games in some other, nonritualistic way, so much the better, but that does not diminish the fact that for him, eating chicken is a sort of system intervention with positive results.

Bearing Dreyfus' earlier points in mind we can take another perspective at Boggs. Boggs, as an expert batsman, would equally be at a loss as the chess grandmaster playing lightning chess to explain how he accomplishes such great results. He might emphasize things like striking posture, swing technique, and eating lemon chicken. The first two are things that many people could agree on, but the problematic third one is no less important, but a part of his tacit model nevertheless. It just happens to be a part of the way he plays baseball. Dreyfus writes, "…expert coping needn't even be even implicitly rational in the sense of being responsive to reasons that have become habitual but could be reconstructed." And as we have concluded, the preparative chicken dinner is not objectively rational, but as a part of Boggs' tacit model of batting, it is an important primer to great performance.

## Flight Simulators

If mental models and tacit models coexist in our coping, do they both stem from the same sources? Sterman argues that simulations should be utilized more in making the behavior of complex systems more understandable to us. He has developed what he calls management flight simulators, which are, in his words, "virtual worlds" in which people can interact with the model, much like they would interact in the real world, but see the results of their actions much more clearly than would be possible in real life. For example the confusing effect of delays can be made transparent via simulation, and the oft-misleading stochastics can be made explicit.

Having just recently taken part in a business simulation game, I can wholeheartedly agree with Sterman on their effectiveness in developing an eye for the behavior of complex systems. A business environment, even a simplified one in a business flight simulator, is an immensely complex network of causes and effects that no one person can hope to be able to grasp in its entirety. That is why we observe and control the world at a higher level of roughness, where we see and set trends rather than individual transactions. Most business models are probabilistic in their assumptions and operation, which is a common feature of models in which it is no longer feasible to model lower, more tangible levels (like for example economics abstracts individual consumer preferences away). The trick lies in being able to interpret the interactions of these trends and applying the right leverage in the right point to push the system towards a more favorable state.

*Simulations grant us a view to the parameters of the simulation and the effects of our actions that would not be possible in the real world*

Using simulations grants us a view to the parameters of the simulation and the effects of our actions that would not be possible in the real world. Simulation allows us to peel away inessential and confusing facets of the system to reveal its core; the core we seek to understand. Things such as delays and unobservable states often confuse us in the real world, where it seems that some causalities that ought to work to our advantage fail to do so while others go unseen and work against us. While this problem is unassailable in the real world, if the models used in simulations fit their purpose well, they are analogous enough that we may gleam understanding from experience in them. The effect of various parameters can be made even more understandable if we allow game participants to vary them and see how it affects the game world. As Sterman (1992) himself puts it, “thus to be effective, management flight simulators must be more than just business games. They must be embedded in a learning environment that encourages reflection on the perceptions, attributions, and other mental models we use to interpret experience as well as the substantive lessons of the situation.” The idea in a simulator is not just to simulate the situation, but to expose the situation and the factors driving it to us. This supports our natural learning abilities and reduces the confusing effects of delays and hidden variables.

According to Richmond, the way simulations affect learning is basically about molding mental models: “call it self-reflective learning. It comes about when simulation outcomes are used to drive a process in which a mental model’s content, and/or representation of content, is changed.” In essence Richmond’s view purports that the virtue of simulations is that they change the content of our mental models. As discussed before, this is a valid perspective, but also lacking. Simulations can also build non-conceptual capabilities. A good example would be learning to fly, not a business organization, but an airplane. Flying an airplane is largely non-conceptual, as evident in the fact that no human could hope to constantly simulate the physical forces actually keeping the plane in the air. The cockpits of flight simulators are designed to resemble the cockpit of the real plane as closely as possible, to make the simulation as close to the real thing as possible. Even the surface materials are chosen to be the same, in order to enable the pilots to develop a tacit model for flying, a feel of the system of flying if you will.

Another advantage of simulations is that they may be used to experience things that are hard, costly or even impossible to do in the real world. For example, it is not possible for the author to spend a few years as CEO of a large company in order to gain business experience and to complete a course for his degree. It’s even less possible when we consider how many peers of his would need to be able to do same. However, using a business simulator, not only is it possible, but rationally thinking even necessary! Simulations enable us to experience things that normally would not be possible, whether is the viewpoint, the situation or our response strategy we wish to try out. And we can go through a variety of runs in a short period of time to develop an intuitive feel for the system, whereas in real life we can only try one course of action in any given situation. To sum it up, simulations open up new situations for us to learn in. As Sterman put it, “most important, when experimentation in the real system is infeasible, simulation becomes the main, and perhaps the only, way learners can discover for themselves how complex systems work.”

## Towards a Broader View of Learning in Simulation

Simulation should not be viewed in the narrow sense of computer-based or otherwise external simulations, they may be an integral part of our inbuilt learning drive. This observation legitimizes the use of simulations in learning even further and may give us intuitive insights to its use. There are some additional viewpoints that can shed further light on simulations.

First, simulations can be seen in everyday life as an instrument of learning. Seeing simulation-based learning in other situations than just the pre-designed runs and games that jump to mind can open up new intuitions to their importance to us. Second, simulation are not just a tool for a single person to learn about things, an important part of action is those that act alongside us and thus it's important to remember the social aspects of learning in simulations. This also ties in with the idea that externalizing oneself from the simulation may not be a good idea in the long run. And for simulations to be effective, the lessons learned in them must be carried on to other situations which are not simulations, in other words, new contexts. Unfortunately, this may not be automatic. Finally, no matter what sort of simulation is in question or what lessons there are to be learned, if the actor in the simulation is not open to the lessons, the simulation is useless. In the next five paragraphs, I will explore these topics.

## Simulation in Everyday Life

When a layman hears the word simulation, she often thinks of the weather forecast and of some near-mythical supercomputer that makes said forecast. Or animations of wind tunnel simulations in designing new cars, etc. On the other hand, when people with technical backgrounds hear the word simulation, things that spring to their minds are models, runs, variables and statistics. What we need in our discussion, however, is a slightly broadened view on simulation which doesn't necessarily exclude the previous two viewpoints but rather builds on them.

As reasonable as the thought of using simulations to pierce the veil laid upon complex systems is, it would be arrogant to think that it is a purely human invention; nature does it too. Not in the sense of running simulations to predict the outcome, but in learning. As Martin and Caro discussed (Martin and Caro 1985) "… have distilled the many hypotheses into three main classes: play as motor training, play as socialization, and play as cognitive or sensorimotor training. All have in common the notion that, as a result of playing when young, the individual is better able to perform some form of serious behavior later in ontogeny." Animals play in adolescence to build skills. Take for example the play of bear cubs. Considering the argument that Martin and Caro rise, what superficially seems to be just passing time and having fun while growing up is in fact a combat simulation which prepares the adolescent bears for their future lives in which their mother no longer competes for the scarce resources of the wild forest for them, but they are left to fend for themselves. Being able to simulate a hostile encounter with another bear in a friendly environment is valuable training for the life ahead; a life when a real fight against a rival may well decide whether or not the bear gets to make cubs of its own. This fact provides the necessary evolutionary link which demonstrates why playing, which is very common amongst young mammals, has evolved. Martin and Caro express this as "biologists generally assume that for a behavior pattern to have evolved and be maintained by natural selection, it must have biological benefits which, on average, outweigh its costs." So animals simulate to survive and the ability to play is in fact an evolutionary advantage.

Of course, since animals lack the self-regulation and self-reflection capabilities of us humans, it might seem a bit off the point to discuss their simulative habits of learning. This is not so, however; we humans do it too. One might argue that little boys fighting and wrestling is essentially the same behavior we see in the bear cubs, but it doesn't stop there. Learning by playing is an innate inclination in human children, as well. Combining this with the previous discussion about non-conceptual learning (which, considering animals, seems all the more natural now) it seems that simulations could be a major part of our lives already, even if it is not readily apparent at first glance. Of particular note is the fact that play most often develops skills that are not conceptual in nature, and as such might be seen as tacit models. Simulations are thus not something that must be artificially constructed, but something that are a part of our nature and nature at large.

## Virtual Worlds and Team Learning

Simulations are not just for individual learning, however. Just as they allow individuals to test their understanding of complexity, groups can also benefit from interaction with the simulation to practice their own interactions. Peter Senge (1990) argues that high-performing teams need “practice fields” in order to further their collective learning skills. Virtual worlds provide a playground for people to experiment in and to build team learning skills. As Senge points out (The Fifth Discipline, pg. 241), “Interestingly, the few examples in business of teams which learn consistently over a long period of time seem to be exactly those settings where effective virtual worlds operate.” Based on Senge’s observations, it seems that simulations can serve as an efficient facilitator of learning to work as a team.

Human interaction and interpersonal chemistry are largely non-conceptual, so that viewing a team learning simulation solely through the glasses of systems thinking may hide some important notions about the large spectrum of learning opportunities present in a simulation. Formal structure in human interactions, no matter how well conceived, guarantees no results. Much of the interactions arise non-conceptually and the attunement of people to the situation and to each other contributes much to the effectiveness of the group. Interpersonal skills are a valuable inbuilt asset in ourselves which can be bolstered by simulations.

## Intersystem Insights

An interesting and familiar phenomenon is that when a close friend is distressed, it’s sometimes easy to see her situation more clearly than she herself does. Her judgment of the situation and the causes and effects related to it may be clouded for a variety of reasons, as people are prone to having biases which affect their evaluation of themselves. A person who has intimate knowledge of the situation but does not suffer from these biases is much more able to make a clear assessment of the situation. This is what might be called “the outsider view”. An actor which is not in the center of the system in question can perceive the whole much better than one that is in the midst of all the action, as she does not have the biases which affect the central actor. Close participation in a system inevitably brings the biases into play, as the actor needs not only consider the system outside herself, but the two-way interaction between the system and herself as well.

Conceptual learning, as previously outlined, can be seen as the adaptation of our mental models to match the real world as closely as possible. These biases, then, distort our perception of the world and our interactions with it and other actors, and thus result in malformed mental models which do not accurately portray the world. It can be hard to see through the biases, since they alter our perceptions in fundamental ways. The Systems Thinker seeks to externalize the problem field and causal relations in order to study them. As Hämäläinen and Saarinen summarize it, “Systems thinking highlights a domain of objects it believes is neglected – systems. But systems remain objects nonetheless, entities to be identified and reflected from the outside.” Being able to distance oneself from a system is an advantage of simulation with regard to the notion that externalization is necessary for an objective study of the system.

Unfortunately, this approach also bears an externalist trap. A systems intelligent actor in a simulation does not wish to externalize the system or push it away to see it more clearly, she wants to immerse herself in the system and learn from it directly. Mental models may be tuned by simple dissection of the systems but tacit models and coping capabilities need contact with the system in order to develop. In this sense, it is not solely advantageous to use simulations as tools for externalization. It can be necessary to be able to immerse oneself in a simulation and to be able to “think real thoughts and feel real feelings” (Weston 1996) to properly get in tune with the system that is being simulated and to be able to develop a feel for it.

## Transcending Context

In addition to immersion in a simulation, one aspect of the simulative learning experience which should not be overlooked is the importance of context. Learning new principles of interaction and laws of system behavior is quite possible in a simulation, but unfortunately the lessons learned do not automatically apply to other situations. People trying to learn by simulation must be able to transcend context and be able to see a more generic framework in the background.

It is not by any means obvious that just knowing about something induces behavior based on that knowledge. An everyday example of this would be the people who smoke. Although it is widely known and largely undisputed in this day and age that smoking is very detrimental to an individual’s health, a large percentage of people steadfastly cling to this habit. Even though they know that in the long run they’d be much better off quitting, in the short term they end up lighting another cigarette. Just because they know of its health effects doesn’t mean that they have been able to internalize this knowledge to the extent that it would affect their behavior.

This means that in some sense, it is necessary to be able to believe in the simulation and believe that the lessons learned therein are real and can be applied to the real world and not just the world of the simulation. Both mental and tacit models are, in a sense, principles which guide us in interactions with the world, and something that is not credible and concrete might not change them at all. Take for example the smokers, which obviously in some sense do not believe that smoking is *truly* harmful to them, or at least that they are better off smoking than quitting.

Senge (1990, pp. 175) categorizes attempts to develop mental models into two categories: reflection and inquiry. Reflection involves scrutinizing the way mental models are formed and how they affect our actions. Inquiry skills have to do with interpersonal communication. He also discusses the way our “espoused theories” differ from our "theories-in-use", by which he means that our professed views differ from what we actually do. In Senge's view, this is not a catastrophe or something that should be gotten rid of, but rather a possibility to close the gap and and thus develop. Smokers would do well to take their espoused theory (smoking is bad for me and I intend to quit) and their theory-in-use (smoking's never done me no harm, and it'd be a pain to quit) and close the gap between them.

Gary Johns addresses contextuality in his paper, "The essential impact of context on organizational behavior" (Johns 2006). His main point in the paper is that context is something that should not be dismissed and factored out from scientific studies. His opinion is that scientific studies try to extract the essence from a phenomenon to generalize it, and this is detrimental to the understanding of the issue in question in the long run. Even though this may apply in many scientific studies, it is also what the human mind is prone to, and what happens in the formation of mental models. This is what Senge calls making "leaps of abstraction". Leaps of abstraction occur when our minds make abstractions to do away with a clutter of details and instead arrive at a simple concept. Considering how limited our cognitive capabilities are in specifics (as evident in, for example, the lack of perfect recall) it is obvious that the human mind must do away with context, at least to some extent, and concentrate on more abstract features. Doubtless there is a sweet spot somewhere between complete abstraction and pure data, and this sweet spot may very well be the tacit models our minds construct when trying to make sense of incoming data concerning, for example, good business practices.

## Making Mental Models more Malleable

When new experiences are available and enough information is available about them to make correct inferences and generalizations from them, all that remains to be done are the changes to the mental and tacit models. This process is, of course, automated and constantly ongoing, but not necessarily very efficient.

A striking example is one that the developer of the business simulator the author partook in, Juuso Töyli, related. A team of executives from a large Finnish company took part in a session of the game, and had prepared a "winning strategy" as well as "impeccable" modelling tools for monitoring their performance in the game. They led their company in the game the same way they had always done in real life. When their calculations did not match the calculations of the simulator and their game performance did not match their expectations, they declared that the simulator was flawed and marched out of the game.

Peter Senge (1990, pp.165) brings up another example. When Japanese auto makers were gaining a large share of the American market, U.S.-based companies began to be worried about the fierce competition from overseas. A group of auto executives travelled to Japan to witness firsthand the source of the competitive advantage of the Japanese companies. However, they were unimpressed, and one executive said, "They didn't show us real plants. There were no inventories in any of the plants. I've been in manufacturing operations for almost thirty years and I can tell you those were not real plants. They had clearly been staged for our tour." Today, we know that one of the cornerstones of lean manufacturing, the manufacturing philosophy that granted the Japanese their advantage, is minimizing (or even eliminating) inventories. But the executives' mental models, which included the notion that manufacturing plants must feature inventories, would not allow for this possibility and the source of the Japanese success remained a mystery.

Even if we disregard such adamant resistance to learning new things, it could be argued most people can see some of the very same disposition in themselves, and if they do not, they should. It is plainly obvious that should our expectations (be they based on intuition, calculation or simulation) be different from observations of the real world, it's the source of the expectations that should be corrected. However obvious this seems, not many of us can claim to have truly taken it to heart.

How to tackle this problem then? If resistance to change and adherence to working, if suboptimal, methods is a proven tactic we utilize almost subconsciously, how can it be overcome? First of all, it is necessary to recognize the mental models. This can be difficult though, since biases tend to make them hazy and intangible. One method of working toward knowing them is to study the heuristics which are in a sense their offspring. A relevant example in a business context is a person's risk-aversiveness. Even though it can be hard to determine which factors have shaped the model, it is reflected in an abundance of heuristics, which are easier to study with introspection. Once a person knows at least a rough outline of his mental model, it is easier to start probing for related biases and their effects on interactions with other people (who may have different conceptions about risk) and on their decision-making.

What is also important to consider is that because in simulations there are no real dangers of any kind, it can be easier for a person to try out new approaches to situations. Mental models and ideas are not the lifeline in survival they often seem to be in everyday life, but something that can be shifted and molded to new shapes. This links to the idea of taking theories lightly, like Donna Orange phrases it in her book: "In this conversation I argue for holding some basic attitudes. [...] A second value or attitude concerns the importance of fallibilism, the commitment to hold theory lightly, to live with uncertainty and ambiguity, and to be always prepared to revise our views. This attitude keeps us constantly ready to learn something, from our patients and from each other." (Orange 1995) While she was speaking of psychoanalysis, the idea carries on to other domains very naturally. Senge tells a story which serves an example of holding theories lightly, in the words of a Harley-Davidson senior executive: "I hear more and more people say, 'This is the way I am seeing things' rather than 'This is the way things are.' It may not sound like much, but the former leads to a different quality of conversation."

## Conclusions

Even though our understanding of causal diagrams and the evolution of the system states of complex systems over time is severely lacking, one does not need to despair. We as human beings possess intuitive tools for comprehending the world and these tools, combined with modern possibilities such as business flight simulators, can make these systems more understandable and controllable. We must not limit learning to simply mean the evolution of our conceptual tools and frameworks, but also include the non-conceptual, tacit learning exhibited by true masters in several fields. A concept of "tacit models" was introduced to portray the non-conceptual models in our minds. Learning also includes learning to lift the lessons learned from a specific context and being able to transfer the knowledge garnered to other situations.

This paper raised five broadened viewpoints to simulations. Simulations are a part of nature and can serve to improve both individual and team performance. For simulations to be most effective, the "feeling for the system" must be maximized and the ability for immersion in the simulation be facilitated. Systems Intelligent actors also feel no compulsion to externalize the system, but to immerse themselves in it, although conceptual externalization also has its merits. In addition being able to experience the simulation, for it to bear fruit it is also important to "hold theories lightly" and be able to carry the lessons learned to other contexts and situation. It is important to recognize one's fallibility and to be aware of the compression of raw perception into mental and tacit models.

Although several shortcomings regarding our ability to comprehend abstractions can be identified, our ability to cope must not be underestimated. Like Hämäläinen and Saarinen (2008) wrote, "In the systems dimension, humans have remarkable abilities to learn and to improve even in the absence of explicit objective knowledge." The human mind is wondrous in its ability to bend to different situations and demands, and with some nudges toward the right direction can master diverse fields. Maybe in the future, simulation can help learning in many disciplines and walks of life, and on all levels of the intellectual hierarchy. In this pursuit, human nature must not be underestimated or forgotten, but embraced.

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Chapter 7

# Fredrickson's Broaden-and-Build Theory, Chemical Engineering, and Systems Intelligence

*Ella Rönkkönen and Esa Saarinen*

*The broaden-and-build theory of positive emotions of Barbara L. Fredrickson argues that positive emotions broaden momentary thought-action repertoires and build longterm intellectual, physical and physiological resources. In this paper the broaden-and-build theory is approached from the point of view of chemistry as a platform for illuminating generative metaphors. Fredrickson's theory of positive emotions is interpreted in terms of catalysts, and discussed using key chemical terms such as porous material, activation energy and coke. We further link chief insights of Fredrickson's theory with the systems intelligence approach of Raimo P. Hämäläinen, Esa Saarinen and their associates. We offer an outline of a perspective on human growth based on chemical metaphors, conceiving positive emotions as catalysts for human flourishing and for the enchancement of systems intelligence. The proposed construct of "the upward spiral of positively catalysed systems intelligence" is intended as a contribution of particular relevance to positive psychology and positive organizational scholarship.*

## Introduction

Emotions are fleeting mental and physiological states, multicomponent response tendencies that open out over short time periods and contribute to a variety of personal resources (Fredrickson, 2004). In the past, emotion researchers have mainly concentrated on the negative emotions, such as fear, anger, anxiety and sadness (Seligman and Csikszentmihalyi, 2000). The negative emotions are in many ways more powerful and more attention grabbing than positive emotions (Baumeister et al., 2001) and they are often conceived as evolutionary adaptations to threats our ancestors faced. The adaptive value of negative emotions seems to be connected with their ability to spark specific action tendencies (Frijda, 1986). Critical to survival, negative emotions narrow the human's thought-action repertoires, affect specific physiology changes in the body and thus, enable the quick and decisive actions needed to adapt the current threatening situation. (Fredrickson, 2004). Positive emotions, on the other hand, are considered more diffuse (Ellsworth and Smith, 1988), fewer in the number of basic types than negative emotions (Matsmoto and Ekman, 2009) and relatively undifferentiated from each other. Moreover, positive emotions are mainly felt in safe and satiated atmospheres (Fredrickson, 1998; 2004).

The broaden-and-build theory of positive emotions (Fredrickson, 1998; 2001) argues that positive emotions broaden momentary thought-action repertoires and help to build intellectual, physical and physiological resources for the future. In evolutionary terms this contributes to greater odds of survival and reproductive success (Fredrickson, 2003a).

Research has indicated that feelings of love, joy, enthusiasm, interest, gratitude and contentment can contribute significantly to several beneficial life outcomes, such as friendship development (Waugh and Fredrickson, 2006), marital satisfaction (Harkel and Keltner, 2001), higher incomes (Diener, 2000), better physical health (Richman et al., 2005) and remarkably even in living a longer life. According to a landmark study of the lives of 180 Catholic nuns, the nuns who expressed the most happiness, interest, love and hope in autobiographical essays written in their youth lived up to ten years longer compared to nuns who expressed the fewest positive emotions (Danner et al., 2001). Studies also show that good feelings benefit people's bodily systems in a number of ways, including speeding recovery from the cardio-vascular after effects of negative effect (Fredrickson et al, 2000), and increasing the immune function (Davidson et al., 2003). Furthermore, positivity is connected to better mental and physical health outcomes (Tugade et al., 2004, Davis, 2009) such as increased happiness (Fredrickson and Joiner, 2002) and reduced inflammatory responses to stress (Steptoe et al., 2005), and to effective team work (Losada 1999, Losada and Heaphy 2004).

On the basis of a bulk of research, it seems safe to conclude that positive emotions do contribute significantly to personal growth and development. A key point in Fredrickson's groundbreaking work is to point out that this is achieved by the broadening of the individual's habitual modes of thinking and acting which triggers building effects as a result. In other words, individuals who experience positive emotions can transform themselves, become more creative, knowledgeable, resilient, socially integrated and healthy. Furthermore, individuals are not stagnant and instead grow continually towards optimal functioning (Fredrickson, 2004).

The systems intelligence approach studies human intellect in action as it emerges in unfolding real-life environments and contexts. As an approach to human agency, the systems intelligence approach combines a holistic outlook with a localized, contextualized and positively tuned emphasis on the human potential. The systems intelligence approach follows the tradition of System Thinking (Jackson 2000; 2003; Senge 1990) in believing in adopting the concept of a system to approach holism and the phenomena of connectivity and interrelatedness (Saarinen and Hämäläinen, 2004; Hämäläinen and Saarinen, 2006; 2007a; 2008; Luoma, 2009). At the same time, the systems intelligence perspective works with a keen sense of the experiential, subjective and phenomenological dimensions of our human endowment, and with a commitment to do justice to phenomena not necessarily accountable from an objective, from-outside perspective (Hämäläinen and Saarinen, 2007b). Of particular relevance to systems intelligence are those human abilities that relate an individual to other human beings in the intersubjective realm and in forms that are nonverbal and inarticulate (Stern, 2004). It emphasises attunement to situations, contexts, other people and to the present moment (conceived of as "systems") as humanly fundamental. The commitment to talk about the human subject and systems at the same time and as interrelated is a distinct aspect of the systems intelligence approach. It seeks to bring back that rich human endowment, that "systematicity" that research has found even in infants (Bruner, 1983; Beebe and Lahmann, 1998), which the systems thinking movement often has bypassed (Hämäläinen and Saarinen, 2008). Reaching out beyond the narrow realm of the cognitive and objective, the systems intelligence perspective connects an action-oriented systems perspective with a focus on the human sensitivities (Saarinen and Hämäläinen, 2004, Hämäläinen and Saarinen, 2008).

The aim of this paper is two-fold:

- To reconstruct Fredrickson's broaden-and-build theory of positive emotions using chemistry as a framework for illuminating generative metaphors.

- To link Fredrickson's theory with the systems intelligence perspective, and use Fredrickson's theory, as reconceptualised in this paper, in order to highlight and develop further some chief features of systems intelligence.

The result is an outline of *the upward spiral of positively catalysed systems intelligence*, a construct we believe is highly useful for positive psychology and positive organizational scholarship and for the understanding of human agency at large.

## Positive Emotions as Catalysts

The broaden-and-build theory of positive emotions (Fredrickson, 1998; 2001) argues that positive emotions broaden our momentary cognitive, attentional, and motivational capacity beyond basic needs and build long-term personal resources. As empirically demonstrated (Fredrickson and Branigan, 2005), the array of thoughts and actions that come to mind is widened when positive emotions are experienced. In the studies of broaden-and-build hypothesis with 104 college students it was observed that positive emotions broadened the scope of attention, the scope of cognition as well as the scope of action compared to neutral state (Fredrickson and Branigan, 2005). These broadened thought-action repertoires can have the effect of building an individual's personal resources, including physical resources, intellectual resources, and social resources. Thus, people who experience more positivity grow psychologically and become more optimistic, more resilient, more open, more accepting and more driven by purpose (Fredrickson et al., 2003). Furthermore, they build constructive mental habits since positivity opens us to moments and thus the surroundings are more efficiently observed and appreciated (Fredrickson, 2009 p. 92). Barbara L. Fredrickson enlightened the potential significance of positive emotions as follows (Fredrickson, 2004, p. 153):

> ”Positive emotions provide the fuel, creating a self sustaining system. In particular, positive emotions generate what I have called an upward spiral towards optimal functioning and enhanced emotional well being."

The concept of an upward spiral is highly appealing, and it is one of the most catchy notions of positive organizational scholarship. How should we understand this important semi-intuitive concept? We propose to reconstruct it using concepts of catalyst chemistry, the first author's primary field of research.

Let us first determine the flourishing as living within an optimal range of human functioning, characterized by goodness, generativity, growth, and resilience (Fredrickson and Losada, 2005). In this paper, we shall assume that human flourishing can be approached in terms of thoughts, attentions and actions, i.e., whatever the details of human flourishing, it will involve thoughts, attentions and actions lived out by the subject in a way that is appropriate for the flourishing to take place.

Our first proposal based on chemical engineering vocabulary amounts to a suggestion concerning the flourishing of an individual on the theoretical level. We prose that the goal of a human life is to have *the reversible equilibrium reaction* 1 to occur as far as possible towards its equilibrium state:

$$\text{Individual + attentions, thoughts, actions} \leftrightarrow \text{flourishing individual} \qquad (1)$$

*The reversible reaction* means that a reaction can happen in both directions. The *chemical equilibrium* denotes the fact that there exists a condition (an equilibrium state) where the products of the reaction are formed at the same rate at which they decompose back into the reactants. Thus, the concentration of each reactant and product remains constant. At equilibrium state, the forward and back reactions occur at the same rate. Thus an individual is thought to grow in the dimensions of attentions, thoughts and actions in line with the goal to flourish. Likewise, in a reaction taking place towards flourishing, the individual is thought to be subject to attentions, thoughts and actions appropriate to growth in flourishing. In this context the *equilibrium state* of human flourishing would describe the ideal state of living at "an optimal range of human functioning, characterized by goodness, generativity, growth, and resilience" (Fredrickson and Losada, 2005).

However, it is possible in chemistry that a mixture might seem to have no tendency to change, and still it is not at its equilibrium state. This is because there exists a *kinetic barrier* which prevents the relevant change from taking place. This barrier can be approached by the concept of *an activation energy* which is needed for the reaction to occur. Sometimes this activation energy can be very high. For example, gaseous hydrogen and oxygen are virtually inert at room temperature, but react rapidly to water when exposed to platinum catalyst (Fogler, 1999).

Likewise we propose it is useful to approach the hindrances to flourishing in terms of *kinetic barriers* within us which hinder the reaction 1 to take place – the point being that the kinetic barrier can be overcome with a substance called *a catalyst*.

Although catalytic reactions were already used in antiquity, the principles of catalysis were slow to become unveiled. The term *catalysis* was introduced in 1836 by Berzelius (Hagen, 1999). Catalysts, in chemical discourse, are substances which

- increase the rate of chemical reactions
- do not have an effect on the thermodynamic equilibrium of the reaction
- do not change during the reaction (Fogler, 1999).

This means that catalysis is a cyclic process: the reactants are bound to one form of the catalyst and the products are released from another, regenerating the initial state. The intermediate reaction complexes are usually highly reactive and difficult to detect (Hagen, 1999). To illustrate the importance of catalysis, notice that most of our liquid fuels and some 80% of chemical products are manufactured with the assist of catalytical conversions (Santen et al., 1999). Chemical catalysis can be generally divided into homogeneous, heterogeneous and bio catalysis (Richardson, 1989).

Heterogeneous catalysis, which we shall use here as a metaphor, involves more than one phase, and typically the catalyst consist of *a support material* and *an active material* (e.g. a metal) (Fig 1). The active material is dispersed on *a support* material that enhances the effectiveness of the catalyst or minimises the cost of the catalyst.

Sometimes the support is a *porous structure*, upon which the active material is spread, to increase and to extend the surface area. A catalyst with a large area resulting from many *fine pores* is called *a porous catalyst*. The large surface area is beneficial in order to attain reaction rates high enough for the process to occur. Often the support and the active material interact, affecting the catalytic reaction (see the supported catalyst structure in Figs. 1, 2 and 4) (Richardson, 1989; Fogler, 1999).

Examples of heterogeneous catalysis are many, including reduction, oxidation and electrocatalytic reactions. An illustrative example is the so called three-way-catalyst, consisting of Pt and Rh metal particles supported on a ceramic monolith to control the emissions of CO, NO and hydrocarbons from automotive exhausts by the overall reactions of 2-4. This catalytic treatment of motor vehicle exhaust has been applied in all passenger cars e.g. in USA since the 1975 models (Santen et al., 2005).

$$CO+1/2O_2 \rightarrow CO_2 \qquad (2)$$

$$NO+CO \rightarrow 1/2N_2+CO_2 \qquad (3)$$

$$C_xH_y+3/2xO_2 \rightarrow xCO_2+y/2H_2O \qquad (4)$$

One instructive way, we propose, to view the broaden-and-build theory and the upward spiral circle towards flourishing individual (reaction 1) is to envision positive emotions in terms of a heterogeneous catalysis.

We shall say that *a positive emotion catalyst* consists of the *support material* and *active materials* dispersed on it. Fredrickson, (2009, pp. 39–48) introduces ten most common positive emotions in the order of their feeling frequency: joy, gratitude, serenity, interest, hope, pride, amusement, inspiration, awe and love. However, love is in many ways an exceptional emotion as it has aspects or reflections of all the other nine emotions, amounting a "many-splendored thing" (Fredrickson, 2009). Indeed love is a fundamental construct which in most of the great spiritual traditions is perceived as the ultimate source of good. The speciality of love, a transient and ever-fleeting in its essence but mesmerizing in its gravity, has inspired some of the most impressive lines civilisation has produced, such as the words of Rumi:

This is love: to fly toward a secret sky,
to cause a hundred veils to fall each moment.
First, to let go of live.
In the end, to take a step without feet;
to regard this world as invisible,
and to disregard what appears to be the self.
Heart, I said, what a gift it has been
to enter this circle of lovers,
to see beyond seeing itself,
to reach and feel within the breast.

Love, as an overreaching and arch-like fundamental emotion, we suggest, can be seen to act as *a porous support* structure, while other positive emotions, as conceived in a fredricksonian broaden-and-build spirit, are *dispersed active materials*.

In other words, we suggest that reaction 1 on the positive emotion catalyst takes place at the interface of the love *support* and the *active* positive emotion *materials*. In general, in catalysis, the more porous the support, the more extended the surface area – the more effective the support. This is because the porous structure means more channels and pores in the material which enhance its total surface area. Following this metaphor, we suggest that the more *porous* the (love) support, the more effective the catalyst. The porosity of love can be seen to demonstrate itself in the myriad forms love can operate, for instance by being patient, kind, not-envying, not-boasting, not-proud, not-rude, not-self-seeking, not-easily-angered, by rejoicing-with-the-truth, by being protecting, trustful, hopeful, and always persevering, if we dare to apply, with due respect, the immemorial characterizations of 1. Cor 13 in this context.

In general a catalyst should have the following characteristics:

- *activity* on the certain specific reactions (involving reference to a measure of how fast one or more reactions proceed in the presence of the catalyst),

- *selectivity* to catalyse only certain specific reactions (involving reference to a measure of the fraction of the starting material that is converted to the desired product) and

- *stability* against deactivation, i.e. loss of activity (involving reference to the lifetime of a catalyst in a certain process).

Since the priorities in today’s industry require the efficient utilization of feedstock and energy with the lowest possible environmental impact, the relative order of importance of these functions is often considered to be selectivity > stability > activity (Hagen, 1999).

Let us illustrate these considerations using the first author’s primary area of research on biomass gasification gas clean-up. Both zirconia and nickel based catalysts can remove an undesirable tar molecule from the complex mixture of the gasification product gas. In this application the removal of tar, e.g. naphthalene ($C_{10}H_8$) and toluene ($C_7H_8$), is necessary in order to utilize the gas to any of its further use e.g. in energy production. However, the mechanism of these two catalysts is not the same, meaning that different reactions enable the tar removal from the gas. In the case of zirconia the main reaction is a two step partial oxidation of tar (Eq. 5 and 6 for toluene) (Viinikainen et al., 2009; Rönkkönen et al., 2009; Juutilainen et al., 2006) whereas over Ni mainly dry and steam reforming (Eq. 7 and 8) reactions occur (Hepola, 2000; Simell, 1997):

$$C_7H_8 + 5.5\ O_2 \rightarrow 7\ CO + 4\ H_2O \quad (5)$$

$$CO + \tfrac{1}{2}\ O_2 \rightarrow CO_2 \quad (6)$$

$$C_7H_8 + 7\ CO_2 \rightarrow 14\ CO + 4\ H_2O \quad (7)$$

$$C_7H_8 + 7H_2O \rightarrow 7CO + 11\ H_2 \quad (8)$$

Similarly, in the path towards flourishing, it is important to travel beyond the "one-size-fits-all terms like happy and good into precisely named emotional states" (Fredrickson, 2009). This means that diverse positive emotions as *active materials* will enable various kind of actions, thoughts, attentions to *react* with the individual. As a result, various emotions can contribute to several longterm building effects.

In heterogeneous catalysis, the reactions occur between species in different phases, e.g. gas-solid, liquid-solid, and liquid-gas. The most common of these is the gas-solid reaction, and we shall use it here for illustration. Most catalytic reactions follow the multi-stage process shown as an example in Fig 1. In this process the gaseous reactants 1) are transferred (by *mass transfer processes* such as diffusion) to the external surface of the catalyst particle and further in the catalyst pores leading to the reacting surface sites of the (e.g. metal) catalyst. Then, 2) the molecules *adsorb* on the surface of the metal because of what are known as *the attractive forces* between molecules and the metal. The reacting surface molecules are brought close enough, and 3) *the desired surface reaction* occurs. Once the reaction is over, the *reaction products* 4) are transferred (e.g. by diffusion) from the pores and from the surface and the catalyst is left unchanged. This is an ideal catalyst reaction: the rate of a reaction is increased and the catalyst is left unchanged. Thus, it can continue to participate in the same process again (Bowker, 1998; Hagen, 1999; Fogler, 1999).

Thus conceived, the positive emotions act as catalysts in the reactions between an individual and her attentions, thoughts and actions, resulting in *a temporarily broadened individual* as an intermediate result and as *an individual with building effects* in the longer run (a.k.a. flourishing individual) if the cycle is repeated. By "a temporarily broadened individual" we mean a subject that is temporarily more optimistic, more resilient, more open, more accepting, and more driven by purpose (Fredrickson, 2009, p. 91) than she tends to be before the intervention. By "individual with building effects" we mean a subject whose psychological strengths are thus affected more permanently.

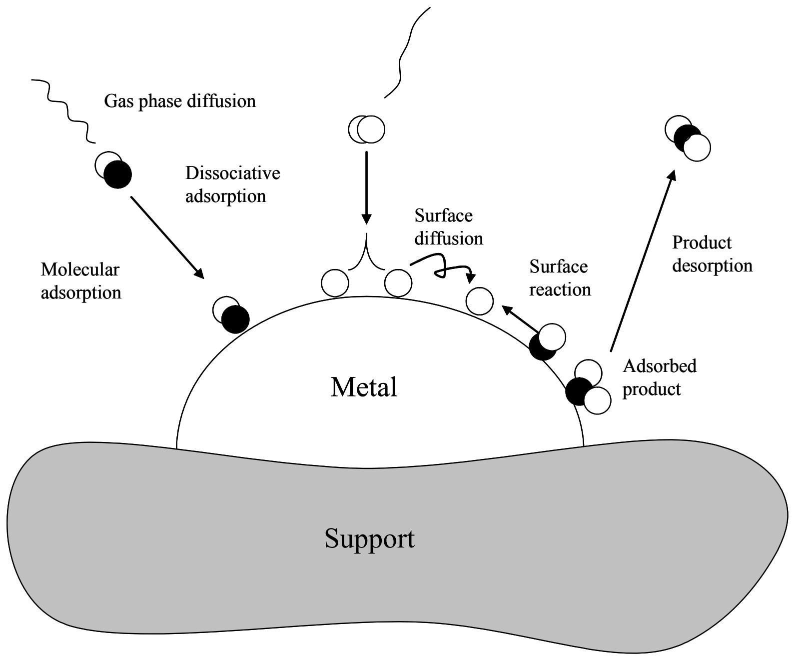



Figure 1. A heterogeneous catalytic reaction on the surface of the catalyst (Bowker, 1998).

We propose that the steps of *the catalytic system of upward spiral towards the flourishing of an individual* include both the momentary circle of broadening as well as its repeated cycles to be discussed shortly (and depicted in Fig 2). Furthermore, we suggest that systems intelligence (of self as a system) involves the ability to be mindfully (Langer, 1989) aware of the possibilities and feasibility of *the catalytic system of upward spiral towards the flourishing of an individual*.

The momentary circle of broadening is a temporary state, yet significant in its effects. People in a state of positivity have wider outlook, more ideas come to mind, more actions are viewed as possible and more creativity is experienced (Fredrickson, 2009).

We shall now pick up from a metaphorical, almost poetical description from Fredrickson in order to develop out chemistry-inspired reconstruct of the broaden-and-build theory and of Fredrickson's ideas on the upward spiral towards optimal functioning. In her landmark book *Positivity* Fredrickson writes:

> ”Positivity – whether it blooms as joy, serenity, or any other hue on your positivity palette – literally gives you a new outlook on life. This, as I've mentioned, is the first core truth about positive emotions. Imagine yourself as a flower your petals drawn in tightly around your face, if you can see out at all, it is only a speck of light. You can't appreciate much of what goes on around you. Yet once you feel the warmth of the sun things change… your petals loosen and begin to stretch outward exposing your face. You see more and more. Your world literally expands. Possibilities unfold.” (Fredrickson, 2009)

Setting this process in the conceptual frame of a chemical engineer yields a step by step process description or mechanism for the key reaction 1, which demonstrates how the mechanism of the reaction is different with the catalyst as opposed to without it. In general, the overall process by which heterogeneous catalytic reactions proceed can be broken down into a sequence of individual steps (as shown in Fig. 1) (Fogler, 1999). Furthermore, in order to understand and further develop and scale-up chemical processes, the mechanism and kinetics of the reactions need to be known. Representing the individual as "a flower bud", and the actions, thoughts and actions as "flower petals" the mechanism of the *summary reaction* 1 runs through the following stages:

1) *mass transfer* (diffusion) of the individual (marked as flower bud in Fig 2.) to the surface of the positive emotion from the state of neutrality or languishing ("the individual moves towards positivity and starts to feel the first signs of positive emotions"). Similarly occurs the mass transfer of attentions, thoughts and actions towards the positive emotion catalyst (marked as flower petals).

2) *adsorption* of the individual on the active site of the positive emotion. This creates an individual with an urge which is associated by positivity (in the sense in which e.g. play is associated with joy) (Fredrickson, 2004), which in turn creates *the attractive forces* for step 3 to manifest ("the individual starts to undergo the feeling of the positive emotions").

3) *dissociative adsorption* of attentions, thoughts and actions (marked as flower petals in Fig 2.) on the positive emotion because of *the attractive forces* made possible by the individual with a positively charged urge ("the individual's thoughts, attentions and actions start to get reoriented as a result of the positive emotions").

4) *surface reactions* on the positive emotion catalyst to manifest a broadened individual (marked as flower bud with the added petals in Fig 2.) ("the effects of the positive emotions upon the individual can be seen even by others").

5a) *desorption* of (the release of) the broadened individual from the surface of the active site of the positive emotion ("the individual moves on, as affected by the positive emotions to some extent and with the new thought-action repertoires they immediately give an opening for").

6a) *mass transfer* (diffusion) of the individual back to a neutral state and possibly again to the surface of a positive emotion ("the individual goes back to a neutral emotional state").

In addition to the one-time reaction path just described, the possibility of a higher-level reaction path also exists and can be described in the chemistry-inspired language for positive emotions. A higher-level reaction path follows when after step 4), instead of 5a) and 6a), the broadened individual *stays at* the stage of dissociative adsorption and thus continues to undergo the effect of the support material and of the positive emotion. The effects of the catalyst are multiplied as there is a loop from positive emotions to action-thought repertoires which repeats the reaction process on the surface of the catalyst. In other words, in the higher-order reaction the steps are:

5b) *dissociative adsorption* of broadened attentions, thoughts and actions on the positive emotion catalyst (marked as flower stems in Fig 2.); the broadened attentions, thoughts and action keep on being affected by the positive emotion catalyst ("the individual's thoughts, attentions and actions are more deeply reoriented").

6b) *surface reactions* within the broadened individual and her broadened specific thought-action-repertoires (marked as a flower with added petals *and stems* in Fig 2.) ("the broadened individual is building several long term effects upon the individual, which can be seen also by others").

7) *desorption*, the release of the individual from the active site ("the individual moves on, and the repeated feelings of positive emotions together with the new thought-action repertoires generate enduring social, physical or intellectual building effects which become part of the individual's transformed self"

8) *mass transfer* (diffusion) of the individual with building effects (marked as a flower with added petals and stems in Fig 2.) back to the neutral state and back to the circle ("the individual goes back to the neutral emotional state and has a chance to move again towards the positive emotion").

Building on the imagery of our petals-and-stems description, we can now articulate the upward spiral towards the flourishing of an individual. It can be conceived as a life-long process where loops of the momentary circle of broadening have the possibility to *add petals* to the individual's personal blooming while similarly the parallel loops towards longterm building effects have the possibility *to create stems of* flowering.

In principle, any step (mass transfer, adsorption, surface reaction or desorption) of a chemical catalytic reaction can become the *rate limiting step*, i.e., constraint upon the process. Indeed, the rate of the whole reaction can become severely limited by a particular step. Often in chemistry this means that the overall rate of reaction is equal to the rate of the slowest step in the mechanism. For this reason, it is important to know the rate limiting step so that the rate of the reaction could be increased. When the mass transfer steps are fast compared to the reaction steps, the concentrations in the near vicinity of the active sites are indistinguishable from those in the bulk fluid and the mass transfer does not affect the rate of the reaction. However, if the reaction steps are fast compared with the mass transfer steps, then mass transfer affects the reaction rate (Fogler, 1999).

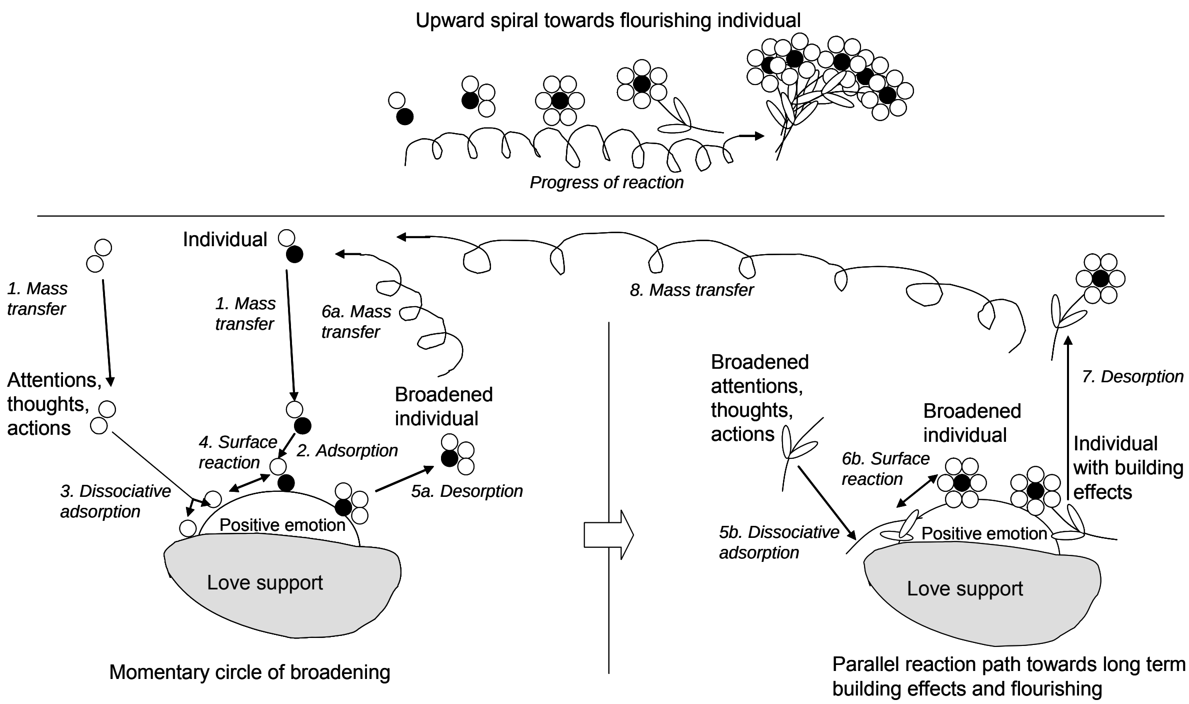
As an illustration, consider, an individual who moves by *mass transfer* processes towards positive emotion (step 1) and then *adsorbs* on the surface of the positive emotion (step 2). Then, in a state of positive emotion (such as joy) she might became an individual with an inner urge for action (in the sense in which e.g. joy can create the urge to play (Fredrickson, 2009)). When this action (play) is *adsorbed* (step 3), the individual is momentarily broadened resulting from the surface reactions (step 4 creating an *intermediate reaction product*). The broadened actions/thoughts/ attentions adsorb on the surface of the positive emotion because of the *attractive forces* between the adsorbed individual on the positive emotion and the broadened actions/thoughts/attentions. Thus broadened, the individual is brought together with more creative thoughts, attention and/or actions (e.g. to actions unrelated to play while still playing). Since the broadened effect is temporary, the broadened individual is *desorbed* from the surface of the positive emotion (step 5a) thus freeing also the positive emotion catalyst. And the individual *mass transfers* back to the neutral state (step 6a). "Just as day lilies retract when sunlight fades, so do our minds when positivity fades. Threatened with negativity, our minds constrict even further. As positivity and negativity flow through us the scope of our awareness blooms and retracts accordingly" (Fredrickson, 2009, p. 55.).

Notice, however, that at this point of the cycle, the individual can also choose to *adsorb* to the active site of a *negative* emotion, thus generating quite different reaction pathways. We can use a quotation from Fredrickson (2009, p 231) to illustrate the crucial dimension of choice of *the adsorption step*:

> ”Life gives us negativity on its own. It's our job to create positivity. Positivity is a choice - a choice we all need to make again and again, day after day… Your emotions are as far from random as they are from fixed by your genes… And the more you value positivity, the more often its upward spiral will lift you to new heights… The more positivity you seed and harvest, the better become your prospects for flourishing."

However, as Fredrickson rightly points out, "there is no limit, how often our minds can cycle through these expanded and retracted awareness" (Fredrickson, 2009). Furthermore, as empirically demonstrated (Fredrickson and Joiner, 2002): "positivity and openness feed on each other each reinforcing and catalyzing each other. This is the upward spiral that the positivity triggers in you". Thus, it seems that the momentary reaction cycles of broadening can start to catalyse themselves. In other words: the momentary reaction cycles of broadening enable a *parallel reaction path* towards *reaction products* of long term building effects and flourishing (e.g. in the sense in which play can build enduring physical (Boulton and Smith, 1992) and social (Aron et al., 2000) as well as intellectual problem solving resources (Fredrickson, 2004).

These considerations suggest that *the rate limiting step* in the catalytic system of upward spiral circle towards flourishing individual might well be step 2, *the adsorption* of an individual to the surface of a positive emotion. This includes the assumption that the concentrations of the reactants (individual and attentions/thoughts/actions) in the near vicinity of the active sites of the positive emotions are indistinguishable from those in the bulk fluid and thus, the mass transfer does not affect the rate of the reaction. In other words, it might be that positivity resides at all times near us, but we need to attach or *adsorb* on its surface. This observation highlights the role of the individual herself in the process of her flourishing. In a sense, the individual is only a decisive cognitive step away from what would enhance her personal flourishing. A step, which however should be chosen "again and again, day after day" (Fredrickson, 2009). This point of course will ring familiar to anybody who approaches it from the point of view of spiritual traditions that emphasise the momentous role an individual has in her own potential transformation.




**Steps in momentary circle of broadening**

1. Mass transfer of individual (from the state of neutrality) and attentions/thoughts/actions to the surface of positive emotion

2. Adsorption of individual on the active site of positive emotion (individual with positively charged urge)

3. Dissociative adsorption of attentions, thoughts and actions on the positive emotion

4. Surface reaction: individual with positively charged urge and attentions, thoughts and actions react into broadened individual

5a. Desorption: broadened individual desorbs from the positive emotion freeing similarly the active site of the positive emotion

6a. Mass transfer of the broadened individual to the state of neutrality with added petals of personal flourishing

**Parallel reaction path towards long term building effects and flourishing:**

5b. Dissociative adsorption of broadened attentions, thoughts and actions on the positive emotion

6b. Surface reaction: broadened individual reacts with broadened specific thought-action-repertoires to make individual with building effects

7. Desorption: individual with building effects desorbs from the surface of the positive emotion complex freeing similarly the positive emotion

8. Mass transfer of the individual with building effects to the state of neutrality with added stem of the personal flourishing

**Summary of the reaction**: individual + attentions-actions-thoughts ↔ Broadened individual + Individual with building effects (a.k.a. flourishing individual)

**Progress of the reaction:** repeated loops lead to flourishing individual as several petals of flourishing are added in parallel with several stems.

Figure 2. The mechanism of the catalytic system of upward spiral circle towards flourishing of an individual.

Table 1 summarizes various positive emotions when viewed as catalysts, with paradigmatic parallel attentions, thoughts and actions to contribute to broadening and to possible long term building effects (adapted from Fredrickson, 2003b; 2009). For example, a joy catalyst on the love *support* contributes to playing and creative actions in the short run and to enduring physical, social and intellectual resources in the long run. (Free play has been shown to have crucial impact upon children's social, emotional as well as cognitive development. Free play as child is connected to better adjustment in society, better stress handling capacity and even to smartness (Wenner, 2009).)

## Positive-Emotions-Catalysed-Reactions are Energetically Favourable

Why do we need the catalytic system of the upward spiral towards the flourishing of an individual and not just act rationally in a state of neutrality towards flourishing? It was suggested earlier that the reaction 1 is a *reverse equilibrium reaction*. This means that a reaction can happen in both directions and that there exists a condition where the products of the reaction are formed at the same rate at which they decompose back into the reactants. However, in everyday life we often encounter situations in which no movement towards flourishing is taking place and yet the *equilibrium state* of personal flourishing in the sense of reaction 1 has been achieved, neither. Somehow people can get stuck in their path to flourishing. This familiar phenomenon suggests that there exists a kinetic barrier within us for the reaction, meaning that a certain *activation energy* is needed for the reaction to occur. When *the kinetic barrier* is overcome, the path towards the flourishing individual "who lives within an optimal range of human functioning, characterized by goodness, generativity, growth, and resilience" (Fredrickson and Losada, 2005) is made possible. Furthermore, in *the reverse reaction*, the possibility emerges in which the flourishing individual will provide the appropriate thoughts, attentions and actions in line with a drive for human flourishing. In other words, the significance of catalysis as a process is enormous, if one can make it happen.

The magnitude of the significance of catalysis, when it takes place, is a point we cannot overstate. Recall what Santen et al (1999) point out in the preface of their book *Catalysis: An Integrated Approach*:

> ”Chemical reactions, for which one would expect half-life times as long as centuries, can be accomplished in minutes to hours with the magic power of a mysterious black box containing a catalyst."

This point perhaps illustrates the striking power of positive emotions as triggers of change.

We shall now turn to another important aspect of our analysis of positive emotions as informed by the chemistry metaphors – the concept of energy.

Table 1. Positive emotions as catalysts to broaden-and-build an individual towards optimal functioning (adapted from Fredrickson, 2003a;b; 2009).

| Catalyst | Features | Attention, thoughts, actions to contribute broadening | Long term building effects |
|---|---|---|---|
| Joy | Feeling playful, bright, light, spring in the steps, inner glow | Play, pushing limits, being creative | Enduring physical, social stress handling, intellectual resources |
| Pride | Upright posture, slight smile | Sharing news from achievement with others, envisioning of new achievements in future | Fuels self-esteem, and achievement motivation |
| Interest | Sense of possibility or mystery, fascination, feeling open and alive | Exploring, taking in new information and experiences, expanding the self, learning more | Knowledge and intellectual complexity |
| Content-ment | Feeling that everything is right as it is | Savouring current life circumstances, integration of the circumstances into new view of self and world | Produces self-insight and alters worldviews |
| Gratitude | Feeling of appreciation of something that has come to our way | Creative and wide array of actions to promote the well being of other people | Builds and strengthens social bonds and friendships, builds social resources, motivates permanent faithfulness and spiritual growth |
| Love | Contains and overlaps all the other positive feelings | Exploring, savouring, and enjoying people and life at large | Inspired and uplifted interactions to build and strengthen social bonds and attachments |

In chemistry, *bonds* have to be weakened in order to allow for the change of one substance into another, and this involves the input of *energy*. To increase the rate of a reaction you need to increase the number of *successful collisions* of the reacting particles. Collisions only result in a reaction if the particles collide with enough energy to get the reaction started. This minimum energy required is called the *activation energy* (Fig. 3). Remarkably, a catalyst provides an alternative route for the reaction. *That alternative route has a lower activation energy resulting in an increase of the reaction rate*. We believe this point is absolutely vital to appreciate, and a strong indication of the usefulness of the chemistry metaphor in the connection of the study of positive emotions and flourishing.

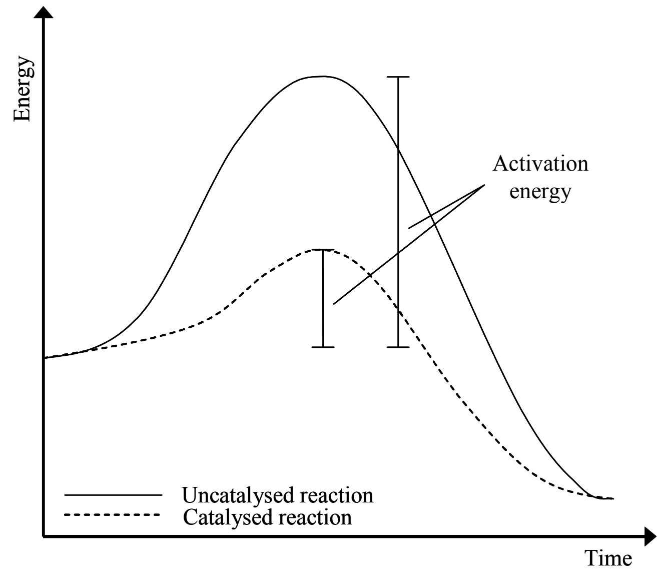



Figure 3: Generic graph showing the effect of a catalyst in a hypothetical exothermic chemical reaction. Uncatalysed reaction is shown with the upper line and catalysed reaction with the lower line in the graph.

As in any catalytic process, the positive emotions catalysts are ideally not consumed or changed during the process but only facilitate the kinetic effect of cognitive broadening and self growth. This means that the potential of an individual to react according to the reaction 1 is significantly accelerated on top of a platform of positive emotions as compared to a situation without them (non-catalysed conditions). The non-catalysed conditions would mean actions, attentions and thoughts in a state of emotional neutrality (perhaps through emotionally neutral rational thinking) towards flourishing individual.

Furthermore, this change in the rate of reaction, vital for catalysed reactions and for the functioning of positive emotions as reconstructed here, is made possible because the mechanism of the reaction is sharply different when the catalyst is involved and when it is not involved. The path to the goal of flourishing with positive emotions is energetically favourable compared to the path without positive emotions.

Why is *the activation energy* and *the kinetic barrier* within us lowered by positivity? Energy is a semi-intuitive concept often alluded to in human sciences, organizational research and their applications. Differentiated from the physical concept of energy, energy in human contexts can be approached in a number of ways but here we find it useful to view it as "a type of positive affective arousal, which people can experience as emotions – short responses to specific events – or mood – longer-lasting affective states that need not to be a response to a specific event" (Cross et al., 2003). Since energy is a reinforcing experience, people attempt to enhance, prolong, or repeat the conditions they perceive to be increasing it. Likewise, people try to diminish or avoid the circumstances that are perceived as decreasing their energy (Collins, 1993). Furthermore, since energy is a positive affect, people who feel high levels of energy have a tendency to view events positively and to expect positive events to occur (Arkes et al., 1988).

It has been suggested that the energy for human actions comes from four main wellsprings: body, emotions, mind and spirit. Positive emotions contribute to the quality of energy; when people are in a state of positive energy, they perform as their best (Schwartz and McCarthy, 2007). Fredrickson observes in her book (2009, p. 226) that based on her 20 years of studies on positive emotions, positive experiences outnumber negative experiences in their relative frequency by about 2 to 1 with most people. At the rate of 2-1, life is not particularly distinctive. When the ratio is raised to 3 to 1, a major transformation occurs, "you have stepped up to a whole new level of life". The ratio of 3-1 is the tipping point of flourishing, Fredrickson suggests. Many researchers believe that at the fundamental level, positivity alters the brain and affects the way the individual interacts with the world (Ashby et al., 1999). This is where the catalysis starts to take place.

## Positive Emotions as Catalysts Towards Systems Intelligence

The research of Fredrickson and her associates have demonstrated that people who experience positive emotions take more easily a "big-picture" view, attending to the general outline of images rather than to the details (Fredrickson and Branigan, 2005). They are more open to new information, are more creative as more ideas and thoughts come into their mind. Research suggests that positivity enhances broader flexible cognitive organisation and ability to integrate diverse material (Isen, 1990). With positive emotions, the scope of the attention is widened (Fredrickson and Branigan, 2005).

These key features of positive emotions are vital for systems intelligence. As is customary within the systems thinking movement, the systems intelligence approach wants to find ways to articulate the human strive towards the big picture as opposed to the details. Anything that enhances the subject's abilities to see the forest for the trees is welcome news for systems intelligence. Some of that is bound to be related to the subject's cognitive realm, but not all, as a subject might well approach a whole in the sense in which a conductor in the living and emerging presence of the performance of a symphony. Many of the skills that are called upon in *that kind of extended grasping of wholes* are likely to be emotion-related – and are part and parcel of a fredricksonian broaden-and-build process.

Indeed, anything that increases an individual's skills to adapt successfully to wholes and to conduct productively "processes of systems thinking" (using the apt phrase of Luoma, 2009), is welcomed by systems intelligence. Many of the parameters to be encountered are likely to have a strong subjective and intersubjective twist to them, as opposed to the positivistic objective. This introduces a powerful playing ground for positive emotions. From the point of view of systems theorizing, as well as the understanding of emotions, we believe this point is critical to appreciate. It is vital to bring the research on emotions and the research on systems to bear on one another. (On this theme, see also Hämäläinen and Saarinen, 2008 and Luoma et al., 2008.)

Many forms of systems thinking tend to emphasise the objective and explicit forms of knowledge, with the idea of describing systems from outside as objective phenomena. This is fine in many contexts, but typically will amount to disregarding emotions along with other subjective phenomena. Yet it seems obvious that emotions are particularly relevant for humans precisely because they allow the subject to sense the environment and the situation, other human beings and their intentions etc., more holistically and acutely. The subject can adapt more successfully, because she senses a possibility in the air, or a threat around the corner, even when she cannot tell what it is. More generally, as pointed out in the systems intelligence literature, many key aspects of the functioning of the systems with respect to which the subject is systems intelligent might not be *cognitively accessible* to the agent in question. In order for an agent to act systems intelligently in a system she need not know the system in its objective characteristics and might not be in a position to represent or describe the system for others. As Hämäläinen and Saarinen (2004, 2008) emphasize, for an agent to act intelligently with a system it may be enough for a human to have a "feel" of the system. Indeed, such a feel of a system might well be forthcoming well before any rational understanding of it, a point reinformed by infant research. In all of this emotions loom large. We venture to suggest that a key way in which positive emotions "broaden-and-build" is by extending the individual's ability to *feel systems*, be they contexts, situations, the intentions of other people, or oneself as a whole, etc. Positive emotions broaden-and-build the sensitivities with which humans *tune to their systemic environments* and thus broaden-and-build the individual's capabilities to adopt and to thrive.

We are suggesting that positive emotions not only expand the cognitive mindscape of human subjects but also – and importantly – their *systemic interface* with their environments. Positive emotions bring new possibilities into the individual's scope of orientation and realm of sensibilities, thus enabling a wider feel of systems and more intelligent actions within those systems. This is remarkable indeed, as all action can be conceived as taking place within systems (environments, contexts, etc). Not only do positive emotions broaden-and-build the individual's long term capabilities but also her immediate skills of adapting and succeeding with the systems at hand.

An important aspect of such an extended feel of systems relates to the individual's ability to link with other people. That capacity has been demonstrated to be enhanced by positive emotions. For instance, positive emotions enable people to find more varied and adaptive ways to use their social support network (Cohn and Fredrickson, 2006).

These observations are reinforced by the fact that positive emotions increase individuals' use of adaptive reframing and perspective-taking coping skills (Fredrickson and Joiner, 2002). As a result, positive emotions offer a support structure for the cognitive aspects of an individual's system intelligence as it operates: "The tools to higher awareness via systems intelligence include the reframing and rethinking of own thinking regarding the environment and feedback structures and other systems structures of that environment. " (Saarinen and Hämäläinen, 2004)

As C. West Churchman once put it, systems approach starts when you perceive the world through the eyes of another person (Churchman, 1968). Churman's point is largely cognitive in nature, but it can be interpreted more widely. According to empirical studies by Fredrickson and her colleagues, positive emotions broaden the sense of self in connection to others and thus make people feel a self-other overlap more easily as well as "oneness" with the people close to themselves and with people in groups. Positivity shifts from the "me" view to more overlapping view of the "we". (Waugh and Fredrickson, 2006). As a result, the individual understands herself easier as a part of the whole, the influence of the whole upon herself and the influence of herself upon the whole, all chief aspects of systems intelligence (Saarinen and Hämäläinen, 2004).

Systems intelligence amounts to intelligent actions in the context of complex systems involving interaction and feedback (Saarinen and Hämäläinen, 2004). One potential obstacle here is created by various forms of separateness and non-connectivity with other people. But positivity has been shown to act as a counterdose to disconnectivity. For instance, positive emotions facilitate changes from divisive group attitudes into inclusive group identities (Fredrickson, 2009 p. 69). Indeed, positivity helps individuals to stay open and alter the view towards strangers. Remarkably, people under positivity recognize people of different races in ways more similar to their own race, meaning that we are able to see the person behind the racial label. Positive emotions thus help to avoid the trap where all the Chinese look similar in the eyes of Europeans and vice versa (Johnson and Fredrickson, 2005). It is easier to be systems intelligent with the help of positive emotions because you more easily link with other people emotionally and cognitively.

The long list of systems intelligence relevant inducements of the broadening effects of positive emotions include:

- Creative and optimal solutions to everyday problems become easier (Fredrickson and Joiner, 2002).

- Marital satisfaction is highly correlated to the level of feeling self-other overlap between the couple (Aron, 1992).

- Relationships in general are closer, longlasting, attracting loyalty instead of bitterness (Fredrickson, 2009)

- Broadening builds "both strategic alliances and globe-spanning friendships" (Fredrickson, 2009).

- Managers with greater positivity are more accurate and careful in making their decisions and more effective interpersonally, they infect it to the group members making a better coordination among team members and reducing the effort needed to get their job done (Sy et al., 2005; Staw and Barsade, 1993).

- People who come to the bargaining table with a cooperative and friendly spirit – "riding on positivity" – (Fredrickson, 2009), in contrast to negative or neutral emotions, are more likely to incorporate a future business relationship in the negotiated contract (Kopelman et al., 2006).

- Organizational groups tend to start working on "we" principle towards common goal (Fredrickson, 2009)

It is natural for people to desire improvement and a change for the better. As observed in the change literature, often a major change can result as a consequence of a minor initial move and with minimal conscious effort (Saarinen and Hämäläinen, 2004). What is the role of positive emotions in bringing about major output with minor input? We believe a paradigmatic type of major-change-through-minor-impact is one where a small initial change enhances the positive emotions of the participants, in many cases highly irrationally and beyond the objective facts, with the result that *the catalysis described above starts to unfold*. (Such logic is clearly at work in "the emergence and amplification of small change" analysed by Plowman et al., 2007.)

Based on the above examples which do not intend to be comprehensive, positive emotions seem to fuel and broaden the individual and open the way for the person for Systems Intelligent actions and behaviours. The proposal here is that positive emotions are *catalysts* for Systems Intelligent behaviours and actions. In this view the momentary reaction circles of broadening produce a momentary Systems Intelligent observer (analogously to the broadened individual of Fig. 2).

Systems intelligence aims to identify the visible and invisible parts of environment conceived of as a system and to work with those systems productively (Saarinen and Hämäläinen, 2004). Systems intelligence often involves a "thinking of thinking" process where the person re-thinks his own thinking. The role of mental models and other mindset-related matters in human affairs and actions is generally acknowledged (see e.g. Senge, 1990). The vital role of emotions is less often paid attention to, while there is little doubt of its significance for our decisions making processes and modes of operating (Frijda, 1988) Even less focus is directed on the fact that humans are systems, i.e. wholes the structure of which cannot be reduced to the functionings of its parts. To be a human being is to be a complete human being and one intertwined with "strange loops" (Hofstadter 2007).

Thus, it can be conceived that the catalytical system of Fig. 2. might start to produce a self-sustaining positive loop with Systems Intelligent building effects. A remarkable outcome of the catalytic system described in Fig. 2 would be an individual with Systems Intelligent building effects. The catalytic system of Fig. 2. would amount to *the upward spiral of positively catalysed systems intelligence*.

## Bad is Stronger than Good and Systems Intelligence is Even Stronger

One aspect of the life of a chemist is that while ideally catalysts should last forever, in actual reality they *get damaged*. Use wears them out, with the result of *deactivation*, i.e., the loss of activity of the catalyst. The causes of deactivation are basically three-fold: chemical, mechanical and thermal. The mechanisms of the deactivation can be grouped into six: (i) poisoning, (ii) fouling, (iii) thermal degradation, (iv) vapour compound formation accompanied by transport, (v) vapour–solid and/or solid–solid reactions, and (vi) attrition/ crushing. The groups (i), (iv), and (v) are chemical in nature while (ii) and (vi) are mechanical (Bartholomew, 2001).

Positive and negative emotions cannot fully coexist, since the thought-action repertoire cannot be broad and narrow at the same time (Fredrickson, 2004). From an evolutionary perspective, survival and reproduction depend on giving priority to avoiding bad rather than pursuing good (Baumeister et al., 2001, p 360), thus suggesting that the negative emotions have more power compared to positive emotions (Baumeister et al., 2001). However, according to Maslow's motivational theories, the positive feelings begin to direct behaviour when the deficiency motives such as hunger, deprivation and danger are satisfied (Maslow, 1968), and much of Fredrickson's work amounts to unveiling the evolutionary and motivational significance of positive emotions. It is indeed clear that both negative as well as positive emotions are evolutionarily crucial; negative emotions as narrowing the thought-action repertoires in order to react to an immediate threatening situation and positive emotions for the benefit of growth and optimal functioning.

In our lives in contemporary technological consumer societies, even if natural threats are rare in everyday life, our inbuilt and evolutional *tendency to focus upon the minimizing of bad* is still strongly functioning within us as a gift of evolution. Using again the chemistry inspired metaphors of the discussion above, one could say that to the extent that "bad is stronger than good", we have a tendency to close our petals from light and to close ourselves in *nonporous* negativity (Fig. 4). In catalytic terms this can be described as the *sintering* of the *support* of the positive emotion catalyst, which amounts to reducing the *surface area* of the (love) *support* where the positive emotions could *adsorb*. This is analogous to the case where chemical catalysts sinter, lose their porous structure, thus leaving less active space for the reactions because of prolonged exposure e.g. to high gas phase temperatures (Richardson, 1989).

Another usual deactivation mechanism is *coke formation* (Fig 5A) where carbon may get chemisorbed strongly as a monolayer or physically adsorb in multilayers and in either case block access of reactants to metal surface sites, or totally encapsulate a metal particle and thus completely deactivate that particle, and plug pores such that the access of reactants is denied inside these pores (Bartholomew, 2001). The concept of *coke formation*, we propose, is quite suggestive as a metaphor for the understanding of the obstacles to positive emotions. Negative emotions, especially fear, can be seen as responsible for the *coking* effects on positivity. Fear bonds with *an active site* as well as with the love *support* of the positive catalyst to block the catalytic function.

Another usual deactivation mechanism is *poisoning* (Fig. 5B). Poisoning takes place as the strong chemisorption of reactants, products or impurities on the active sites which are otherwise available for catalysis (Bartholomew, 2001). As in the case of Fig. 5B, sulphur (S) has adsorbed on the metal, thus blocking the activity of this particular metal site.

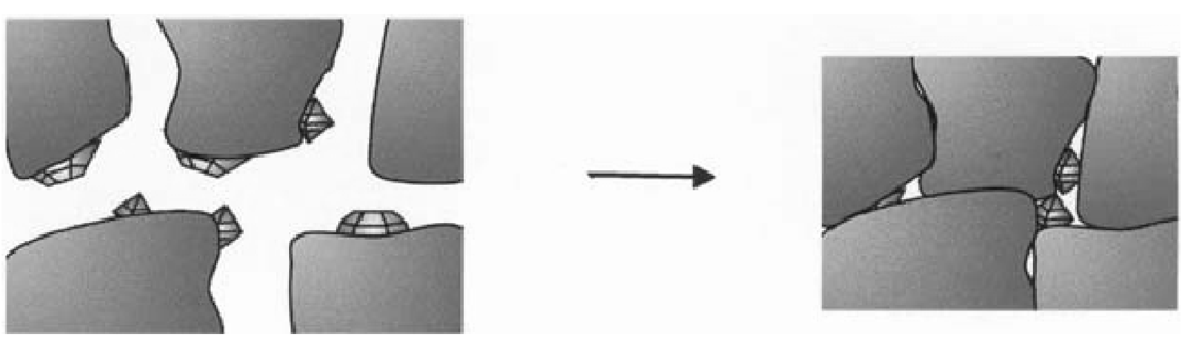


Figure 4. Deactivation mechanism by sintering (Lassi, 2003). The active metals which potentially could serve as catalysts are marked as "diamond structures" on the porous support material.

The limitations to the growth of systems intelligence as described by Saarinen and Hämäläinen (2004, p. 69) include: reactionary mindset, static, mechanical improvement command- and control kind of and no-growth modes of thinking, elementalism, individualism, and cynism. These negative tendencies do seem to function like the catalyst *poisons* depositing on the positive emotion catalyst by the time on stream and thus limiting the surface area for the reactions of *the upward spiral of positively catalysed systems intelligence*.

From the point of view of chemistry, coking is a particularly serious phenomenon. The significance of coking is described powerfully by Bartholomew (2001):

> ”Finally, in extreme cases, strong carbon filaments may build-up in pores to the extent that they stress and fracture the support material, ultimately causing disintegration of catalyst pellets and plugging of reactor voids”

Likewise, when seriously *coked* by negativity the love *support* of the positive emotion catalyst would not have *porosity* or space for activity and in extreme case could lead to disintegration and self-plugging. It could be further thought that if love is the support material for *the upward spiral of positively catalysed systems intelligence*, then the support material for the *systems of holding back* (Saarinen and Hämäläinen, 2004, Hämäläinen and Saarinen, 2007a, 2008) might be fear as *deposited* as *coke* on the original love *support*.

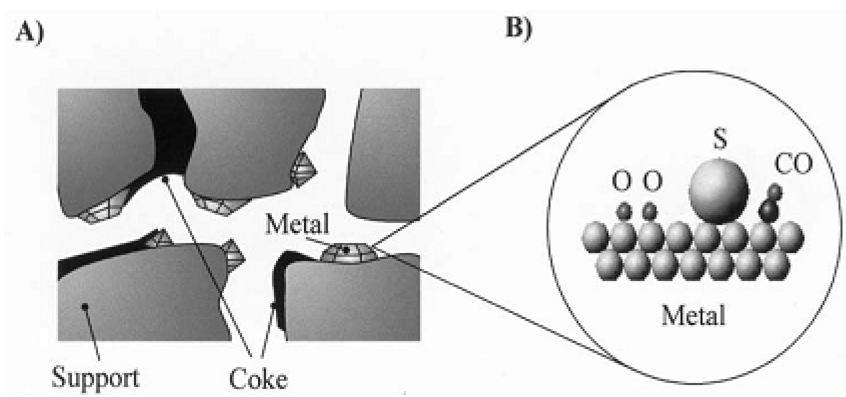



Figure 5. Deactivation mechanisms by A) Coke formation, B) Poisoning (Lassi, 2003).

Luckily, it is also possible to *regenerate* a catalyst. For example, coke depositions can be burned in the air and thereby the catalyst activity can be regained. Similarly, one could envision ways to regenerate the activity of a love *support*. It is indeed inspiring to think of fear as coke to be burned with the flames and air of positivity to reveal the original *support* in its purity. Likewise one could study means to minimise the *sintering* phenomena. One might be tempted here to speculate with the possibility of stepping beyond the current *system of minimizing of bad* and towards *the evolution of positive mindfulness*. In the latter, we would increase the degree of mindfulness of our positive systemic endowment, and be particularly mindful to fight the catalytic *coke* of negativity as well as the *poisoning* of the love support, thus paving the way for flourishing.

In most approaches to human growth reframing and rethinking of one's own thinking looms large. Human beings can observe their thinking and the effects of that thinking on what follows. There is the possibility to become more acutely aware of flourishing-generating modes of thinking as well as of the accompanying practices. Remarkably, according to recent research, randomly chosen working adults who were assigned to practise loving-kindness meditation, increased the daily experiences of positive emotions, which further increased wide range of personal resources such as increased mindfulness, purpose in life, social support and decreased illness symptoms (Fredrickson et al., 2008). Moreover, Fredrickson offers an impressive toolbox for both decreasing negativity and increasing positivity in her book *Positivity*. In our framework, reducing negativity means cutting down the *poisoning* and *coking* agents for the catalyst activity. The techniques that Fredrickson (2009) suggests seem appropriate here (disputing negative thinking, breaking the grips of rumination, becoming more mindful with the use of meditation techniques, assessing media diets, finding substitutes for gossip and sarcasm and learning to deal with negative people with different techniques). We encounter here efficient ways to increase the positivity ratio, through the cycles of Fig. 2.

How could we speed up the overall reaction 1 in line with our process description in Fig. 2? We have suggested that the rate limiting step of the whole process might well be the *adsorption* on the positive emotion catalyst. Fredrickson's list of techniques for increasing positivity could be interpreted as a toolkit for increasing the *adsorption* on the surface of the positive emotion. The relevant techniques include: finding positive meaning in situations, savouring goodness, being kind to others, following your own passions, dreaming of the future, connecting with nature and others, applying your strengths in every day situations and open your mind and heart via meditation practices (Fredrickson, 2009). It is worth noticing the strong presence of life-skill-like and accessible-to-all elements in Fredrickson's list. The tools relate to the fundamentals of what it means to be human, as opposed to being formally trained or being strong in academic competencies. Objective knowledge does not dominate. Here one is reminded of a key emphasis of the systems intelligence approach in its desire to do justice to those aspects of human situational action capabilities that point beyond what can be known or grasped in objective terms. Laugher and humour, two channels of everyday systems intelligence, bear a family resemblance to Fredrickson's list. "Systems intelligence is about compassion and love that makes good pragmatic sense" (Saarinen and Hämäläinen 2004 p. 68).

As already suggested, Fredrickson's theory of positive emotions can be seen as an articulation of the catalytic nature of positive emotions towards human flourishing. The systems intelligence perspective is a theory of the positively tuned, situational, action-based, whole-and-system-oriented, sensibilities based nature of the human condition. As such, it is natural to assume that the systems intelligence perspective builds upon the functionings of the human catalysts for human growth and flourishing whatever they might be. Those catalysts, to the extent they exist and operate via positive emotions, are likely to be only partially accessible to introspection and available to the subject's objective grasp. What is the nature of the skill set of a subject who is able to use positive emotions as a broaden-and-build reservoir in her catalytic processes towards growth? Nothing overtly reliant on system 2 of Stanovich and West (2000) only, we suggest!

Instead, the intelligence that carries the subject day in and day out, indeed since early infancy, will involve rich reliance of sensibilities, intuitions, subjective factors and intersubjectivity skills that positivistically oriented scholars have typically bypassed and dismissed. It is those aspects of the human endowment that the systems intelligence theorists have time and again highlighted. As we have tried to suggest in this paper, that systemic endowment assigns a key role for positive emotions. Positive emotions broaden-and-build human flourishing in the dimension of systems intelligence.

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Chapter 8

# Being Individually Together is Systems Intelligent: Lessons from Volunteerism Research

*Anne Birgitta Pessi*

*This essay brings into dialogue the concept of systems intelligence and the scientific empirics of volunteering. The empirical section presents a phenomenological study that focused on individual-level volunteer motivation and the experience of volunteering. This study produced an octagon model of volunteer motivation – one that can be captured into the expression `individually together´. In the light of these findings the article proceeds to ponder the power and potential of the system called volunteer work from three perspectives: 1) what does the system generate, 2) how does the system a mould human beings, and 3) what kind of `in-between´ does the system endors. It is further suggested that the social system of volunteer work produces novel systemic intelligence by both promoting social interaction of individuals and by widening the other-centred as well as positive horizons of individuals. Concluding discussion focuses on further applications of the approach.*

## Introduction

With this essay[21] I aim to bring into dialogue the concept of systems intelligence and the scientific empirics of volunteering.[22] Research on volunteering takes as its point of departure the motivation to volunteer and the experience of volunteering, subjects that have

[21] The author wishes to warmly thank Professor E. Saarinen for the most insightful comments to previous versions of this text!

[22] The discussion on volunteering in this essay is based on my previous empirical phenomenological studies with Finnish church social work volunteers (see, particularly, Yeung 2004a). I define volunteering as a helping action by an individual that is conducted out of free will and without pay22 in an organizational context. Van Til (1988, p. 6), for example, has defined volunteering as the "helping action of an individual that is valued by him or her, and yet is not aimed directly at material gain or mandated or coerced by others". Three specifications are needed concerning my definition in relation to the van Til´s. First, I include the "helping action" but understand it broadly to include both social work and other activities that a person does for the benefit of others. It must also be noted that "others" might include the volunteer's own personal benefits. Second, I omit "valued by him or her" from the definition as being imprecise and, to a certain extent, already implicitly present in the formulation "helping action". Third, I add "in an organizational context" to the definition. This reflects both the Nordic societal context, and the fact that van Til´s definition includes even helping one´s relatives and family members.

attracted interest and been addressed in a number of empirical studies.[23] So far the interconnections of volunteering and systems intelligence have not been discussed in the literature. The aim of the present paper is to break into that fresh territory.

Systems intelligence combines human sensitivity and engineer thinking and aims to integrate the scientific and humanistic traditions. It concerns intelligent action that engages with situations and contexts considered as interactional wholenesses with subtle systemic feedback mechanisms. Human life and life world is considered from the point of view of various systemic, interactional wholenesses – and indeed in weft of wholenesses. Human beings are considered to have an instinctive, action-oriented, adaptive, holistic, relational capability to face their environment from the viewpoint of engagement. Such ability allows humans connect with complex feedback mechanism. (Hämäläinen and Saarinen 2008, pp. vii–ix; Hämäläinen and Saarinen 2004, pp. 3–4; Saarinen et al. 2004, p.7) This fundamental ability is the focus of systems intelligence. Systems intelligence relates to the wider perspective of systemic thinking (e.g., motivational systems theory, MST, by Ford, on which more below). However, in relation to, for instance, the intersubjective systems theory (IST)[24] by Stolorow et al., systems intelligence approach allows us to further understand particularly how to act in intersubjective social situations.25 (Martela and Saarinen 2008, p. 204–205) Systems intelligence approach recognises the significance of first-person-related subjectivistic aspects of human endowment as fundamental to human systemic engagement (Hämäläinen and Saarinen 2008, p. ix). Furthermore, this approach appreciates the "everyday subtleties which continually mould the system we are a part of" (Luoma 2007, p. 281).

One could perhaps say that systems intelligence allows us to bring two levels of human life – and of analysis – into dialogue. On the one hand, the approach emphasizes the construct of a "system" as fundamental. Thus the systems intelligence perspective emphasizes that (1) *systems* always need to be considered. But at the same time, the systems intelligence perspective wants to emphasize: (2) an *individual* (be it a human being, an institution, et cetera) must never be left out of focus. The point is to reflect these two dimensions at the same time. It is assumed, therefore, that the two can relate to one another productively and adaptively – intelligently. Thus, intelligence (be it social, cognitive, emotional, et cetera) must also be taken into the focus. The overall focus of the systems intelligence approach is both in the system and on individual(s).

[23] Previous empirical studies on volunteer motivation have shed light on a number of aspects, usually concentrating on a particular perspective or group, such as the motives of young volunteers (e.g., Avrahami and Dar 1993; Hustinx, 2001; Schondel and Boehm 2000; Serow 1991) or of elderly volunteers (e.g., Chappel and Prince 1997; Morrow-Howell and Mui 1989; Okun et al. 1998) or, e.g., social service volunteers (e.g., Omoto and Snyder 1993; Chambré 1995; Jakob, 1993). There are also a number of studies, often surveys, which have considered volunteer motives as one of their focus among others (e.g., Gaskin and Davis Smith 1995; Sokolowski 1996). For further examples of volunteer work studies, see Yeung 2004a; 2004b.

[24] E.g., Stolorow and Atwood 1992; Stolorow et al. 2002.

[25] The authors also note that, on the other hand, the IST then makes us more aware of the subtleties of the context which opens possibilitie to become more systems intelligent. It is, indeed, a positive, synergetic cycle of two approaches. Both approaches also underscore both human interpretation and intersubjectivity.

Possibilities to apply the systems intelligence framework to both conceptual and empirical studies are numerous; this is evident also in the various fascinating publications[26] based on the approach. Concerning volunteering, the approach of systems intelligence is indeed of great interest. Three particular points of departure (Saarinen et al. 2004, pp. 7–8) can be noted, based on the knowledge of previous studies on volunteer work and of the phenomenon of volunteering itself:[27]

- Holistic viewpoint
  - focus on human
  - focus also on whole, on an entirety

- Constructive, positive way of looking at phenomena
  - potentials rather than obstacles
  - individuals who wish to succeed together

- Emphasis also on individual responsibility.

The initial impression is that in relation to volunteering systems intelligence offers a potentially fruitful view of the human being as a volunteering subject. In particular, from the point of view of volunteering research, it is natural to perceive individuals as having latent potentials and being more generous and enthusiastic than what is often expected − a view also emphasized in Saarinen's "positive philosophical practice" and "philosophy for managers" (see e.g. Saarinen 2008). I personally believe that the ability of individuals to inspire others – and to be inspired by others – is virtually limitless. As, for instance, great spiritual traditions emphasize and research demonstrates, human beings want to leave a meaningful life.

What is particularly important to realize is that humans are relational beings (see e.g. Fogel 1993). They need connection to others for their growth and in particular in order to be fully inspired (Saarinen et al. 2004, pp. 9–10). We do it anyway but typically not to the full. As Hämäläinen and Saarinen (2007, p. 301) have concluded: "World will be a better place if more people become mindful of their systemic endowment and start to make more use of what they've got". This, as they note, refers us to consider our immediate everyday lives as well as the collective life of mankind.

*From the point of view of volunteering research, it is natural to perceive individuals as having latent potentials and being more generous and enthusiastic than what is often expected.*

The thread running through all my previous research has been the theme of *meaningful life of an individual in a social context*. In my earlier work (e.g., Pessi 2008) I have argued that social ties form the basis of human happiness and contentment; individuals are indeed interested in the welfare of others, not only their own; they are willing to invest time and money for common purposes; and possibilities for constructing deepening social solidarity

[26] E.g., Hämäläinen and Saarinen (eds.) 2008; Hämäläinen and Saarinen (eds.) 2007; Luoma 2009; Luoma et al. 2008.

[27] Further, e.g., review of previous literature, see Yeung 2004b.

truly exist. The key idea of the present article is to provide a meta-level analysis which seeks to study the extent to which the systems intelligence approach resonates to the empirics of volunteer work.

## Empirical Approach: Phenomenology, Motivational Systems Theory and Systems Intelligence

The focus of this section is to present the approach of one particular study that focused on individual-level volunteer motivation and the experience of volunteering. This empirical study[28] in focus applied descriptive phenomenological analysis to volunteer motivation. Several modifications of philosophical phenomenology have emerged. Notwithstanding this, most phenomenological inquiries exhibit the following characteristics: 1) epoché – setting aside initial biases and prejudices, 2) description – the primary aim of describing, not explaining, and 3) equalization – the avoidance of hierarchies and considering items of description as initially of equal significance. (Ihde 1977; Grossmann 1984; Spinelli 1989) Descriptive phenomenology focuses on situations in which meanings and values are experienced as phenomena. Such phenomenology has a human function in that it can provide our existence with an extended sense of the world, "the discovery of the life world", as well as a deepened sense of ourselves. (Spiegelberg 1975, pp. 60–61) Such a goal – to deepen one's understanding of self and the world – resonates strongly with the systems intelligence approach. Furthermore, the view of human nature applied in the current research is in line with the view by Giorgi (1985, pp. 74–75): phenomenological psychology emphasizes that the nature of subjects as societal, historical beings includes the role of "relevant others" as well as "the personal past".

What is then the phenomenon of concern to the present study? Is it individual motives, experiences and the meaning of volunteering, or the phenomenon of volunteer motivation? The focus is on the phenomenon of volunteer motivation *an sich*. The interview data includes both descriptions of experiences of events as they had occurred as well as people's interpretations of those experiences. In order to conduct phenomenological data-determined analysis on volunteer motivation, a flexible and holistic concept of motivation[29] is needed. To that effect, I have used Ford's (1992) motivational systems theory (MST). This theory is designed to represent all three traditional human motivation phenomena: direction, energization, and regulation of behavior. Ford developed the MST stressing "the need to integrate separate but generally compatible ideas into a systematic understanding". The MST is based on a general theory of human development and functioning, D. Ford's (1987) living systems framework, a holistic theory and conceptualization of human beings as self-

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[28] In detail, see Yeung 2004a.

[29] Early theories of motivation viewed humans as reactive organisms obeying their internal and external forces, such as needs (e.g., Maslow 1970), drives (e.g., Miller 1951), ad instincts (e.g., Freud 1926), theories emphasizing stability-maintaining mechanisms. The next stage in motivation theorizing included three new aspects. First, the theme of self-evaluation appeared in self-worth theories, such as those of Harter (1990). The second innovation was personal agency beliefs as in Deci and Ryan's (1985) self-determination theory. The third new approach included concentration on cognitive factors in theories such as cognitive dissonance theory (e.g., Festinger 1957). McClelland (e.g., 1958; 1989) was the first to include the three main motivational components (direction, energization, and regulation of behavior) into a theoretical view of motivation.

constructing adaptive control systems. Such an overall perspective, naturally, fits very well also to the systems intelligence approach. The MST definition of motivation is as follows: motivation consists of the organized patterning of personal goals, emotional arousal processes (i.e., emotions), and personal agency beliefs (i.e., capability and context beliefs). (Ford 1992, pp. 3, 73–5, 78) From the point of view of system intelligence, four factors of MST seem particularly relevant: 1) the comprehensiveness and the width of the definition of motivation, 2) motivation is not considered a vacuous inner factor but a phenomenon including environment and individual reflection, 3) motivation is seen as interconnecting both motives and the elements of commitment, and 4) motivation is reflexive and changes over time.

My study aimed to develop a novel model in order to understand volunteer motivation in terms of the *experience* and its *meaning* for individual volunteers. The interviewees (14 men, 4 women, age range from 26 to 68) are volunteers of the Evangelical Lutheran Church of Finland or its church associations in three of the biggest towns in Finland. Their relation to the Church varies from active to passive. The topics of the interviews covered the past and present experiences and meanings of the subjects' voluntary work as well as views on the future of personal volunteering. The themes of motivation and commitment to volunteerism were not discussed in terms of "why" questions but were incorporated into other issues in all the three time-perspectives: past, present, future. All in all, the phenomenological analysis[30] progressed via four stages: 1) gaining a sense of the whole data, 2) distinction of meaning units, 3) analysis of the meaning units, and 4) from synthesis to a consistent description. The analysis gave rise to "the octagon model of volunteer motivation", which is presented in the following section.

## The Octagon Model of Volunteer Motivation

The study on volunteer motivation − holistically understood[31] − with 18 interviewees yielded as many as 767 elements of volunteer motivation (i.e., meaning units in the phenomenological analysis). The overall analysis − based on analysis of meaning units, toward synthesis and a consistent description − concluded four data-determined continuums to describe the phenomenon of volunteering experience and motivation for it. Together the four continuums form an octagonal map (see Figure 1.), the idea being that each motivational element (767 items) can be located somewhere in this map, either into one (e.g., giving) or two poles (along a dimension, e.g., getting and giving or between

[30] More in detail, see Yeung 2004a. Giorgi (1985) has developed a model for phenomenological empirical psychology, which the present study follows in general outline. Giorgi´s sketch has been criticized (Wertz 1985) for its outline character and lack of detailed reflection on procedure in each of its phases. The present researcher agrees, but views this as a merit of the model, since the outline character of the sketch permits various applications and prevents one from seeing this approach as mechanistic. The present article shares the view of Keen (1975, p. 41) that phenomenology is not reducible to a set of instructions – it is more a research posture.

[31] Motives, in this study, refer, generally speaking, to factors that make a person act. The interviews, however, did not concern only reasons to volunteer. Instead, the motivational elements were more versatile: such elements refer to cognitive/emotional/social processes that cause the arousal, direction, and persistence of (voluntary) actions that are goal directed (on the concept of motivation, see Ford 1992).

dimensions, e.g., thought and action).[32] Thus, these eight poles, by no means, exclude each other.

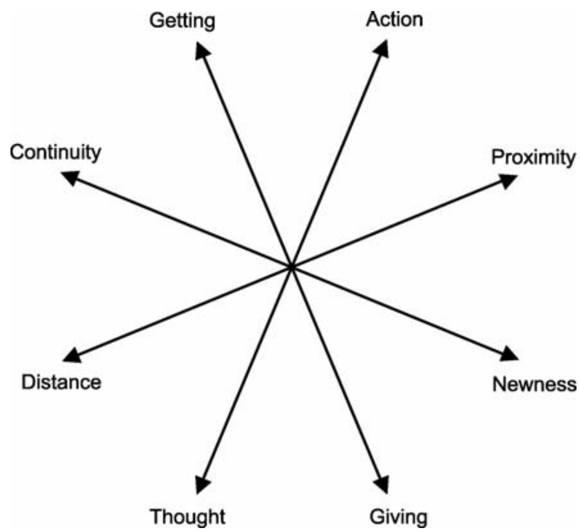


Figure 1. The octagon model of volunteer motivation.

Looking at the *eight poles* of the model, we can see that volunteer motivation includes various, also contradictory, elements at a particular point in time. Motivation can – and surely it will – also alter over time along the coordinates of the octagonal map. The model also has a *meta-dimension*: the model illustrates that volunteer motivation and experience lies in the interaction within the inward–outward dimension of a person; volunteer motivation may be more inward oriented − without being more egoistic − towards varieties of thought, distance, continuity, and getting (i.e., arrows pointing left). Also, the appeal of volunteering may concern the outward elements of an individual − without being necessarily more altruistic − in the numerous ways of action, proximity, newness, and giving (i.e., the arrows pointing right). All in all, late modern volunteer motivation appears a complex, versatile phenomenon.

In terms of late modernity,[33] individuals are today freer – and more compelled – to reflect on their relations with others, their position in (to use the concepts of the octagon model) getting and giving, continuity and change, thought and action, and to fulfil these

[32] As the 767 elements were located on the map − i.e., the data-determined model tested with its own data − the process was not content analysis or rigid grouping but rather interpretation; another researcher might have reached different conclusions. As a whole, this process was quite smooth, indicating that the four dimensions succeed in capturing the richness of the individual experiences and the meanings of the data. All in all, 532 motivational elements found a place along the four dimensions (either at the pole or in middle), and 235 at the intersection between two different dimensions. The latter particularly indicate the holistic and interlocking nature of the four dimensions, which together form a consistent description and synthesis of the volunteer motivation phenomena. The process of building them into one synthetic model (both contentual and visual) was heuristic. Numerous versions were tried, especially visually, before the final synthesis – an octagon model − was achieved.

[33] On late-modernity – and individualistic choices, emancipation, and self-fulfillment related to that – see, e.g., Giddens 1990; 1991, 1994; Fukuyama 1999, and on the risks of the late-modern choises, see e.g., Beck 1992; 1994.

standings either through social activities or more private contemplation − proximity or distance. I have suggested (Yeung 2004b) that the best way to capture the overall findings on volunteer motivation is under the concept of `*individually together*´: the idea being that individuality, independence and social ties, communality mingle in individual experiences. For instance, many people seem to long for even quite intimate social encounters and networks in volunteerism, even though such networks are generally restricted, by choice, to volunteering. Notice also that the meta-dimension of the octagon model exemplifies what Charles Taylor (1992) calls wavering between individualism and relativism − that is, culture of authenticity cannot be reduced to either hyper-individualism or soft relativism − and volunteering indeed is a fruitful empirical arena for such "wavering".[34] These results indicate that volunteering may play a role in both individualism and relativism as well as collectivism − and more particularly, in their mixtures. Volunteering includes moves along the late modernity processes, such as individualization, yet also indications of its countermoves. The way I see it, volunteering is a particular arena for change, personal search, and individuality − as well as continuity and communality. While it is true that the self today is presented with more choices regarding ways of being, one does not have to lose a sense of oneself and the others.

Next, let us take a few concrete examples concerning the most typical motivations found in this study. First, *getting versus giving*. Volunteering is experienced rewarding in a number of different ways; the interviewees mentioned the meaningfulness, conviviality, or concreteness of their chosen form of activity. Voluntary work also offers possibilities to express one's individuality and self-fulfilment.[35] Volunteers had also derived well-being and emotional security from volunteering, including experiences of success and the feeling of being needed and having a personal place in society. Then, giving may be related to, for instance, altruism or personal crises, based on which a person feels s/he has something to offer via volunteering. It must be noted also that getting and giving relate to each other a lot − and more than with any other motivational poles. A chief feature of volunteering is that it is very much a matter of mutual giving and reciprocity: it is very much about gaining by giving. More than is apparent prima facie, volunteer work is about *mutual* help, and it can be a source of considerable personal growth through its specific kind of interaction. The results showed that often when volunteering is initiated with altruistic wishes, the volunteers have been surprised at how much they actually gain.[36]

*Volunteering is experienced rewarding in a number of different ways; the interviewees mentioned the meaningfulness, conviviality, or concreteness of their chosen form of activity.*

Second, *continuity versus newness*; continuity may relate to elements such as personal identity or life-span (such as teachings of the childhood motivating a person to volunteer

[34] Further, see Pessi and Nicolaysen 2009.

[35] This is in line with Wuthnow (1998, p. 218) reporting volunteers claiming to have grown as a result of their volunteering by learning and finding self-images, and reporting (1991) expressions of individuality through volunteering.

[36] The direction of typical motivation change in this data was particularly from altruism towards further gaining which is the reverse of Wuthnow (1995) who however studied young people particularly. Some of the interviewees of this study also explained their satisfaction that their values had "softened", became more social and altruistic.

even decades after), or seeing volunteering as an extension to paid work. Elements related to one's identity and the continuity of its manifestations such as being an active character, being empathetic, or maintaining one's skills also played a role. Newness then may relate to, for instance, personal change. The appeal of volunteering as novelty may also lay in its interesting new subject matter; it may represent a counter-balance to or extension of one's life milieux. It also provides opportunities for learning, meeting challenges, and personal growth – that is, gaining a new perspective on things.[37] Third, *thought versus action*; thought may be related to, for example, living through personal matters and crises via volunteering, and action to, for instance, filling up spare time, wanting to get involved in concrete activities of praxis.

Fourth, *distance versus proximity*. The social nature of the activities seems to be one of the central appeals of volunteering. Volunteer work is a context for meaningful cooperation, and its shared goals are stimulating to most of the interviewees of this study. In the longer run, social contacts (to other volunteers, to paid workers, to those being helped, et cetera) had deepened the commitment to volunteering in most cases. An integral part, more meaningful to some volunteers than others, is a sense of communal spirit. This spirit is often based on a sense of acceptance, joint experiences, a shared sense of humor and, more practically, chats and discussions. But the pole of distance, in the late-modernity perspective, is also fascinating; the interviewees included, for instance, a young lady who was very stressed by her work and still wished to become a friend to an elderly. She, however, never wanted to see other volunteers or participate in any group activities of the organisation. They ended up agreeing that she can only be reached via cell-phone. She gained, thus, both positive social distance and proximity in volunteering. Volunteering indeed was a flexible and fruitful choice, both for her and for this particular organisation. All in all, volunteering may also offer meaningful interaction while a person wishes to limit her/his social networks. The individual may experience being a member of a group even though s/he might actually volunteer only every now and then and never (wish to) meet a larger volunteer group.

## Individually Together: Volunteering as a Social System

The starting point in this article was the assumption that the approach of systems intelligence is likely to resonate to the empirics of volunteer work. The previous section presenting the empirical findings illustrated such resonance *in meta-level*: the three elements of the systems intelligence approach (noted in Introduction) − holistic viewpoint, constructive way of looking at phenomena, and emphasis on individual responsibility – are indeed all necessary in aiming to capture the colourful grass-roots level experiences of volunteering. These viewpoints are clearly relevant to the social system of volunteering.

But we need to move along from the meta-level. Hämäläinen and Saarinen (2007, pp. 9–15) have captured in an illustrative manner the power and potential of systems. The three key aspects of systems, according to Hämäläinen and Saarinen, are: 1) what does the

[37] These results put more emphasis than several previous studies on informal gaining of fresh experiences and perspectives, not so much on actual learning per se. Also Marx (1999) has reported motivation element of getting fresh, new perspective in human services.

system generate, 2) how does the system mould human beings, and 3) what kind of `in-between´ does the system endorse (the way that people influence and are influenced by one another − in the most positive scenario there may be uplifting, stimulating in-between, to reach out towards the upscale register). Such three-fold perspective is useful in trying to understand dynamics of any social system, including volunteering. I will next aim to illustrate the nature of volunteering – based on the above presented empirical findings – in terms of the three aspects of systems as identified by Hämäläinen and Saarinen. In other words, what is the power and potential of the system called volunteer work?

First, *what does volunteering generate*? The fascinating essence of volunteering as a social system concerns its fundamental feature: free will. Unlike many of the social systems of everyday life volunteer work is activity that – by definition – can be based only on free-will choice, both when one starts to volunteer and when one continues to volunteer. The social system of volunteering is thus delicate like a love-affair that is based on subject's own choice: it may flourish and bring joy only in as much as the subject chooses it (just like lovers who know that only free will binds them together). Because volunteerism is voluntary, it can be discontinued at any time. There is an obvious, what could be called, a free-will-delicate-dilemma: the commitment to the system can only rise from an individual choice. Consequently, the mere *existence* of the social ties of volunteering is of intrinsic value. They are a value that the social system of volunteering has generated. But even more remarkably, the system of volunteerism generates the choices that make it emerge – it is a system of generating acts of choice (and whatever subjective correlates they will give rise to).

But even more is taking place. The social nature of the activities is actually one of the central appeals of volunteering, as indicated above in the findings. My work on volunteering underscored the fundamental role of social ties and interaction. One could argue that this is not very surprising finding at all, since volunteerism is in essence a social activity – something people do together. However, besides the free-will-delicate-dilemma also the late-modernity perspective complicates the matter. The fundamental question is then whether and why individuals long for social ties, networks, and interaction through participating in the collective action of volunteering – and why exactly there. This overall finding − the central role of social ties in volunteer motivation and commitment − is captured well by Habermann (2001, p. 378): "Voluntary work is, first and foremost, about being a fellow human being … meeting with "the other" in an attempt to understand our own life."

As a result, the social system of volunteering indeed has the capacity of generating something quite remarkable: a strengthened sense of being a fellow human being and meeting with the other, and all that out of an individual free-will choice. It is a social system of *individually together*: people wanting to come together, to do something together, to do for others. It is a system that offers more individual choice and flexibility than, for instance, work life – yet at the same time a system that offers more and deeper meanings than, for instance, watching TV at home.

*The social system of volunteering has the capacity of generating something quite remarkable: a strengthened sense of being a fellow human being and meeting with the other. It is a social system of being individually together.*

The system of volunteer work also generates *expanding social ties*. Volunteering offers an opportunity to come together with friends and acquaintances but also to meet new people. The findings above indicated that a wish for new, perhaps even close social networks might be highlighted during transitions of personal life, such as retirement, or becoming unemployed or a house-parent. Volunteer work offers experiences of communal spirit and personal meaningfulness for those who long for it, and may well guard against the "fundamental psychic problem in late-modernity". (Giddens 1991, p. 9) While volunteering offers multiple social ties, most people prefer these ties to be restricted to the context of volunteering (illustrating perhaps the fragmented nature of late-modernity). Thus, volunteering often offers meaningful connections with others: bonds, networks, even forms of dependence, in which an individual can experience being a member of a group even though s/he might actually volunteer only every now and then. Interestingly, volunteering may offer such experiences even if one practically never meets the entire volunteer group. The ties of the social system of volunteering still generate a point of reference for personal and societal identity construction.

Furthermore, my research concluded that volunteering is sometimes interestingly felt to be a channel for promoting social interaction – a volunteer as a mouthpiece of values, altruism, faith, and caring. This illustrates the fact that even though volunteerism does not necessarily contribute so much to solving the societal problems of a given context, it maintains and promotes hope to a world in which people still care for each other and respond to each others' needs. People indeed are capable of sympathy − and the system of volunteer work inspires, promotes, maintains, and expands that aspect of us. Volunteering may thus generate forces that might have life-changing influence for an individual (both the helper and the one being helped) and – via that in part also − to a society. Real influence may start from small.

Second, *how does volunteering (as a system) mould human beings*? We have already seen glimpses of the ways in which the social system of volunteering generates something truly significant. Many of these generative results of volunteerism as a system concern also the ways in which volunteering moulds and alters the volunteers as human beings. Examples include identity construction, expanding social ties, or acting as carriers of caring. Perhaps the strongest moulding power, however, concerns the *versatility* of the social system of volunteering. It is indeed a multifaceted, and sometimes complex, system which does not include only the fellow volunteers − with their large versatility − but also, for instance, possible `clients´ (that is, e.g., the people whom the volunteer assists) and the paid staff in the same organisations. It is more complex system than what one meets in, for instance, work places or hobbies. The range of social networks is captured in comments of the interview data, such as: "We as a group – sometimes have such a feeling of nearness and encounter that whew! But then also very gutsy individualism – very individualistic views" (a man in his thirties). The multifaceted social ties of volunteer work offer *multiple mirrors* for an individual; such power to mould is evident in the empirical findings in the ways in which volunteers experience, for instance, growing via volunteering, gaining by learning from others, or going through personal matters in volunteer work.

Perhaps more than anything else, volunteerism as a system molds the volunteer as a human being capable of doing good to another human being. Thus the volunteer has a chance of stepping beyond "systems of holding back" (Hämäläinen and Saarinen 2004).

Third, *may volunteering endorse 'in-between'* − the way that people influence one another? The fundamental features of volunteer work – doing something together, doing something for others – are indeed *about* influencing one another. Even more importantly, they are also about being influenced by others; this indeed relates to the system's power to mould, such as the ability to learn from others in volunteering. In my view, however, the most central role of in-between in volunteering relates to its potential to promote *togetherness*. According to my findings, the social system of volunteer work establishes togetherness in a dual manner (reinforcing the systems nature of the set-up). On the one hand, like-mindedness advances solidarity; for example, some volunteers experience connection with people who are similarly action-orientated or altruistic as themselves. On the other hand, other individuals particularly wish to meet (or/and enjoy having met) people very different from themselves. Furthermore, a shared value-basis and religiosity may play a particular role in this experience of esprit de corps.[38]

Whether the co-volunteers are like-minded or not, a fundamental feature of volunteer networks is sharing - the sharing of deeds and thoughts. Sharing demands and promotes trust. *Trust* indeed is a central notion here: it signals a particularly valuable and subtle `in-between´ of togetherness in the social system of volunteering. Maintenance and promotion of societal trust is a particular challenge under porous social conditions of late-modernity. The abstract concept of trust is empty without the actual social circles in which it actualizes itself, in volunteering either in a practical way (such as co-operation, or mutual helping) or less directly (such as a positive atmosphere or shared values). The results of my empirical work indicate that one's drive towards trust might support and direct behavior towards volunteering − and in turn be maintained and strengthened by it. More specifically, volunteering is a particularly valuable source of societal trust in that the possibility of connecting with people representing various backgrounds and different values and norms. While this might result in conflict in many social systems, my research showed that such diversity among the nets of volunteers and (for instance) paid workers was felt to be a benefit, illustrating what Giddens[39] calls "active trust", a typical late-modern trust mechanism based on open confrontation with others.

*Volunteering is a trust-promoting social system – and indeed social systems intelligence can only be built on (certain degree of) trust.*

Overall, my results picture volunteering as double-edged in relation to the construction of societal trust: volunteering promotes societal trust but it also demands particularly firm trust.[40] This brings us back to what was noted earlier concerning the centrality of free will in volunteering. As Wuthnow (1998, pp. 198, 200–201) states, while volunteering and civic associations cultivate trust, their success depends upon even more subtle factors such as common courtesy.[41] This resonates to the inductive logic of the systems intelligence

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[38] Several religious small group cases reported in Wuthnow (ed.) (1994) also indicate the power of small groups in renewing individual faith and ties with larger denominations and networks.

[39] Caccamo 1998, 126, an interview with Giddens.

[40] Volunteering, e.g., demands firmer trust than paid-work, which relies less on voluntariness and flexibility.

[41] Wuthnow (1998) also felicitously notes that civil organizations "provide opportunities for people to come together to define the conditions under which behavior will take place *as if* trust were present".

approach: the systems intelligence notes exactly the power of such small subtle factors. Micro behavior indeed matters; for instance, even if buying roses to each other is an every-day possibility to most – or all – of us, we seldom do it. A non-rose-buying system (unfortunately) dominates. (Saarinen and Hämäläinen 2004, pp. 30) It was noted already earlier in this article: real influence may start from small.

All in all, these two aspects of trust (to promote versus to demand) in volunteering affirm and nourish each other. Volunteering is a trust-promoting social system – and indeed social systems intelligence can only be built on (certain degree of) trust. Sharing and trust are also about *reciprocity*. A fundamental feature of the social systems of volunteering is the cycle of giving and getting. Volunteering is generally felt by volunteers to be an area of reciprocity – involving mutual help, and personal growth in social interaction. Reciprocity includes emotional rewards such as dispelling a sense of emptiness, earning people's gratitude, and getting a feeling of being needed and having a place in society. My results indicated, to give an example, that often when volunteering is initiated with altruistic wishes, the volunteers have been surprised at how much they actually gain.[42] Reciprocity in volunteering significantly establishes individual motivation and commitment and, in part thus further, societal solidarity formation.

Reciprocity of the social system of volunteering also indicates the interrelatedness of the three notions tackled here; the ability to generate, to mould, to inspire a trust-rich \`in-between´. They each promote the other two, and are being promoted by them. All in all, analytically it would be impossible to draw clear black-and-white distinctions. What is important, however, is to conclude that we have now seen some examples of *the power and potential of the system called volunteer work*. The systemic perspective seems to truly offer novel light on volunteer work.

## Individually Together: Volunteering as Systems Intelligence

The previous section indicated that systemic viewpoint indeed resonates and offers illuminating perspective to the empirics of volunteer work. But what about systems *intelligence*? The core finding above was that volunteer motivation may be captured in the concept of 'individually together', and now I would like to ponder whether being individually together in volunteerism *is* systems intelligent.

My empirical findings discussed in this article have indicated that volunteering takes place in a unique context of a system that the giver and the receiver together (and also, for instance, volunteers themselves together) constitute. The receiver is not only a receiver but an active component, as shown in the results. S/he is a component that participates and takes part in creating the generating, moulding, \`in-between´ power of the social system of volunteering. Something novel and unique is being created, together – and more particularly individually together.

Systems are being created together, and these systems influence each of its part (what they get, gain, whom they become, et cetera) as well as the whole, also in volunteering. An

[42] The direction of typical motivation change in my data was particularly from altruism towards further gaining which is the reverse of Wuthnow (1995) who however studied young people particularly. Some of my interviewees also explained their satisfaction that their values had "softened", became more social and altruistic.

intelligent way to act is to bear such a systems perspective clearly in mind. The key point is that the system that is being constituted together – in a deeply reciprocal manner – can be beneficial to the subjects in unexpected ways, in a number of respects and in a number of dimensions. Thus, it is intelligent for a subject to reach out to the beneficial aspects provided by the volunteer work system. In that sense, volunteerism indeed involves systems intelligence. Being individually together in volunteerism *is* systems intelligent.

But what does this mean in concrete terms? I would like to suggest that we can note two particular ways in which the social system of volunteer work enhances systems intelligence: first, *'social interaction promotion' by volunteering,* and second, '*widening the horizons' by volunteering.* In other words, the social system of volunteer work produces novel systemic intelligence by both promoting social interaction of individuals and of whole society, and by widening the horizons of individual volunteers. I argue that this is unique intelligence that no other institution or phenomena in our society can in a similar − and in such vast − manner generate. Let us next look at these two notions in detail, and particularly in dialogue with some recent studies in positive psychology.

First, *social interaction promotion*. As we saw above, the role of social interaction in volunteer motivation – and in the commitment to volunteer in the longer run – cannot be exaggerated; it provides immense benefits for the individual.[43] For an individual, such networks play a central role also in the construction of personal (social) identity. From the point of view of the whole society, volunteering promotes such beneficial virtues as sharing, trust, and reciprocity. At best, volunteer work generates considerable positive cycles. Systems intelligence as social intelligence, and as related to social skills,[44] can be lived out, practiced and developed in volunteer work. Systems intelligence approach, however, is also able to underscore the fact that volunteering may simply be enjoyable – having pleasurable time together with others. Gaining experiences, becoming braver, having fun!

The fact that volunteering involves both individuality and communality is particularly relevant from the point of view of systems intelligence – it amounts to growing *individually* in the context of living *together*. Volunteering can provide meaningful social contacts and opportunities for activities also in situations in which a person wants to maintain her/his personal boundaries and distance – as seen above. One could of course donate money to charity, but the characteristics of volunteer work as a system of mutual uplift, and as a practice of face-to-face interactions and practical engagement, involve benefits not accessible in the more mechanical give-money-for-people alternative. As a result, the social system of volunteerism has its special appeal to many. As noted in the Introduction, the ability of individuals to inspire others − and to be inspired by others − is practically limitless. We have in this article seen little glimpses of such inspiration in the social context of the motivation to volunteer and the meaning of volunteer work.

Second, *widening the horizons by volunteering.* Volunteering widens individual horizons, and this takes places – and indicates systems intelligence − in two dimensions:

[43] For other studies on the role of social ties in volunteer motivation, see e.g., Clary et al. 1992; 1996; 1998, Chambré 1995; Jakob 1993.

[44] See, e.g., Vilén 2004.

both by widening *positive* horizons and emotions and by widening *social other-centred* (altruistic) horizons. Let us start with the latter. Above we saw the very central role of *wanting to give* in volunteer motivation. All the volunteers interviewed were – to certain, varied extent – motivated by their general desire to help: wanting to promote the well-being of others and to be useful to them. Some of them also emphasized their altruistic characteristics and experienced volunteering as natural, even as a calling, in the spiritual and other senses. Personal difficult experience had also motivated the volunteers to help, some wishing to help others through their own recovery from crisis. Altruism is intimately related to other motivational elements, in particular, 'giving' and 'thought'; volunteers intend to help, and their values and norms exist hand-in-hand with their altruistic wishes. All in all, volunteer work is able to widen – and often in a deeply meaningful manner – the social system (intelligence) of an individual. Being altruistic, kind, generous, giving makes indeed sense: it has indirect (and possibly also more direct) consequences in the systemic setting that is the life of a volunteer.[45] And not only the individual life but also life in a wider society; for instance, generative energy of an individual toward future generations and wider society (such as being a parent or professional know-how). Furthermore, it is particularly generative worry and perspective rather than generative actions per se that correlates with experienced well-being. (Morfein et al. 2004)[46]

*Social bonds are not only valuable resources but also elicitors of positive emotions, and people in positive emotional states broaden their sense of self to include close others.*

Furthermore, previous research has in a fascinating manner indicated in relation to widening social horizons that not only doing good deeds but also just witnessing them – which also takes place in volunteering – gives individuals pleasurable feeling (such as warm, pleasant feelings in the chest) that may further trigger desires of doing food deeds themselves (e.g., Haidt 2003). Such pleasurable physical feelings have recently been reported in relation to witnessing various kinds of good deeds and excellence: gratitude, admiration, and elevation (i.e., emotional response to moral exemplars); particularly the last one motivates individuals to be kind and caring to others. Furthermore, grateful individuals appear to focus on opportunities to give back to others; they may be cued in to social interaction and particularly giving qualities of potential interaction partners. (Algoe and Haidt 2009) Indeed, there is much of literature indicating that gratitude is central in reciprocal altruism. It motivates people to pay back favours. But moreover, gratitude is not just simple tit-for-tat; gratitude motivates people to get closer, to strengthen social ties, to move from exchange relations to more communal relations. (E.g., Algoe and Haidt 2009; Algoe et al. 2008; McCullough et al. 2001; Fredrickson 2004; Trivers 1971; Clark and Mills 1979) Volunteering indeed may be an arena for not only witnessing good deeds but also of gratitude.

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[45] This does not, however, mean that we need to – or should − view volunteering as a tool or of intrumental value.

[46] Morfein and colleagues build here on the classical theory by Erik H.Erikson´s (1977) concerning eight-staged model of individual development. The core task of the seventh step, in middle adulthood, is ego development outcome, meaning generativity versus self absorption. The task in generativity is to perpetuate culture and transmit values through, e.g., the family and working. Strength comes through care of others and production of something meaningful that contributes to betterment of society.

Such consequences of ‘widening the horizons’ by volunteering towards others and altruism may even have interesting health dimensions: for instance, research has indicated connection between higher rates of volunteering and lower rates of heart conditions (Hyyppä 2001; 2002). Volunteers have wider horizons – and they may even live longer. In larger perspective this is in line with, for instance, the classical ‘nun study’ by Danner et al. (2001). This study on autobiographies of 180 Catholic nuns indicated a very strong association between positive emotional content in youth and risk of mortality in later life; there is a highly distict positive link between emotional content in early adulthood and longevity six decades later. Emotion-based constructs reflect patterns of coping with, for example, negative life events (Danner et al. 2001, 804). Positive emotions may have muting effects even on the bodily responses to negative emotions (Fredrickson and Levenson 1998).

These social other-centred horizons take place individually together: people gain by giving, give by gaining. Volunteer work is a field of reciprocity, in a complex manner. Also recent altruism research[47] shows that caring for others carries considerable benefits for individuals. This takes us towards our second dimension: widening not only of social other-centred but also particularly *positive* horizons by volunteering. Interestingly, previous research[48] has also indicated that caring for others and being happy are interrelated phenomena. Cohn and Fredrickson (2006; also Waugh and Fredrickson 2005) have shown that social bonds are not only valuable resources but also elicitors of (further) positive emotions, and people in positive emotional states broaden their sense of self to include close, and potentially close, others[49]. Positive emotions not only broaden one’s perspective but also motivate one to do things that will build resources for the future (Fredrickson 1998). Also, people in positive emotional states form more inclusive social groups (Dovidio et al. 1998) and even perceive strangers in a more positive light (Forgas 2001).

Repertoires of positive emotions, all in all, build a variety of personal resources for individuals; they may be physical (such as skills, health; see, e.g., Danner et al. 2001) or social (e.g., support networks, see, e.g., Aron et al. 2000), intellectual (e.g., control, knowledge, intellectual complexity, see, e.g., Csikszentmihalyi and Rahunde 1998) as well as psychological (such as optimism, creativity, see, e.g., Fredrickson et al. 2003)[50]. What is deeply significant is that such resources accrued by positive emotions are durable: they outlast the transient emotional states (Fredrickson and Branigan 2005, 315). Also, it has been indicated that positive emotions and broadened thinking influence each other

[47] This has also served evolutionary purposes; concerning evolutionary theory of altruism, see, e.g., Brown and Brown 2006; Flescher and Worthen 2007. For literature review concerning altruism, see, e.g. Pessi and Saari 2008; Pessi 2009; Yeung 2006.

[48] E.g., Post and Neimark 2007.

[49] See also, e.g., Fredrickson 1998; 2001; Fredrickson and Branigan 2005 concerning in more general Barbara L. Fredrickson´s `broaden-and-build´ theory of positive emotions which indicates that positive emotions are complex phenomena that help create adaptive behavior. The core hypothesis is that positive emotions broaden the scope of attention and thought-action repertoires of individuals. In contrast, negative emotions narrow thought-action repoertoires. All in all, this theory notes that positive emotions orient our pshyciology and cognition toward cumulative long-term benefits.

[50] Further, see, Fredrickson and Branigan 2005; Fredrickson 1998; 2001.

reciprocally. Together they may produce an upward spiral over time; people may experience true increases in their well-being. (Fredrickson and Joiner 2002; Burns et al. 2008) Volunteering is a possible arena of multifaceted positive emotions and well-being: it offers joy, contentment, even elements of happiness – and often particularly through the experiences of meaningfulness and of purpose, sometimes altruism. Volunteers thus all in all have both *wider* and more *positive* horizons − and they may live not only longer but happier.

These moments of widening horizons in the social system of volunteering may be small and quiet, yet deeply touching, moments of social encounter: a forcefield constituted from a human being to a human being. This again resonates to the earlier noted inductive logic of the systems intelligence approach; small in big. The ability to see the whole only begins from looking at the incremental and seemingly insignificant – what is close at hand. The ability to create larger effects begins from an ability to generate relevant small deeds. Volunteer work in its individually together sense is such activity: large in small, significant in incremental. Still it may have life-changing influence.

## Concluding Discussion

This essay has focused on the inter-connections between the systems intelligence approach and individual volunteer experiences and motivation. It has indicated that not only is the systemic viewpoint fruitful for understanding volunteer work in a deeper manner but that volunteer work indeed promotes systems intelligence. The article suggested that the social system of volunteer work produces novel systemic intelligence by both promoting social interaction of individuals and by widening the other-centred as well as positive horizons of individuals. This concluding discussion will focus on further applications of the approach.

Individuals need connection to others and to greater meanings - to horizons of significance as Charles Taylor[51] puts it - in order to fulfil and maintain their authenticity. Volunteer work individually together offers such connection via the two ways of systems intelligence enhancement: both via social interaction promotion and by widening positive and other-centred horizons. Both ways are also virtues in human social interaction; Saarinen et al. (2004, p. 14) have noted both features and virtues of systems intelligence behavior. The former include, among others, humour, listening, encouragement, kindness, and the latter, for example, optimism, wisdom, courage, openness, and sympathy. (Saarinen et al. 2004, p. 18) Indeed, experiences in volunteer work may teach and support all noted elements. Volunteer work is an excellent example of not only social behavior but pro-social behavior; it is not always about helping and altruism but it is always about individual coming together, doing together, and particularly doing something for a shared purpose, often for the common good. Indeed, individually together.

Where next? Systems intelligence approach can be utilized for interventions, in two levels: in everyday life, and in organisations (e.g., at an educational institutions or a company) (Saarinen et al. 2004, p. 18). We similarly need interventions to further invest in

[51] Further on the connections between the empirics of volunteering and the philosophy of Charles Taylor, see Pessi and Nicolaysen (2009).

volunteer work and citizen participation; for example, it seems a rewarding way to study and learn ethics at schools would be to actually do volunteer work, together with others?[52] Another area of volunteer research – and praxis – that is still under-developed is the volunteer work projects in corporate business, as part of both corporate social responsibility and human resources development (both learning and recreation). These are just two examples in which the systems intelligence approach and the praxis of volunteering could - and should - be put into synergy in order to improve, and to conduct further research on, the everyday life and wellbeing of social systems.

Moreover, just looking at the overall phenomenon of volunteer work raises dozens of questions and viewpoints for the systems intelligence approach; what about the systems intelligence of volunteer work organisations? How would a systems intelligent institution develop their volunteerism activities? Definitely they would at least pay attention to the volunteers themselves; to learn from their viewpoint, to respect the individual-level and group-level systems intelligence. Furthermore, can we talk about the systems intelligence of the public sector in promoting – or not – volunteer work? And how about different kinds of volunteer groups in comparison, and in relation, to each other? What if we would look at third sector organisations and corporate business in cooperation – how would the systems intelligence then look like?

The questions, and possible applications, could continue and continue. A critic may say that systems intelligence approach looses something in its width and in its enormous application potential. It is a bit like the critics viewpoint on the loved-and-hated concept of social capital in sociology; it manages, at the end, in the critics' view, to illustrate nothing or everything concerning social interaction. I have, however, firm belief in the systems intelligence approach. The width of the approach opens indeed both inter-disciplinary *potential* and *challenge* for social sciences. Concerning the former, the core contribution, in my view, of the systems intelligence approach lies in its fantastic, holistic and indeed respectful view of (every single) human (social) being. Concerning the latter, challenges are always to be loved − and deeply − by the academia as well as all others wanting to learn and to develop.

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[52] Further on such an idea, and research on such projects abroad, see, e.g., Grönlund and Pessi (2008). Concerning systems intelligence in the school context, see also, e.g., Salaspuro-Selänne and Soini (2004).

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Chapter 9

# Cinema Author's Embodied Simulatorium – a Systems Intelligence Approach

*Pia Tikka*

*The essay relates the cinema author's creative processes to the systems intelligence approach. The underpinning assumption is that cinema stands forth as an intersubjective frame of sensemaking. This idea is reflected against the early systemic views of the Russian filmmaker and theoretician Sergei M. Eisenstein. In its unfolding, the cinema author's creative processes are described from a particular point of view, that is, that of the enactive mind point by means of introducing the neuroscientific concept of embodied simulation as the bodily basis of these processes. This is applied in the hypothetical model of cinema author's mental workspace, the embodied simulatorium as it is termed. In this paper it will be discussed how embodied processes constitute what in this volume is referred to as systems intelligence.*

## Introduction

In the first half of 20th century, the Russian film director Sergei M. Eisenstein was engaged in the challenging process of describing the organizational principles of the unified systemic whole of an artistic process, in particular, that of authoring cinema.[53] He held that the status of film director (later 'author') should not be like that of a dictator but rather one of a holistic agent, whose creative work synthesizes the socio-emotional needs of his audience, that was to say, the interest of the Soviet citizens. This was so not only in theoretical terms but also in practice. Eisenstein was situated right in the eye of the storm of radical social changes, doing his best to *make things work* in the Soviet system. Loosely related to the present context of this volume, Eisenstein was making his best out of the conditions of his life-environment in terms of what may be called *systems intelligence*.

My focus will be on reflecting the embodied aspects of cinema authoring process, as I've conceived of them in my book *Enactive Cinema: Simulatorium Eisensteinense* (2008),

[53] I argue elsewhere (Tikka 2008, 2009) that an important framework of Eisenstein's systemic thinking was Alexander Bogdanov's scientific Marxism formulated in *Essays in Tektology: The General Science of Organization* (1913-1922). Tektology formed the underground force of the Soviet 'psychoengineering' and may retrospectively be acknowledged as pioneering Cybernetics and General Systems Theory in Europe and in the United States. (see Susiluoto 1982, Biggart el al. 1998).

against the holistic framework of systems intelligence. To meet this challenge, I will highlight what may be called author's *embodied simulatorium* (Ibid., p. 243). The notion refers to a kind of mental workspace that enables the author to imagine, create, and manage cinematic processes that are assumed emotionally coupled to those of the spectators (Ibid., p. 230). Apparently conflicting with the first impression, this assumes that the processes within embodied simulatorium are assumed to be, to a great extent, sharable, intersubjective, and socially conditioned. Eisenstein seems to talk about the intersubjective core of what is now described as embodied simulatorium when he writes: ”It is obvious that a work of this type has a very particular effect on the perceiver, not only because it is raised to the same level as natural phenomena but also because the law of its structuring is also the law governing those who perceive the work, for they too are part of organic nature (…) the secret consists of the fact that in each case both *us and the work* are governed by *one and the same canon of law*” (Eisenstein 1987, p. 12).

Intuitively seen, considering the multiple agents involved in creating cinematic systems (e.g., actors, other artistic and technological collaborators, and ultimately, the spectators), the authoring process seemingly calls for socio-emotionally sensitive authorship that performs *in a systems intelligent manner*. Referring to Saarinen and Hämäläinen (2004, p. 3), a systems intelligent author, employs the pragmatic and collaborative attitude of an individual in her efforts of *making things work* within “feedback intensive” social environments. At its best, a systems intelligent effort may empower an upward-spiraling movement of “cumulative enrichment and improvement” (Saarinen and Hämäläinen 2007, p. 64). In his times, Eisenstein exemplified such a positive attitude, when he dreamed of ‘*psycho-engineering*’ the Soviet working masses towards social well-being with the help of his *emotion-driven* machinery of cinema.[54] Highlighted as "a key form of human intelligence and a fundamental element in the adaptive human toolbox" (Hämäläinen and Saarinen 2004, p. 3), which fundamentally involves also human sensitivity (Saarinen and Hämäläinen 2004, p. 9), systems intelligent approach may be argued to involve similar aspects of socially oriented psycho-engineering that were elaborated in Eisenstein's times.

*Apparently conflicting with the first impression, the processes within embodied simulatorium are assumed to be, to a great extent, sharable, intersubjective, and socially conditioned.*

The early Russian systems scientist Alexander Bogdanov's *Tektology: The General Science of Organization* (1913–28) and the contemporary German holism in the field of biology seemed to converge in Eisenstein's approach to human cognition as a “multisensuous” emotion-based system (Tikka 2008). While many later systemic approaches aimed at a similar kind of universal explanation framework, they seemed to overlook the emotional aspects of human nature in favor of the rational engineering aspects. In 1948, the year of Eisenstein's death, Norbert Wiener introduced *cybernetics* mainly as a theory of *governing* complexities, followed by Ludvig van Bertalanffy's influential *General Systems Theory* (1968). Today's systems theories tend to emphasize rather the *self-*

[54] The idea of artists as ‘psycho-engineers’ and art as a method for organizing “the human psyche through the emotions" was also advocated in the writings of Sergei Tretiakov, a close friend and collaborator of Eisenstein. (In Tretiakov 1923, p. 202 in Manovich 1993, p. 22; Bordwell 1993, pp. 5, 116, 136; Tikka 2009, p. 222)

*organizing* characteristics than 'steering', with regard to human technological, biological, cognitive, and social systems (e.g., Varela et al. 1991). However, only recently the unconscious emotional aspects of human cognition, which Eisenstein emphasized, have been legitimated as the fundamental basis of the 'higher-level' cognitive systems, for example, in neurosciences (e.g., Damasio 1999, 2003), or in cinema studies (e.g., Tan 1996, Grodal 1997, Smith 2003, Tikka 2008). Instead, outside of the earlier, what one may call 'emotion-hostile' scientific discourse, the cinema practice has for over the last hundred years relied on the author's intuitive abilities to harness the embodied emotional systems into the service of practical cinematic systems.

In this essay systems intelligence is viewed as an omnipresent defining characteristic cognition, or mind. It will mainly draw from the enactive cognitive sciences and neurosciences, thus deliberately deviating from the psychological or philosophical views on learning organizations, team dynamics, or artificial intelligent systems, which so far have dominated the discussion on systems intelligence. Cinema author's creative process is tackled in terms of today's scientific understanding on *enactive mind* (Varela *et al.* 1991) and *embodied simulation* (Gallese 2003, p. 2005). The article is concluded with a case study, applying the conceptual model of *embodied simulatorium* (Tikka 2008) in practice.

## Enactive Mind

Many contemporary cognitive scientists would consider mind as an emergent feature of a psychophysiological brain or brain–body system, while the most radical group goes as far as to argue that the mind transgresses from the traditional brain–body system to the world. As representatives of the latter view, the proponents of *enactive* cognitive sciences, Francisco J. Varela, Evan Thompson, and Eleanor Rosch (1991), assume that mind is *embodied* and *emerges* in the holistic first-person experience of being and playing a part in the intersubjective world. In this essay the notions of mind, body, and world are considered as interrelated, interdependent, and to constitute parallel conceptual perspectives on the subject's *enactive situatedness.* In agreement with the dynamist view, I presume that a systems intelligent cinema author not only observes and manipulates the system 'from outside', but herself exists and acts 'within' the system, i.e. the system embeds the author as well as is embodied in the author's *enactment*. A guiding metaphor for the enactive cognitive scientists features "a path exists only in walking" (Varela et al. 1991, p. 239), i.e., an enactive mind comes into being through its continuously changing situatedness in the world.

*If cinematic systems are assumed to model the recursive character of cognition, they should also meet the recursive character of such systems.*

According to other contributions systems intelligence seems to be an elementary aspect of what I've come to understand as an enactive cognition, in deviation from traditional cognitivist views. For comparison, consider how Varela et al. (1991) differentiate the '*cognitivist'* and '*enactivist'* answers to the question *what is cognition?* The cognitivist relies on "information processing as […] rule-based manipulation of symbols" (Ibid., 42), while an enactivist relies on "history of structural coupling that brings forth a world" (Ibid., 206). For the second question, *how cognition works*, the cognitivist harnesses "any device that can support and manipulate discrete functional elements —the symbols. The system interacts only with the form of the symbols (their physical attributes), not their meaning" (Ibid., 42), while for the enactivist the system works "[t]hrough a network consisting of multiple levels of interconnected, sensorimotor subnetworks" (Ibid., 206). Further, when one wants to know *when a cognitive system is functioning adequately*, the cognitivist would answer: "When the symbols appropriately represent some aspect of the real world, and the information processing leads to a successful solution to the problem given to the system" (Ibid., 42–43). An enactive cognitive system, instead, functions adequately "[w]hen it becomes part of an ongoing existing world (as the young of every species do) or shapes a new one (as happens in evolutionary history)" (Ibid., 207).

Generally, a cognitive entity can be modeled *as a dynamical system* involved in continuous interaction processes with other entities, the underpinning cognitive dynamics of which emerge in a complex self-referring dynamics, as stipulated by Port and van Gelder's dynamical approach to cognitive structures (1995), the developmental dynamics of Thelen and Smith (1996), or the dynamical patterns theory of Kelso (1995), and carrying similarities with, for example, the *Multiple Drafts* model by Dennett and Kinsbourne (1992). The dynamist's basic explanatory toolbox applies also for the system around of the systems intelligent person. Such processes are characterized by 'inputs linked with outputs', intra- and interrelated feedback loops, top-down processes interacting with bottom-up processes, bifurcations and transgression in continuously fluctuating states, to name few of the plausible functions. As Hämäläinen and Saarinen note, the system theoretical concepts "may seem technical but they are directly applicable in the characterization of systems intelligence", and useful tools for, to name an example, analyzing social dynamics of a problem solving situation (2007, p. 72). Also, complex cognitive or social systems typically generate effects beyond the modes and functionalities of their components, have primacy over their components while at the same time these components influence the system, and, in addition, show emergent features, not reducible to the features of its elements (Saarinen and Hämäläinen 2004, pp. 11–12).

Inspired by the dynamical systems view to mind, I posit that cinema can be seen to reflect the underlying psycho-dynamics of human experience by applying the bio-cybernetic concepts of Humberto Maturana and Francisco Varela (1980). In this light, cinema can be seen to stand, on one hand, for (1) an emergent embodiment of an author's creative expressiveness built on both conscious and unconscious dimensions of mind (*autopoietic* system), and, on the other, for (2) an *authored simulation model* of the experiential world, which in the cinema composition becomes partially framed according to the author's subjective selective decisions (*allopoietic* system). The latter kind of system carries features of an autonomous, self-referential simulation system, which, when once produced and set into movement, goes on playing out the fictional world independently of its author.

The human body could be viewed as an organic framework, the psychophysiological principles of which define the framework of any cinematic system, but also, in reciprocal manner, the dynamics of cinematic work could be understood as modeling human thought. This suggests that a complex system authored by a cognitive entity would constitute a model for aspects of its author's proper mind, such as attitudes, interests, aesthetic preferences, and ethics, embedded in the cinematic work as a particular kind of expressive worldview.

The two hypothetical domains of 'external' and 'internal' are often modeled as separate domains of mind, this for the sake of conceptual clarity. Yet, the reader is reminded that the holistic view to cognition allows converging both the unconscious and conscious conceptualizations of human mind into one notion of embodied, or enactive cognition. In Damasio's terms, on the one hand, this perspective reveals one's conscious, cognitive act of perceiving oneself in interaction with the world (exteroception), and, on the other, it involves simultaneous unconscious perceptual activities (interoception), which are oriented to controlling the wellbeing of the subject (2003, p. 107). Consequently, adopting the first-person perspective and subjectivity may lead to a distorted understanding of mind, if *only* the conscious aspects of mind are taken into consideration. Alas, cinema can be regarded to represent simultaneously a kind of *miniature model of phenomenal world* (an exteroceptive model 'outwards') and a model of the emotion dynamics of the embodied simulatorium (an interoceptive model 'inwards') (Tikka 2008).

Although cinema can be seen as a model of human experience, the practical implementation is at any rate complicated, particularly if modeling complexity of the scale of mind is set as the starting point. Consider, for example, the *recursive character of cognition* that suggests a subject's earlier experience (e.g. memories, habits, and bodily routines) modifies all new experiences (e.g. perception, imagination, and anticipation), as implied by Neisser (1976). Such cognitive processes are understood to emerge in what have been characterized as 'inner' and 'outer' loops of cognition, the first "deeply rooted in its physical implementation as its most immediate environment (inner loops of mind-environmental participation)" and the latter "extensively involved in the surrounding environment in terms of culture, society, economy, etc. (outer loops)" (Kaipainen 1996, 266). Although cinema may be claimed to "externalize" its creator's mental processes, the traditional linear structure of cinema is typically 'fixed' and lacks the dynamics of reorganization "on the fly". From the dynamical systems point of view, if cinematic systems are assumed to model (even partially) the recursive character of cognition, they should also meet the recursive character of such systems. To create a model of such a system, the author may introduce *a feedback loop* into the cinematic framework. In fact, elsewhere I have sketched a new genre of *enactive cinema* (Tikka 2008, 2006), which constitutes a direct systemic coupling between the spectator's psychophysiology and the cinematic system.

While the attribute of 'enactive' carries the explicit sense of meaningful, read here, systems intelligent, acting in the world, it is the *embodied simulation of the world and the other people* that will provide the environment for creative enactment of the cinema author.

## Embodied Simulation

In contrast to the common view to cinema as a private subjective experience, Gallese's concept of *embodied simulation* (2005) allows a description of cinema as an *intersubjective* experience. Elsewhere I have argued that *embodied simulation* constitutes the cinema author's neuronal basis of understanding and imagining the *behavior and feelings of other people* (Tikka 2008). Furthermore, the concept of embodied simulation allows framing the creative process of filmmaking and the related spectator experience into *one intersubjectively shared complex system.*

My understanding of this draws also from the discovery of the mirror neuron system, first in monkey brain (di Pellegrino et al. 1992, Rizzolatti et al. 1996, among others) and in human brain (e.g., Fadiga et al. 1995, Hari et al. 1998). Their findings suggest that merely observing someone to grasp an object actually activates in the pre-motor regions of the brain the same neural networks that would be activated if the observer were actually grasping the object herself. This discovery has been celebrated amongst the neuroscientists as a plausible neuronal explanation for intersubjectivity and socio-emotional behavior, such as empathy.[55] As Gallese argues, embodied simulation involves “mediating between the multi level personal background experience we entertain of our lived body, and the implicit certainties we simultaneously hold about others. Such personal body-related experience enables us to understand the actions performed by others, and to directly decode the emotions and sensations they experience” (2005, p. 42). Embodied simulation may be assumed to be in work when the art gallery visitor ‘feels’ the movements of the artist’s hand working on an art object only by looking at the brush traces on its surface (Freedberg and Gallese 2007, pp. 200). In a similar manner, in her “embodied simulatorium” the cinema author may ‘imagine’ or ‘feel’ how her characters experience the events of their fictive lives, or even how the future cinema viewer, elsewhere referred to as ‘simulated spectator’ (Tikka 2008), experience these events.

Emerging form the author’s embodied simulatorium, the allopoietic product of her cognitive processes (cinema montage) is understood to equip cinema with *an intersubjective frame of sensemaking*. Neuroimaging experiments of intersubjective correlation (ISC) by Uri Hasson and others (2004) support the assumption that if several people are watching the same cinema scene, their individual cortical activities have the tendency to synchronize with others. However, in another experiment they have also shown that the intersubject correlations differ in terms of the film genre and the level of aesthetic control of the films, a higher aesthetic control relating to higher intersubject correlation, and vice versa (Hasson et al. 2008). This implies that creating shared emotional experience within groups of people is not for granted but it relies greatly on the cinema author’s systems intelligent performance, the capability to simulate other people’s emotional dynamics. This not only includes understanding the emotional imagination of individual spectators, but also, at the same, elaborating cinematic material so as to make different spectators’ emotional systems pulse together.

*At conscious levels of cognition individual differences often become more apparent, however, at the biological, physiological level the behavior of individuals seems surprisingly similar.*

At conscious levels of cognition individual differences often become more apparent than the *dominating* similarities driven by the emotional system, which indisputably constitutes the basis of complex social behavior and social organizations. However, at the biological, physiological level the behavior of individuals seems much more similar. This is

[55] For further reading on the neuronal basis of social interaction, see Hari and Kujala (2009).

not only due to physiological similarities, but *also* due to environmental and cultural conditions, for example, natural living environments, education, religion, gender views, and historical situatedness.

When Eisenstein argued in his time that the dynamical structures of the author's creative mind surrender themselves to further scrutiny in the functional structures of artistic productions, he believed that psychology would provide the instruments for describing "*in exactly the same way*" both "*the complex compositional elements of form*" and "*the content of the work for itself*" (Eisenstein 1987, p. 10). Today, if accepting the holistic enactive approach to mind, such activities as intuition, association, metaphoric thinking, conceptual blending, or imagination, which are typically related to creative aspects of cognition, involve a continuous retrieval, recycling, and reconstruction of the complex total of embodied (unconscious or conscious) memory traces of ones whole life. The theory of *embodied metaphors* (Lakoff and Johnson 1980, 1999) suggests that our languages, conceptualizations, and symbol systems are actually based on bodily being-in-the-world, such as "walking a path" or "falling like a stone", but even in expressions like "under-stand". In their framework lived experiences constitute so-called *image-schemas* that become projected to more abstract conceptualizations. Relying on recent neuroscientific views on human concept formation (Rizzolatti and Arbib 1998, Lakoff and Gallese 2005, Hari and Kujala 2009), I consider the role of embodied metaphors as constituting the conceptual-bio-cultural simulation interface between the domains of subjectivity and intersubjectivity, thereby forming the basis of shared understanding, and what is here discussed as systems intelligence in general.

But it is worth noting that already Eisenstein recognized the significance of body-based metaphors as the means of sharing subjective emotional experiences with the others (Smith 2004, p. 314). He often compared the process of filmmaking to basketweaving or orchestral composition, in which carefully selected threads of 'being-in-the-world' folded in such a way that they support the construction of complex spatio-temporal rhythms of the cinema experience. On one hand, the cinema author's embodied simulation determines the *emotional* basis for all 'forms' of enactive cognition. On the other, the author's *embodied simulatorium* harnesses these emotive-cognitive activities to serve the creation of culturally shared end products.

## Case Study: Embodied Simulatorium Applied

In order to focus on the idea of *embodied simulatorium as a mental workspace enabling any agent's systems intelligent performance*, an imaginary case study is discussed. As the reader is encouraged to imagine herself in a creative process of filmmaking, the complex bio-cultural aspects related to the embodied simulatorium can be highlighted.

Our imaginary cinema author might be elaborating a fiction film based on a script by a professional screenwriter. Imagine, that the socio-emotional treatment of the film she is developing seems to demand showing the acts of torture experienced by the main characters in the hands of the superior political agents. The scene may feature an interrogation of a woman and her young daughter, during which the child is sexually violated. Taken the fact that a major part of our daily information flow cultivates scenes of violence (e.g., everyday life, news, entertainment, etc.), this short scene description may already have caused the reader's imagination to involuntarily start off on fly, images automatically emerging in the reader's embodied simulatorium without calling them.

Though the scene, which describes the painful and shameful experiences of the characters, could be constructed through non-showing, our filmmaker may decide to rely on the realistic construction instead. In order to be able actually to *show* the scene, one has to *imagine* how the characters behave and what they actually experience.

In the light of professional filmmaking practice, producing a realistic torture scene seems a relatively easy task as one may rely on a group of actors, set-designers, special effect designers and cinematographers, perhaps even experts working with the issues related to the practice of torture (e.g., prisoners, physicians, military officers, etc).

The systems intelligent embodied performance of the filmmaker embraces social world defined by general conventions, norms, education, religion, and so on. When considering the obvious injustice executed by superior powers, it may be interesting to refer to the neuroscientific findings (Singer *et al.* 2006), which suggest that the intensity of empathic activation in brain is directly related to the subject's judgment of right or wrong acts of another person. This altruistic punishment (e.g., 'She got what she deserved') embedded in our brain may explain the popularity of action or thriller films, where suffered unfairness is revenged. However, in our imaginary scene no revenge takes place, only humiliation.

Our question is, how the filmmaker in her creative mind simulates the pain, humiliation, and fear of death on behalf of the tortured, on the one hand, and the pleasure of power, routine work, or self-disgust on the part of the torturer, on the other. Despite the cultural conventions and professional instruments, the final scene will eventually arise from the filmmaker's own socio-emotional experiences and *her attitude* towards what is described, converging in the enactment of her *embodied simulatorium.* As was also emphasized in Eisenstein's thinking, the filmmaker's attitude towards what is represented frames the (socio-emotional) *system* of the systems intelligent performance into the focus.

For further elaboration of the embodied simulatorium in general, consider the differences between the following experiences in particular: (1) observing a violent event (a rape) only a few steps away from herself, which demands immediate reaction (a 'real' world context), (2) observing the same event on the screen reinforced by a dramatic sound environment (a spectator context) or, (3) imagining a violent event happening just a few steps away from herself 'as-if' the violation would take place 'in reality' (cinema author context). Although events (1), (2), and (3) differ in terms of the socio-cultural context of 'real' and 'not-real', however, in the embodied simulation context they are assumed to represent *variations of the same neural activation in someone's brain.*

> *Meanings emerge in the mind's simulatorium in the process of making sense of what is happening in 'between the lines' against one's experiential background.*

The first case (1) without doubt calls for a particularly systems-intelligent enactment and may carry severe consequences also for the observer herself. However, I deliberately ignore this first case for the favor of the cases (2) and (3), which directly relate to the filmmaking process. For some spectators of screen event (2) living through the violence on screen is too disturbing and they simply have to block their eyes and ears. Yet, the embodied mind continues simulating the scene based on the awareness that the event is going on. The effort invested in voluntary rejection, on the one hand, and the involuntary emergence of the events on the spectators' mental screen, on the other, enforces the fact that she cannot escape the scene. Embodied simulation allows assuming that the spectator 'feels' the fear and the pain of the violated through the involuntary simulation of her own experiences of pain and humiliation. But according to my claim, this is assumed to hold for the authoring process. Imagine that the imaginary cinema author may not be *psychophysiologically capable* to simulate the scene (3), because it is just too painful. If unwilling to modify the original scene by rescuing the woman and the child in the last minute, the filmmaker can always return more associative treatment of the scene. As many skillful filmmakers, with Eisenstein in the frontline, have emphasized that meaningfulness is not embedded in one-to-one depiction of what is happening. Meanings emerge in the mind's simulatorium in the process of making sense of what is happening in 'between the lines' against one's experiential background.

One enacts inseparable manner with the phenomenal world. The convergence of observation, motor enactment, and imagination of the same type of act in the cortical simulation processes has also consequences for the conceptual treatment of what is typically understood as 'real' and 'not-real'. Generalizing a bit, but keeping the particular torture scene in mind, it is obvious that a *systems intelligent* cinema author should be capable of compensating the limits of her practical experiments with the all-embracing possibilities of her embodied simulatorium. In the embodied sensemaking, as exemplified above, the real and fiction mix. Enactive perception-action theory argues that conducting so called 'pure' reduction of the phenomenal world into non-embodied or 'objective' aspects is irrelevant (and implausible) (Noë 2007). This holds also for what is typically conceived of as 'pure' fiction or 'pure' fact. In a similar manner, applying only 'pure' professional methods does not make our imaginary scene come alive, but the holistic socio-emotionally meaningful complexity created by an embodied, systems intelligent agent. The meaning dynamics of cinematic art, paradoxically, is all about "the hidden" in imagery but "the exposed" in embodied simulatorium.

## Conclusion

The essay has related a cinema author's creative processes to the systems intelligence approach. The underpinning assumption was that cinema stands forth as an intersubjective frame of sensemaking. In its unfolding, the cinema author's creative processes were described from the *enactive mind* point of view, through introducing the neuroscientific concept of *embodied simulation* as the bodily basis of these processes. This was followed with a related hypothetical model of cinema author's mental workspace, the *embodied simulatorium*.

Eisenstein was the one who recognized that *unconscious* dynamics dominate not only the spectator's behavior but also the author's own cognition. From his own experiential resources of embodiment Eisenstein found his emotional themes, to discover "whole new tracts of utterly unexpected territory whose existence [he] never dreamed of" (Eisenstein 1995, p. 14). Today, to study oneself, to analyze the emotional 'feelings' and the author's own attitude towards different themes, remains as fuzzy an effort as it was in Eisenstein's time. However, two distinct Eisensteinian kinds of method exist to tackle the problem at hand. On one hand, the cinema author may gain control over the underpinning dynamics of her own embodied resources by widening her life-experience, for example, through professional practice and personal education. This accumulated experience then, in a reciprocal manner, feeds back and shapes the author's autobiographic self. On the other, the recent neuroscientific methods may help to understand the underpinning neural dynamics of the authoring process, as well as those of the spectator experience. By acknowledging the prevailing modes of socio-emotional interaction and gaining more understanding on the psychological aspects of cinematic arts one may for her part contribute to wellbeing, thus empowering in positive manner what Eisenstein's contemporary discourse described as 'life-building', and which could be referred to as 'systems intelligent performance' today.

So far, direct correlation between neural activities and the mental imagery of the filmmaker's creative mind still remains inaccessible. While the future may hold the keys for gaining access to inner neural activities of the mind's creative systems, understanding the implications of the embodied dynamics to the systems intelligent authoring process already frames one of the most interesting research questions. How does our biological similarity support intersubjectivity and cultural sharing? Put in other words, to what extent can we claim to share (embodied) experiences with the others? Above, the embodied simulatorium has been described as being fundamentally conditioned by life-long socio–emotional situatedness. The case study has helped to discuss how these embodied processes constitute what in this volume is referred to as *systems intelligence.* The assumed cinema author studying her embodied 'feelings' and 'thoughts' has been shown to perform within the socially conditioned domain of systems intelligence. To conclude, I wish the essay will open some paths for theoretical and practical elaboration of the embodied simulatorium and the related systemic approach.

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# Name Index

# Subject Index