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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 factors[1]. 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.

[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.)?

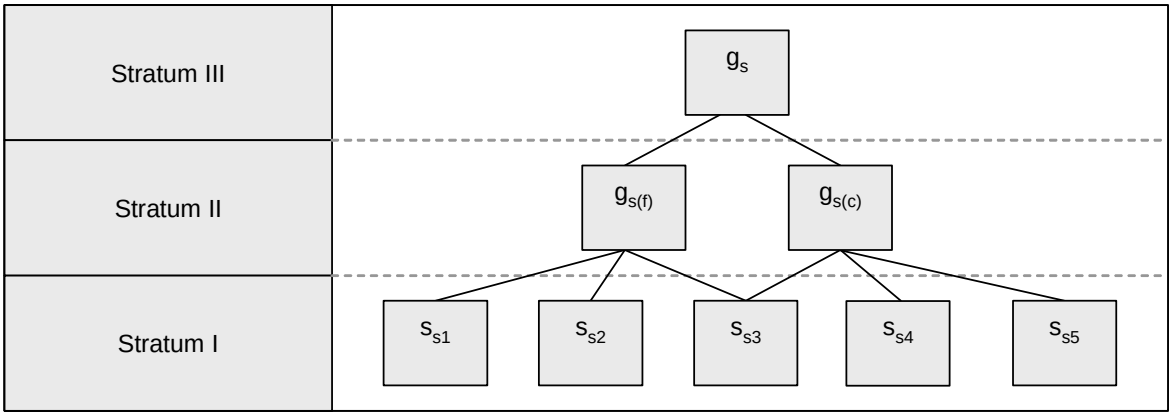

Figure 1. A hierarchical model of systems intelligence

"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.

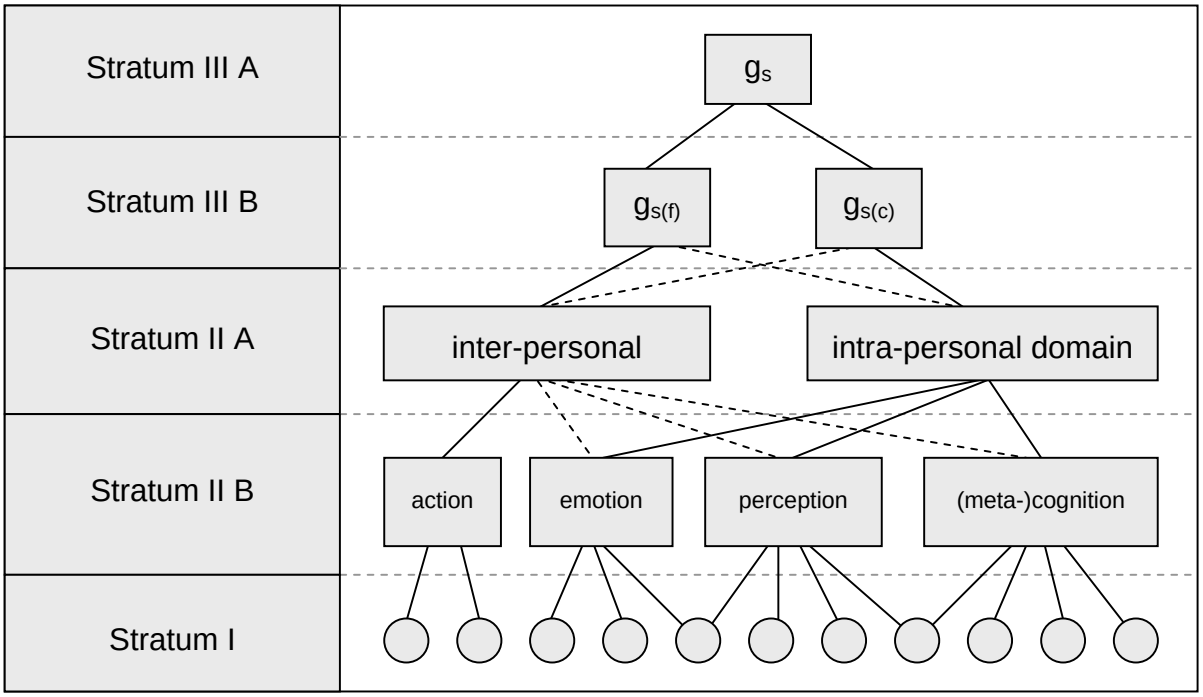

Figure 2. An extended hierarchical model of systems intelligence and hypothesised relationships

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, ***g_s ("g systemic")***, may be referred to as ***specific systems intelligence skills and competences, the 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

Criteria of a *what*	***when***	***how***	***how much***	***how often***	Classification
	✓ generalised	×	✓ typical level	✓ frequency	trait (disposition)
	×	✓ manner	×	✓ frequency	style
	×	×	✓ maximal performance	×	ability
	✓ 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.

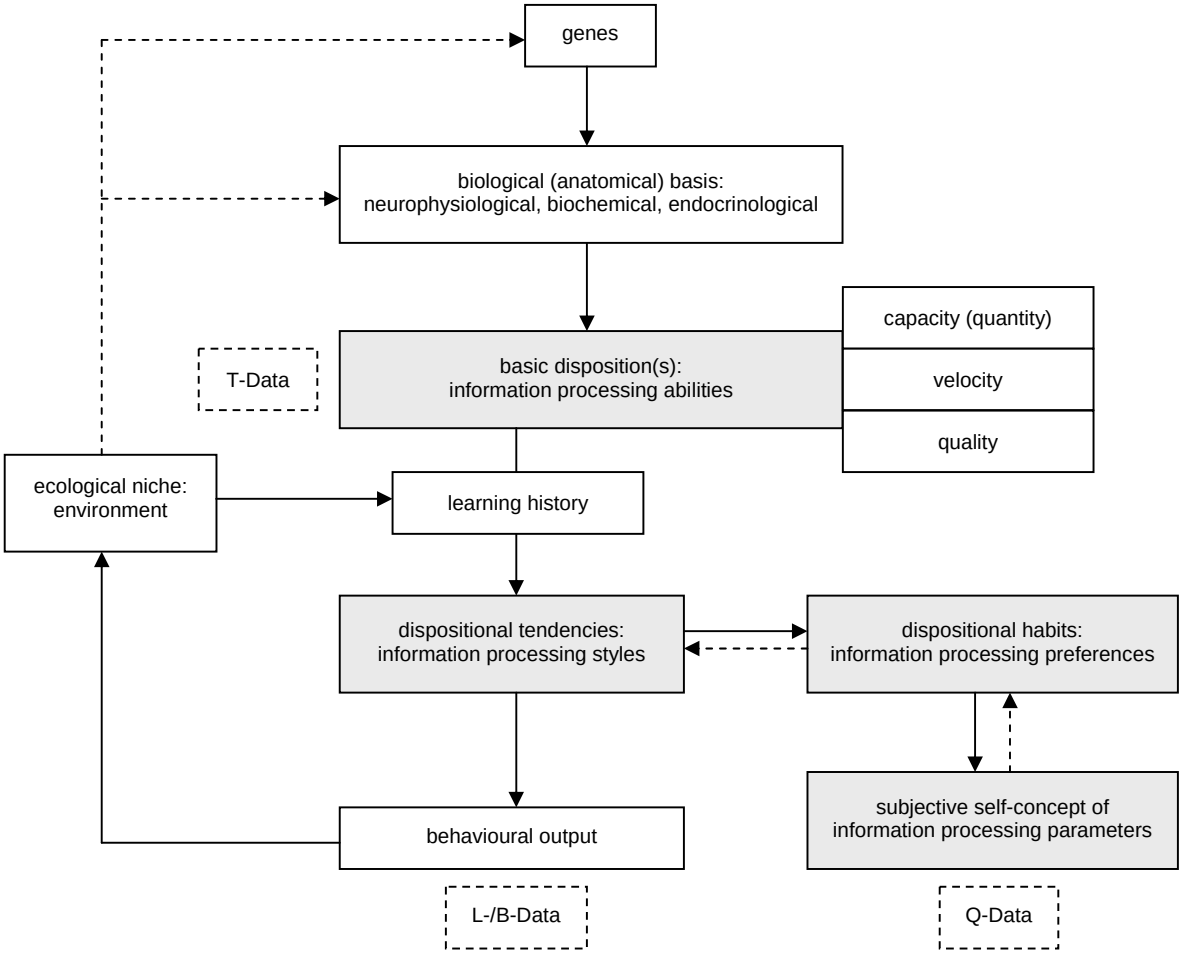

Figure 3. The relationships between information processing abilities, styles, and preferences as well as the data-type (L/B, Q, T) associated with them

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.

*Methodologic*al *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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Author

John F. Rauthmann is currently studying psychology at the University of Innsbruck, Austria. His interests and research areas are personality and individual differences. Email: j.f.rauthmann@gmx.de

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