

Chapter 2

The Nature of Intuitive Thought

Abstract In the recent decades, the most prominent theoretical framework to explain thinking concerns the *dual process theories of cognition*. These theories posit the existence of two separate cognitive systems, System 1 and System 2, that are in charge of autonomous and non-conscious cognition, and volitional and conscious cognition, respectively. The dual process theories form a strong basis to build a structural model of intuitive thought. Intuition is a form of cognition generated by ontogenetic System 1 processes, as differentiated from phylogenetic, or instinctive System 1 processes. Intuition is a form of skilled action, based on expertise. Intuition is a domain-specific capacity and thus highly context-sensitive, generated and activated by environmental and social cues. Thus the environment plays also a significant role in both the generation of intuitive cognitive processes as well as in cueing and priming the existing processes. I will argue, that in a structural model of intuitive thought the environment can be construed as a “System 3” that has direct cognitive bearing to the processes driven by Systems 1 and 2.

Keywords Dual process theories • Jonathan Evans • Keith Stanovich • Daniel Kahneman • System 1 • System 2 • John Bargh • Ap Dijksterhuis • Gerd Gigerenzer • Gary Klein

While it may appear at first glance that we are conscious of much of our actions and thought, this is not the case. In fact, a great deal of our everyday activities and cognitive processes are non-conscious.

In the recent decades, the most prominent theoretical framework to explain this duality of thinking concerns the *dual process theories of cognition*. These theories posit the existence of two separate cognitive systems, System 1 and System 2, that are in charge of autonomous and non-conscious cognition, and volitional and conscious cognition, respectively.

The dual process theories form a strong basis to build a structural model of intuitive thought. Intuition, I will argue, is a form of cognition generated by ontogenetic System 1 processes, as differentiated from phylogenetic, or instinctive System 1 processes. I will proceed to argue that intuition is a form of skilled action, based on expertise generated within a domain by deliberate practice and experience.

Because intuition is a domain-specific capacity, it is also argued that intuitive thought is highly context-sensitive, generated and activated by environmental and social cues. Thus the environment plays also a significant role in both the generation of intuitive cognitive processes as well as in cueing and priming the existing processes. I will argue, that in a structural model of intuitive thought the environment can be construed as a “System 3” that has direct cognitive bearing to the processes driven by Systems 1 and 2.

I will present below a structural model of intuition and intuitive cognitive processes in the context of the dual process theories, accommodating for both the demarcation criteria of intuitive thought processes as well as the structural relationships between the Systems 1, 2 and 3.

2.1 Dual Processing

The duality of thinking expressed in such distinctions as conscious versus non-conscious thought, or volitional versus autonomous thought, has been addressed traditionally in terms of various divisions of thought (see Chap. 1). The most prominent and widely received present-day positions concern the *dual process theories of thinking*.

Theorists in various areas of research have ended up with the conclusion that the functioning of the mind can be characterized by two different types of cognition, including cognitive psychology, social psychology, neuropsychology, naturalistic philosophy, decision theory and clinical psychology. (Stanovich 2004, p. 34.)

The dual-process theories are involved especially with higher cognitive processes, such as judgment and decision making (Frankish and Evans 2009). Major contributors to this field include Jonathan Evans (Evans 2003, 2009, 2010; Wason and Evans 1975; Frankish and Evans 2009), Keith Stanovich (Stanovich and West 2000; Stanovich 2004, 2009) and Daniel Kahneman (Kahneman 2011; Tversky and Kahneman 1974; Kahneman and Frederick 2005).

Dual process theories of cognition, stemming back to the 1970s and 1980s, hold that the mind is not a single cognitive structure, but rather consists of (at least) two quite different systems. Keith Frankish and Jonathan Evans describe the central idea of this position as follows:

Dual-process theories hold that human thought processes are subserved by two distinct mechanisms, one fast, automatic and non-conscious, the other slow, controlled and conscious, which operate largely independently and compete for behavioral control. In their boldest form, they claim that humans have, in effect, two separate minds. (Evans and Frankish 2009, p. v.)

These theories can be characterized either as dual system theories, or as more localized dual process theories. In the relevant literature they are also regarded all together as a loosely integrated whole also called dual process theories. (Frankish and Evans 2009, p. 1.) For the sake of clarity, I will adopt here the convention of

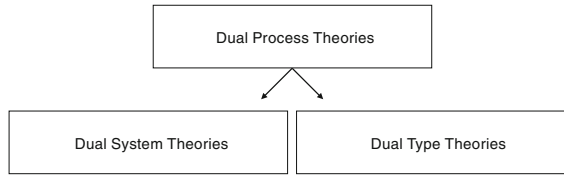


Fig. 2.1 Dual process theories can be split into the two subgroups of dual system theories and dual type theories

referring to the total group of theories as the *dual process* theories, the systemic positions as *dual system* theories, and the process-focused positions as *dual type* theories (Fig. 2.1).

The dual process dichotomies have been referred to in the literature by quite a few different monikers. For example, experiential–rational (Epstein 2002), automatic–intentional (Bargh and Chartrand 1999), reflexive–reflective (Lieberman 2000, 2009) and unconscious–conscious (Dijksterhuis 2004; Dijksterhuis and Nordgren 2006). In the majority of the dual process literature, the distinction to System 1 and System 2, coined by Keith Stanovich and Richard West, is the most widely used (Stanovich and West 2000).

2.1.1 The Two Systems

The most common formulation of dual processing is the division of the mind into *two systems*:

Dual-process theories of thinking and reasoning quite literally propose the presence of two minds in one brain. The stream of consciousness that broadly corresponds to System 2 thinking is massively supplemented by a whole set of autonomous subsystems in System 1 that post only their final products into consciousness and compete directly for control of our inferences, decisions and actions. (Evans 2003, p. 458.)

Frankish and Evans elaborate:

These theories come in different forms, but all agree in positing two distinct processing mechanisms for a given task, which employ different procedures and may yield different, and sometimes conflicting, results. Typically, one of the processes is characterized as fast, effortless, automatic, non-conscious, inflexible, heavily contextualized, and undemanding of working memory, and the other as slow, effortful, controlled, conscious, flexible, de-contextualized, and demanding of working memory. (Frankish and Evans 2009, p. 1.)

Frankish and Evans go on to note that System 1 concerns associative, context-bound and non-linguistic reasoning, whereas System 2 deals with rule-based, abstract and language-involving reasoning. (Frankish and Evans 2009, p. 3.)

First of these systems, the System 1, is evolutionally old, and shared with most higher animals. It is the system where most non-conscious processing, such as

instinct and emotion, takes place. It is a very powerful cognitive apparatus, able to simultaneously process significant amounts of information without conscious intervention (Dijksterhuis and Nordgren 2006, pp. 96–97; Kahneman 2011, p. 416). System 1 is fast and autonomous. It is non-conscious: the processes in System 1 take place for the most part unknown to the cognitive organism. (Evans 2003, p. 458).

System 2 is, on the other hand, evolutionally relatively recent, and typical only to humans and perhaps some of the most advanced primates. System 2 consists of the conscious processing capacity of the organism, and enables such things as logical and analytic reasoning. As Evans points out, “System 2 thinking is characterized as slow, sequential and correlated with cognitive capacity measures, which sounds like the stream of consciousness—or the flow of information through working memory—and this in turn leads us to think of System 2 as conscious” (Evans 2009, p. 37).

System 2 is, however, very limited in processing capacity and also considerably slower than System 1. Where System 1 can process several streams of information in parallel, System 2 is mostly capable of processing only a handful of information. System 2 processes information serially and relatively slowly (Table 2.1).

Most typically the two systems can be characterized by the rough attribution of System 1 as the locus of non-conscious processing and System 2 as the locus of conscious processing. As shall be seen below, this division into two completely separate non-conscious and conscious systems is not a very viable one. However, as a rough division it conveys some of the essential nature of human cognition.

Another critical element is the idea of the highly differentiated capacities of the two systems. As was pointed out above (see Sect. 1.3), the human conscious apparatus is constrained by working memory limitations, leading to the fact that the capacity to consciously process information is very limited. (See e.g. Miller 1956; Dietrich 2004; Lieberman 2007; Buschman et al. 2011).

Whether System 2 is equated with consciousness, working memory -driven processes or attention, all three suffer from the same cognitive limitations that typically manifest as the inability to focus attention: “Intense focusing on a task can

Table 2.1 Typically attributed properties of the two systems

System 1	System 2
Evolutionarily old	Evolutionarily recent
Shared with animals	Distinctively human
Non-conscious	Conscious
Automatic	Controlled
Fast	Slow
Implicit	Explicit
High capacity	Low capacity
Associative	Rule-based
Non-linguistic	Linguistic
Non-voluntary	Voluntary

make people effectively blind, even to stimuli that normally attract attention.” (Kahneman 2011, p. 23.) This phenomenon was stunningly demonstrated in an experiment by Christopher Chabris and Daniel Simons, where they asked students to count basketball throws. Meanwhile, a person in a gorilla suit entered the court, but only a fraction of the participants noticed this quite significant anomaly in the game. (Chabris and Simons 2010.)

While the conscious capacity of the human mind is highly limited, System 1 does not seem to suffer from such limitations, as the Nobel Laureate Daniel Kahneman argues (Kahneman 2011, p. 416). It looks like we have a huge amount of non-conscious processing taking place every moment, taking care of the autonomous functions in our bodies, parsing sensory information for potential threats and interests and allegedly also creating new associations presented as the ‘a-ha!’ moments typical to creativity.

The two systems can also be differentiated in terms of whether the processes they carry out are explicit or implicit. System 1 involves implicit processing, that is to say, processes that create a cognitive input only of their end result. An example of such a process would be creative rumination, or Peircean musement, leading to an ‘a-ha!’ moment. In such rumination, the processes and associations that create the final moment of clarity are left unseen.

Finally, a typical differentiation of the two systems concerns the role of volition in guiding cognitive processes (Stanovich 2009; Baumeister and Tierney 2011; Kahneman 2011). System 1, owing in part to the non-conscious and implicit nature of its processes, concerns mostly involuntary processes. This is best exemplified by instinctive reactions such as reacting in disgust to a scary animal like a snake. System 2, in part, concerns the ability to guide and direct cognitive processes. It is important to note that for most dual process researchers, System 2 does not mean a cognitive system completely under our volition; but rather it is where volition can be applied.

Roy Baumeister has in his willpower research introduced the concept of *ego depletion* (Baumeister et al. 1998; Baumeister and Tierney 2011). Baumeister argues that with demanding tasks, the capacity to volitional activity decreases. Kahneman, in turn, points out that both self-control and cognitive effort are types of work that tax the cognitive system. (Kahneman 2011, p. 41.) As research by e.g. Harriet and Walter Mischel shows, when people are presented with a demanding task together with a temptation such as a sweet, they are more likely to succumb to the temptation. (Mischel and Mischel 1983.)

While there are such caveats to the twin nature of the mind, many argue that the arrangement between the two systems is, in fact, quite optimal. As Kahneman notes, “Constantly questioning our own thinking would be impossibly tedious, and System 2 is much too slow and inefficient to serve as a substitute for System 1 in making routine decisions” (Kahneman 2011, p. 28). He also points out,

The division of labor between System 1 and System 2 is highly efficient: it minimizes effort and optimizes performance. The arrangement works well most of the time because System 1 is generally very good at what it does: its models of familiar situations are accurate, its

short-term predictions are usually accurate as well, and its initial reactions to challenges are swift and generally appropriate. (Kahneman 2011, p. 25).

There is a large amount of compelling evidence that points towards the existence of two separate cognitive systems. System 1 is evolutionally old, parallel processing, non-conscious, high-capacity, implicit and autonomous. System 2 is evolutionally new, serial processing, conscious, low-capacity, explicit and volitional. Many researchers, however, hold that the dual system view is too simplistic.

2.1.2 Type 1 and Type 2 Processing

The dual-system formulations of dual processing present a compelling picture of how the mind works. As Evans and Frankish, among others, argue, these formulations are, however, currently oversimplified. (Evans and Frankish 2009, p. vi). According to Kahneman, the two systems are rather “characters in a story”—abstractions used to make sense of how our cognition takes place. (Kahneman 2011, p. 19 ff.) He notes, “‘System 1 does X’ is a shortcut for ‘X occurs automatically.’ And ‘System 2 is mobilized to do Y’ is a shortcut for ‘arousal increases, pupils dilate, attention is focused, and activity Y is performed.’” (Kahneman 2011, p. 415).

There are, in fact, not two separate systems that would function as independent modules, but rather the two systems are intertwined: “System 2 is partly realized in cycles of System 1 activity, involving the mental rehearsal of action schemata” (Evans and Frankish 2009, p. vi.) Evans writes further, “There may not be any stable versions of System 2 at all—just a set of interacting units (including working memory) that get activated to deal with a particular task” (Evans 2009, p. 38). He continues,

If System 2 requires working memory then as a *system*, it must also include many other resources, such as explicit knowledge and belief systems together with powerful, type 1 processes, for identifying and retrieving data that is relevant in the current context, not to speak of the role of attention, language, and perception in supplying content for type 2 processing. (Evans 2009, p. 42.)

Evans has proposed moving from the position of two systems to one embracing two *types* of cognitive processes. According to Evans, these two types roughly coincide with what was originally thought of as the functions of the two systems. (Evans 2009, p. 33.)

Type 1 processes are defined as autonomous processes that do not require working memory. *Type 2 processes* are defined as processes involving cognitive decoupling and mental simulation that require working memory. One way to distinguish the two is to call them *intuitive processes* and *analytic processes*, respectively (Table 2.2).

The easiest way to differentiate the dual type and dual system formulations is that in the former the typically mind-related properties of the two systems are

Table 2.2 Type 1 (intuitive) and Type 2 (analytic) processes

Type 1 processes (intuitive)	Type 2 processes (analytic)
Fast	Slow
High capacity	Capacity limited
Parallel	Serial
Non-conscious	Conscious
Contextualized	Abstract
Automatic	Controlled
Associative	Rule-based
Experience-based decision making	Consequential decision making

excluded from the identification criteria of the two types of processes. This includes the evolutive distinction, the human/animal distinction and the relationship of emotions to the two systems.

One of the critical distinctions of the two types of processes is whether they employ working memory. “In place of type 2 processes, we can talk of *analytic* processes [that] are those which manipulate explicit representations through working memory and exert conscious, volitional control on behavior” (Evans 2009, p. 42). While the working memory is often likened to System 2, the two are not in fact entirely the same:

Working memory does nothing on its own. It requires, at the very least, *content*. And this content is supplied by a whole host of *implicit* cognitive systems. For example, the contents of our consciousness include visual and other perceptual representations of the world, extracted meanings of linguistic discourse, episodic memories, and retrieved beliefs of relevance to the current context, and so on. So if there is a new mind, distinct from the old, it does not operate entirely or even mostly by type 2 processes. On the contrary, it functions mostly by type 1 processes. (Evans 2009, p. 37).

Type 2 processes need the constant application of working memory, such as in calculating by using an algorithm, in evaluating various choices in decision-making, or in practicing a new skill. In these processes, attention is directed not only on the outcome of the process (the solution, the decision or the product of skill), but also on the intermediary steps.

Type 1 processes, in turn, operate autonomously, without the need of direct attention or the application of working memory. “Autonomous processes are those that can control behavior directly without need for any kind of controlled attention.” (Evans 2009, p. 42.) Due to this independence from working memory, Type 1 processes can be either entirely non-conscious (as in creative association or autonomous processes) or they can post only their end result into consciousness, often with the result that the cognitive agent may be unable to explicate how she ended up with such a result.

Type 1 processes are fast and automatic. They typically involve high processing capacity and low effort. Type 2 processes, in turn, are slow, controlled and they involve a limited capacity and high effort. (Evans 2009, p. 33.)

In terms of cognitive architecture, Type 2 processes are sequential whereas Type 1 processes can be massively parallel (Evans 2009, p. 33). In other words, Type 2 processes can take place only one at a time, for example in a logical inference or a decision tree, where one step is evaluated at a given moment. Type 1 processes can, on the other hand, take place simultaneously, and there can arguably be a great number of such simultaneous processes ongoing (e.g. walking and whistling a tune while the sensory apparatus is parsing the environment for potential dangers and evaluative processes are dealing with information gathered earlier in the day, possibly producing an insight).

Finally, Evans introduces a third type of cognition, reflective Type 3 processes, that mediate between Type 1 and Type 2 processes. These involve decision making and conflict resolution. (Evans 2009, p. 50). Here Evans approaches the position advocated by Keith Stanovich, where both System 1 and System 2 are broken down to smaller subsystems.

2.1.3 Algorithmic, Reflective and Autonomous Minds

Where Evans' position shifts the focus from the modularity of the two-systems view to a process view, Keith Stanovich has developed his position by introducing further divisions in both Systems 1 and 2 (Stanovich 2004, 2009.)

Stanovich (2009, p. 56) argues, that it is erroneous to claim that the autonomous System 1 consists of only one system. Rather, it is a collection of many different kinds of subsystems that roughly coincide with the demarcation criteria of System 1. The autonomous mind “contains many rules, stimulus discriminations, and decision-making principles that have been practiced to automaticity [...]” (Stanovich 2009, p. 57.)

These Stanovich calls “The Autonomous Set of Systems”, in short, TASS:

In actuality, the term used should be plural because it refers to a *set* of systems in the brain that operate autonomously in response to their own triggering stimuli, and are not under the control of the analytic processing system. I thus have suggested the acronym TASS (standing for The Autonomous Set of Systems) to describe what is in actuality a heterogeneous set. (Stanovich 2009, p. 56.)

Instead of systems or types, Stanovich emphasizes *modes* of processing. Reflecting Daniel Dennett's conventions in the book *Kinds of Minds* (1997), Stanovich labels the source of Type 1 processing, TASS, as the autonomous mind.

While TASS takes care of most of the functionality typically attributed to System 1, Stanovich is not satisfied with the System 2 as a single system either. He rather argues that also the System 2 is divided into at least two distinct subsystems. (Stanovich 2009, p. 57.) The algorithmic level of Type 2 processing is called the algorithmic mind. Finally, the reflective level of Type 3 processing is called the reflective mind. (Evans and Stanovich 2013, p. 230.)

The algorithmic mind deals with slow thinking and computation. The reflective mind, in turn, evaluates, initiates and discontinues ongoing processes in the autonomous or algorithmic minds: “Decoupling processes enable one to distance oneself from representations of the world so that they can be reflected upon and potentially improved” (Stanovich 2009, p. 63).

Stanovich argues that we have a divided relationship to the genetically dictated behavioral modules. “Short-leash” goals are implemented by the TASS, and have a genetic basis. These include biological instinctive behavior and reflexes. However, following his famous catch-phrase (and book title), “Robot’s Rebellion,” the “genetic robot” can also rebel against these short-leash instructions by the long-leash capacity of the reflective and algorithmic minds. The reflective mind can set new goals that may well be at odds with the instinctive drives of TASS. By setting goals as reflective individuals, we can “rebel” against the instinctive goals we are programmed with by evolution. (Stanovich 2004; Frankish and Evans 2009, p. 18.)

The execution of typical System 2 features, such as cognitive decoupling, or TASS override—i.e. the event where a System 1 input is interrupted volitionally and a new process is initiated—are, according to Stanovich, driven by the reflective mind: “TASS will implement its short-leashed goals unless overridden by the algorithmic mechanisms implementing the long-leash goals of the analytic system. But override itself is initiated by higher control.” (Stanovich 2009, p. 57.)

Stanovich argues that “the algorithmic level is subordinate to higher level goal states and epistemic thinking dispositions. These goal states and epistemic dispositions exist at what might be termed the *reflective level of processing*—a level containing control states that regulate behavior at high level of generality.” (Evans and Stanovich 2013, p. 230.) While the initiation of a TASS override may be carried out by the reflective mind, the actual substitute process, for example a logical calculation, will take place in the algorithmic mind.

Algorithmic and reflective minds can be differentiated in measurement of individual differences between cognitive ability and thinking dispositions. (Evans and Stanovich 2013, p. 230). Cognitive ability concerns the capacity of the algorithmic mind to sustain decoupled inhibitory or simulating representations and is reflected in general intelligence. (Evans and Stanovich 2013, p. 230; Stanovich 2009, p. 62.) Thinking dispositions, in turn reflect various higher level states of the reflective mind, for example collecting information, evaluating points of view, or making an analysis of the upsides and downsides of a situation before making a decision.

Stanovich’s position can, thus be summarized as a tripartite division between the autonomous, the algorithmic and the reflective mind, where the autonomous mind consists of several System 1 subsystems and the algorithmic and reflective mind correspond with properties of System 2, especially concerning serial processing and conscious reflection and decision making, respectively.

To bridge Stanovich’s view with that of Evans’, one could roughly say that the System 1 subsystems, or The Autonomous Set of Systems (TASS) are responsible for Type 1 processes. The algorithmic part of System 2 is, in turn, responsible for Type 2 processes. And finally, the reflective part of System 2 is responsible for Type 3 processes.

Evans' and Stanovich's theories bring a lot of dynamics to the arguably too static Dual System model. This position can now be developed further in the context of intuitive thought.

2.2 The Structure of Intuitive Thought

Whichever definition we want to use about intuition, a feature common to practically all of them is that intuition is primarily non-conscious. This non-conscious thought is reflected in intuitive insight.

In other words, intuition belongs in the domain of System 1. While Evans' and Stanovich's elaborations above must be taken seriously, in order to construct a structured model of intuitive thought, it may be useful to temporarily revert back to the Dual System terminology. The model presented below will use the Dual System position as a starting point, but it will also incorporate the key ideas from both Evans' and Stanovich's positions.

2.2.1 *The Nested Systems*

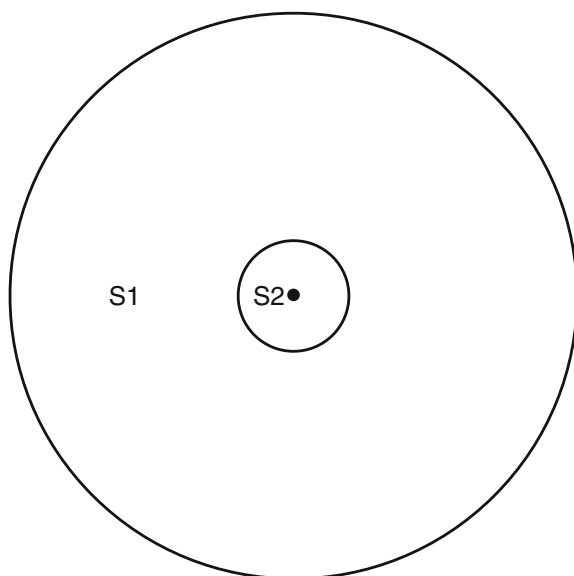
To recap, human cognition is divided into two functionally different mental systems whose properties and capacities differ highly from one another. One of these, System 1, concerns the autonomous and involuntary cognitive functions. The other, System 2, concerns the conscious capacity to reflect, compute and volitionally adjust behavior.

While System 2 is limited to processing only a few inputs at a time in series, it too employs many of the processes driven by System 1. For example, in drawing logical inference, the rules of inference must first have been memorized, i.e. committed to System 1, before the algorithmic System 2 inference can take place.

System 2 drives processes that employ attention and focus and that tap into working memory, in other words, Evans' Type 2 and Type 3 processes. System 1 is, in turn, responsible for most of our behavior and actions, as well as producing associative thought patterns. As Kahneman points out, one "of the main functions of System 2 is to monitor and control thoughts and actions "suggested" by System 1, allowing some to be expressed directly in behavior and suppressing or modifying others" (Kahneman 2011, p. 43).

The two systems are not separate mechanisms, but rather interact constantly with one another. System 1 generates both inputs and explicit processes for System 2 to reflect on and compute with, and conversely, System 2 monitors and controls the suggestions of System 1 within the constraints of working memory capacity and volitional capacity.

Instead of separating them, the two systems can be construed as a nested system (Fig. 2.2). System 2 functions as the locus of attention, constrained by

Fig. 2.2 The nested systems

working memory. System 1 functions as the home of the cognitive processes. As Engle points out, working memory is not just about memory, but rather using attention to maintain or suppress information. He holds that working memory concerns memory only indirectly, and that a greater capacity in working memory means a greater ability to control attention rather than a larger memory. (Engle 2002, p. 20.)

Ludwig Wittgenstein wrote in his *Tractatus logico-philosophicus* that the self “shrinks to a point without extension, and there remains the reality co-ordinated with it.” (Wittgenstein 2004, §5.64.) This dimensionless point is the locus of attention: whatever we happen to be conscious of at a given moment. The locus of attention determines the contents of System 2. Whatever enters the working memory to be addressed either algorithmically or reflectively depends on where the attention is directed.

The content of consciousness are the processes that register in System 2, in other words those processes ongoing in the cognitive system that register in the working memory. This includes perceptions processed by System 1 sensory subsystems as well as associations and other cognitive inputs from System 1. Most cognitive processes take place in System 1, and only scarce few of them register at a time in System 2.

One way to observe the two systems is that System 1 is *the* cognitive system, and System 2 is constrained by the center of attention within it, whether it be centered by perception, computation or reflection. System 1 produces by various mechanisms the thought processes out of which a few post their end result into the conscious mind, or the System 2.

To put this into Evans’ terms, Type 1 processes are most of the cognitive processes taking place in the cognitive system. Type 2 processes are the algorithmic

processes that require attention and working memory. Type 3 processes are, in turn, the reflective self's influence and mediation between Type 2 and Type 1 processes. While Type 2 and Type 3 processes employ working memory and are thus driven by System 2, both employ constantly processes generated by System 1. Thus they also affect the ongoing Type 1 processes.

Intuition concerns the Type 1 processes that post their end result into System 2. The massive System 1 can parse through a tremendous amount of information without our being aware of it, reacting fast to a salient input. A typical example is the cocktail party effect. While our consciousness interprets the dozens of conversations going on at the party as noise, our System 1 singles out interesting inputs constantly from the noise. And as soon as something interesting is mentioned – for example, your name – your attention shifts immediately towards the interesting conversation.

The capacity alone does not, however, suffice to explain how some people can make such great intuitive leaps of inference and innovation, whereas others do not. To understand how intuitive thought processes are generated, we must look deeper into the nature of System 1 processing.

2.2.2 Phylogenetic and Ontogenetic Type 1 Processes

The processing power of System 1 alone does not suffice to explain how we have such a capacity as intuition. A further look at the structure of System 1 is required.

While System 1 can be studied in terms of neural correlates, this alone does not give us deeper insight on how intuitive insight is generated. There are areas in the brain that are indicated in intuitive decision making (Lieberman, 2000, 2009; Dietrich 2004; Goel 2007; De Neys and Goel 2011; see also Sect. 1.3 above). But the question of how these neural correlations translate to intuitive thought is still largely unknown.

In order to understand how intuitive insight is generated, we should rather look at the origin and function of Type 1 processes that take place in the System 1. These can be roughly divided according to their evolutionary background into phylogenetic and ontogenetic processes (Table 2.3).

Phylogenetic processes are non-conscious processes that are strongly heritable. These include the functioning of the autonomous nervous system, the fight or flight reflex and other reflexes, many emotional reactions and parental protective behavior. Phylogenetic processes have developed through the biological evolution of our species. They are common to every human being, most of them shared even with the majority of higher animals. These processes have proven to function well in ensuring the survival of our species throughout millennia.

Ontogenetic processes are acquired through experience and practice. While phylogenetic processes drive the *instinctive* side of System 1 cognition, ontogenetic processes are the driver of *intuition*. Intuitive thinking is, in other words, directly linked to previous experience and expertise – a finding that has been corroborated by much of the literature on intuition. (See e.g. Klein, 1998; Gladwell 2005;

Table 2.3 Examples of ontogenetic and phylogenetic processes

Ontogenetic processes	Phylogenetic processes
Skills	Physical reactions
Beliefs	Emotional reactions
Decision making heuristics	Protective parental behavior
Expert decisions	Fight or flight
Creative ideas	Maximizing energy intake

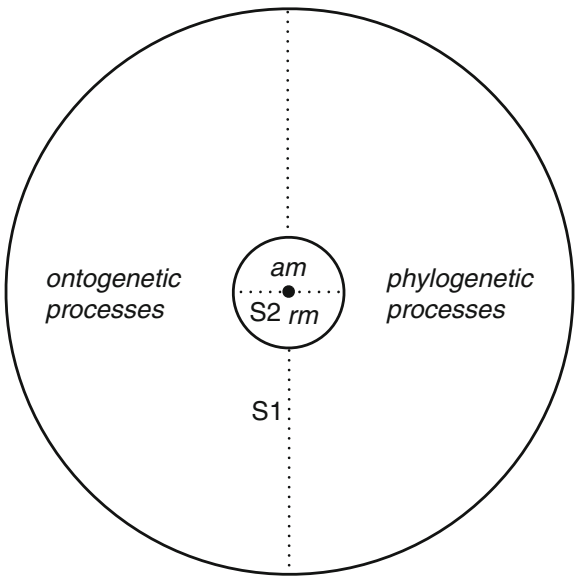
Gigerenzer 2007; Dane and Pratt 2007; Kahneman 2011; Kahneman and Klein 2009; see also Sect. 1.3 above.) As Stanovich notes, System 1 is not limited to evolutionarily compiled knowledge, but also can access information in the System 1 generated through learning and practice (Stanovich 2009, p. 71).

Intuition is not a magical know-all facility, but rather a form of *skilled action driven by ontogenetic Type 1 processes*. To this end, the nested model can now be augmented with the division of the System 1 into two subsystems, the ontogenetic and the phylogenetic systems that drive, correspondingly, ontogenetic and phylogenetic Type 1 processes (Fig. 2.3).

Intuition is about utilizing past experiences and the associative nature of the System 1 to produce viable insight in various situations. The challenge with using intuitions is now to tell the two types of Type 1 processes apart from one another. The differentiation between ontogenetic and phylogenetic processes gives us tools for such differentiation.

If a Type 1 input is recognized as a phylogenetic process, it should typically be ignored. Phylogenetic Type 1 processes have developed through biological evolution to function well in our natural environment.

Fig. 2.3 Ontogenetic and phylogenetic processes in the System 1 and the algorithmic/reflective minds in the System 2



With cultural evolution, the environments in which we function have changed a great deal, and instinctive behavior seldom produces viable results. Consider for example the instinct to maximize energy intake. In the energy-abundant environment of today, this will not lead to the well-being of the person, but rather causes a variety of discomforts if not checked by System 2, or supported with ontogenetic Type 1 processes, such as the habit of regular exercise.

Therefore, the rough guideline in identifying the viability of Type 1 inputs is to judge them by their evolutive background. Ontogenetic Type 1 processes have been adapted to our present environment, and thus we should rather generally follow these. While this is a good rough guideline, the issue of identifying viable intuitions is considerably more complicated than this and will be addressed in greater detail below.

2.2.3 On the Possibility of the Smart Unconscious

In the recent decades, a substantial amount of research has been gathered that points towards a large portion of advanced cognition occurring autonomously (See e.g. Bargh et al. 1996; Bargh and Chartrand 1999; Jacoby et al. 1992; Draine and Greenwald 1998; Kahneman 2011; Dijksterhuis 2004; Dijksterhuis and Meurs 2006; Dijksterhuis and Nordgren 2006). This gives rise to the question: how smart is the non-conscious mind?

John Bargh is one of the most vocal proponents of the automaticity of cognition (See e.g. Bargh et al. 1996; Bargh and Chartrand 1999). Bargh has become famous for his experiments on non-conscious social priming, where given words or impulses have triggered new kinds of behavior (Bargh et al. 1996). Perhaps the most famous of the priming experiments is one where one group of students where exposed to words typically associated with old age, such as ‘Florida,’ ‘wise’ and ‘lonely’. (Bargh et al. 1996, p. 236.) After the test, these students walked significantly slower. The argument is that the students adjusted their behavior automatically to reflect the idea of old age.

Automaticity is developed by an interplay between internal, or more local, cognitive processes and the environment. Bargh and Chartrand go on to argue that mental representations are, not unlike Peirce’s and James’ habits (see Sect. 1.2), processes that, once activated, carry out their function regardless of the initial stimulus that activates the process:

The activated mental representation is like a button being pushed; it can be pushed by one’s finger intentionally (e.g., turning on the electric coffeemaker) or accidentally (e.g., by the cat on the countertop) or by a decision made in the past (e.g., by setting the automatic turn-on mechanism the night before). In whatever way the start button is pushed, the mechanism subsequently behaves in the same way. (Bargh and Chartrand 1999, p. 476.)

Bargh and Chartrand argue that such automatic processes are in our very best interests. They liken them to “mental butlers” who take care of our needs without having to be asked to do so. (Bargh and Chartrand 1999, p. 476.)

Bargh’s position presents a far more potent hypothesis as is entertained typically by dual process theorists. In the dual process theories, System 1 is often considered as a relatively straightforward mechanism, where given stimuli trigger automatically predetermined processes (be they phylogenetic or ontogenetic in nature). Bargh seems here, however, to posit that in addition to containing such automatic processes, System 1 could be construed as capable of very complex processing.

The social psychologist Ap Dijksterhuis takes this already controversial idea one step further. He argues that intuitive decision making is, in fact, superior to analytic decision making, at least if the problem at hand is complex enough. (Dijksterhuis and Nordgren 2006, p. 96.)

On the grounds of both their own empirical work on intuitive decision making, as well as the works of Bargh and others, Dijksterhuis and Loran Nordgren have formulated a theory of the smart unconscious, or the “Unconscious Thought Theory” (Dijksterhuis and Nordgren 2006; Dijksterhuis 2004). The basic idea of the Unconscious Thought Theory is that intuitions may, in fact, be preceded by a great deal of non-conscious processing (Dijksterhuis and Nordgren 2006, p. 106).

Following the dual process literature, Dijksterhuis and Nordgren argue that there are two types of thought: conscious and unconscious. Dijksterhuis and Nordgren define conscious thought as follows:

We define conscious thought as object-relevant or task-relevant cognitive or affective thought processes that occur while the object or task is the focus of one’s conscious attention. This rather complex definition simply describes what laypeople would call thought. (Dijksterhuis and Nordgren 2006, p. 96.)

Non-conscious thought is defined thus: “Unconscious thought refers to object-relevant or task-relevant cognitive or affective thought processes that occur while conscious attention is directed elsewhere” (Dijksterhuis and Nordgren 2006, p. 96).

Dijksterhuis and Nordgren present five principles that formulate the Unconscious Thought Theory: the *capacity principle*; the *bottom-up-versus-top-down-principle*; the *weighting principle*; the *rule principle*; and the *convergence-versus-divergence principle*.

The *capacity principle* means that conscious thought is constrained by the low capacity of consciousness (Dijksterhuis and Nordgren 2006, p. 96; see also above Sect. 1.3). Non-conscious thought, in turn, has no such immediate constraints, and can process a great deal more information than consciousness (Dijksterhuis 2004; Dijksterhuis and Nordgren 2006). Thus, the higher capacity of non-conscious thought gives it an advantage in evaluation and decision-making.

The *bottom-up-versus-top-down principle* concerns the schematic differences between non-conscious and conscious thought. Dijksterhuis and Nordgren argue that conscious thought works schematically, or top-down. Non-conscious thought, in turn, works aschematically, or bottom up. (Dijksterhuis and Nordgren 2006, p. 97.) They argue that conscious thought is inherently hierarchical, whereas

automatic processes are not. Dijksterhuis and Nordgren found out in their experiments that conscious thinkers tend to think in terms of stereotypes:

Our findings clearly demonstrated that conscious thinkers applied stereotypes more than unconscious thinkers did. They judged the target person in a more stereotypical manner, and their recall was biased in that they recalled more stereotype-congruent than stereotype-incongruent behavioral descriptions. Unconscious thinkers did not demonstrate stereotyping. (Dijksterhuis and Nordgren 2006, p. 98).

Furthermore, they argue that conscious thought is riddled with “jumping to conclusions”, a finding that is well in line with the research on heuristics and biases by Tversky, Kahneman and others. (Dijksterhuis and Nordgren 2006, p. 98; see also Kahneman 2011, p. 79 ff.)

Whereas conscious thought operates schematically, with a tendency towards stereotypes and jumping to conclusions, Dijksterhuis and Nordgren argue that non-conscious thought operates aschematically, integrating information to form an objective summary judgment. (Dijksterhuis and Nordgren 2006, p. 98.) Dijksterhuis and Nordgren hold, rather controversially, that unconscious thought causes better organization of information in memory. (Dijksterhuis and Nordgren 2006, p. 99.) Finally, they argue that unconscious thought is not just a residual process of earlier conscious processing, but an active, goal-directed process in itself. (Dijksterhuis and Nordgren 2006, p. 99.)

The *weighting principle* means that the non-conscious mind automatically weighs the relative importance of attributes relevant to decision-making, whereas conscious thought often leads to worse results (Dijksterhuis and Nordgren 2006, pp. 99–100). Consciousness operates with the most accessible information, putting disproportionate weight on plausible, accessible or verbalizable attributes at the extent of others. (Dijksterhuis and Nordgren 2006, p. 100.)

The *rule principle* means that conscious thought can follow strict rules, whereas non-conscious thought works more in terms of rough estimates. (Dijksterhuis and Nordgren 2006, p. 101.) There is some evidence towards the non-conscious mind’s capacity to resolve complex evaluation-related problems, such as buying an apartment or a car (Dijksterhuis 2004). Certain types of tasks, for example complex arithmetics, are however unresolvable for the non-conscious mind. Incubation will not be likely help you determine how much is 17×24 . A conscious, rule-based process is required. In tasks requiring rule following, non-conscious thought is not of much use. Its power lies in its associative capacity.

The *convergence-versus-divergence* principle means that conscious thought is focused and convergent, whereas non-conscious thought is fuzzier and more divergent. In a series of experiments, Dijksterhuis and Meurs demonstrated that conscious thinkers generated more typical answers to creative problems, whereas non-conscious thinkers who were distracted from thinking about the problem generated more divergent and creative solutions (Dijksterhuis and Meurs 2006). To conclude, non-conscious thought appears to be more conducive to creative thinking than conscious thought owing to its more divergent and associative nature.

While some of their conclusions about the functioning of the non-conscious is rather controversial, Dijksterhuis and Nordgren do arrive at a similar general conclusion as the formulation given above, in Sect. 1.3. According to them, intuition is based on previous experience and access to relevant information. (Dijksterhuis and Nordgren 2006, p. 106.)

In Dijksterhuis' experiments, subjects made decisions about buying apartments. They were divided to three groups: immediate deciders, analytic deciders and intuitive deciders. The immediate deciders were shown the options and asked to pick one straight away. The analytic deciders evaluated the options consciously before making a choice. The intuitive deciders were distracted with a task that occupied much of their working memory (a two-back test). After the distraction, they were instructed to pick the option that best suited them. The results were consistently that the immediate deciders performed the worst, whereas—somewhat surprisingly—the intuitive deciders performed better than both immediate and analytic deciders. (Dijksterhuis and Nordgren 2006, pp. 95–96.)

Dijksterhuis and Nordgren argue that this is due to the working of a “smart unconscious” that grinds through the available data and is able to tap into the massive associative capacity of the non-conscious mind. In particular, the quality of conscious decision making has a reverse correlation with the complexity of the problem, whereas the quality of non-conscious decision making stays relatively constant. (Dijksterhuis and Nordgren 2006, p. 103).

From this Dijksterhuis and Nordgren conclude that with simple problems, the better strategy is to employ conscious evaluation, whereas for complex problems, it is better to first familiarize with the problem and then distract the conscious mind for example with a puzzle game for a while, to let the non-conscious mind process through the options. (Dijksterhuis and Nordgren 2006.) This should, in the light of the Unconscious Thought Theory, produce better results intuitively.

The research of Bargh, Dijksterhuis and their colleagues does indeed present by the least a credible case for a smart unconscious that is grinding through a massive amount of information without our being aware of it. This evidence is also partly coincident with the literature on dual process theories. Perhaps the smart unconscious is powered by highly advanced and complex ontogenetic Type 1 cognitive processes that can address issues where the limited-capacity System 2 cannot come up with enough novelty.

This would be further supported by the phenomenon of incubation typical to creative thought, where the associative capacity of System 1 can produce new and viable cognitive inputs from Type 1 processes (Dijksterhuis and Meurs 2006; Csikszentmihalyi 1996). This point of view would go a long way in explaining how incubation and intuitive decision making work, and why it, at least in some settings, appears to trump analytic decision making.

Recently, the research of both Bargh and Dijksterhuis has, however, met with substantial criticism. Most prominently, the critique has been grounded on a number of failed replications of both Bargh's priming experiments as well as Dijksterhuis' decision-making experiments. (See e.g. Huizenga et al. 2012; Shanks et al. 2013.)

The critics of the smart unconscious argue that the failures to replicate warrant caution against drawing conclusions concerning the power of non-conscious thought. Huizenga et al., in evaluating Dijksterhuis' research, blankly state that "Based on our findings, and those of previous studies, we conclude that Unconscious Thought Theory does not provide an adequate description of unconscious and conscious decision processes." (Huizenga et al. 2012, p. 340.)

Shanks et al., failed, in turn, to replicate Bargh's research. They state that their results support a view that conscious thoughts are a primary driver of behavior and that unconscious influences "have limited and narrow effects" (Shanks et al. 2013, p. 10.)

John Bargh has generated some responses to his and Dijksterhuis' critics (Bargh 2011, 2012). He goes on to state that there are at least three reasons why the criticism of the smart unconscious is either non-conclusive or outright fails.

First of all, Bargh argues that the assaults on the smart unconscious are based on an outdated idea of the unconscious mind that equates it with the subliminal. (Bargh 2011, p. 636.) In the light of the dual process theories, the nature of the unconscious is now understood much better than in classical psychology.

Second, after closer scrutiny, many of the "failures to replicate" do, according to Bargh, produce at least equivalent results between conscious and non-conscious thought – a result that is surprising enough from the point of view of the assumption that conscious deliberation should be clearly superior. (Bargh 2011, p. 639.)

Third, he argues that the situations where more prominent positive results are produced are such where the decision making deals with more "real-life" situation, compared to the decision theorists' replications. (Bargh 2011, p. 642.) Bargh also cites a number of quite successful replications of priming experiments. (Bargh 2012; see e.g. Hull et al. 2002; Decoster and Claypool, 2004; Cameron et al. 2012.)

In the light of the present research and the debate linked with it, the question of the smart unconscious cannot be resolved conclusively. However, when Bargh's and Dijksterhuis' and their colleagues' social psychological research is seen in the wider light of both the neuroscientific evidence for non-conscious processing as well as some of the dual process research in the field of cognitive psychology, it is far too early to throw it out of court only due to a failure to replicate some of the key experiments.

In addition, while the idea of a smart unconscious may be untenable, there is further research that goes to show how learned non-conscious processes can produce viable cognitive inputs that register as intuitive, without the need to posit highly complex computational or intelligent interactions within the non-conscious mind.

2.2.4 Intuition as Skilled Action

While the idea of the smart unconscious warrants further study, a large amount of research points towards the superiority of non-conscious thinking in certain kinds of

situations that can be explained without the need to postulate a non-conscious intelligence. Rather, this view to intuitive thinking and decision-making starts with the assumption that instead of a complex computation, intuition is more like skilled action.

Gerd Gigerenzer presents a four-fold taxonomy for explaining intuitions. According to Gigerenzer, *gut feelings* are produced by *non-conscious rules of thumb*. These are, in turn, based on *evolved capacities of the brain* and *environmental structures*.

Gut feelings are intuitions as experienced. They “appear quickly in consciousness, we do not fully understand why we have them, but we are prepared to act on them.” (Gigerenzer 2007, pp. 47–48.) The problem with the trustworthiness of gut feelings is that many other things appear suddenly in our minds that bear a similar clarity and that we feel like acting on, for example the urge to grab an extra dessert. But not all such reactive System 1 behaviors are good for us.

Rules of thumb are, according to Gigerenzer, what produces gut feelings. These are very simple heuristics that are triggered either by another thought or by an environmental cue, for example the *recognition heuristic*, where a familiar brand evokes positive feelings. (Gigerenzer 2007, pp. 47–48.) *Evolved capacities* are what rules of thumb are constructed of. They include capacities such as the ability to track objects or to recognize familiar brands. (Gigerenzer 2007, pp. 47–48.)

And finally, *environmental structures* determine whether a rule of thumb works or not. The recognition heuristic may work well when picking up a can of soda or even stocks, if it is directed towards trusted and well-known brands. (Gigerenzer 2007, pp. 47–48.)

Here, Gigerenzer comes close to both Bargh’s and Dijksterhuis’ theorizing. Where he differs, however, is in refusing to posit a complicated processing mechanism in the non-conscious. Rather, Gigerenzer’s experiments show to some degree that intuitions are, in fact, often quite simple.

The core idea in Gigerenzer’s model is quite similar to Herbert Simon’s idea of intuition as recognition: “The situation has provided a cue; this cue has given the expert access to information stored in memory, and the information provides the answer. Intuition is nothing more and nothing less than recognition.” (Simon 1992, p. 155.)

Gigerenzer holds that environmental triggers give rise to simple cognitive mechanisms that have proven to be very efficient both in terms of the evolution of the species as well as that of the organism.

For example, the recognition heuristic – a simple rule of going with a familiar brand—enables us to make surprisingly good decisions when faced with multiple choices (Gigerenzer 2007, p. 112). Going with a familiar choice, people could make better choices just by picking the more recognizable option, for example in predicting sports scores, or evaluating colleges (Gigerenzer 2007, p. 111 ff.).

While the evolutionary basis of such recognition is, of course, quite complicated, requiring many non-conscious memory- and association-related tasks to succeed, the rule of the thumb itself is relatively simple and does not require a smart non-conscious evaluation of choices or computation. Rather, it is based on the process

triggered by the familiar choice that generates a pleasant emotional association, or a gut feeling.

The problem with Gigerenzer's position is that while there are some heuristics that seem to work pretty well in many situations (such as the recognition heuristic), heuristics are also notoriously misleading, and often indiscernible from *negative heuristics*, or cognitive biases. In fact, the study of heuristics and biases, made famous by Amos Tversky and Daniel Kahneman, has become one of the most substantiated research traditions in intuitive decision making.

Gary Klein has developed a similar position to Gigerenzer's in his famous decision-making research. In Klein's *recognition-primed decision making model*, decisions are made neither by a rational, conscious weighing scheme, nor by a fast non-conscious calculation, but are based rather on quickly recognizing viable strategies for action based on expertise. (Klein 1998.)

Like Gigerenzer's, Klein's idea is based on Herbert Simon's conception of intuition as recognition. According to Klein's research, people do not in fact typically make decisions by rationally evaluating choices. (Klein 1998, loc 202.) Rather, a great majority pick up a choice that first comes to mind, mentally simulate it, and if it seems to work, go with the first viable one, without ever considering options. This decision-making scheme follows the strategy of *satisficing*, (accepting the first viable option), made famous by Simon, in contrast to the more rational strategy of *optimizing*, i.e. weighing all possible options and picking the one that comes out on top as best. (Simon 1956.)

The difference between Gigerenzer's and Klein's positions is in that where Gigerenzer assumes that gut feelings are produced by heuristics or rules of thumb that are typical to all humans and produced by our environment, Klein's idea of recognition-priming is based on picking up much more individually complex strategies of action based on prior experience and expertise.

In terms of the dual process terminology, both Gigerenzer's and Klein's positions employ Type 1 processes that are triggered by an environmental event or another thought. Klein's position, however, starts with the assumption that the relevant ontogenetic Type 1 processes, or the primed strategies, are complex skills or skill-sets, such as a military strategy or a chess move that is chosen based on the recognition of its applicability to the situation at hand.

We have now three different points of view to explaining intuitive insight: first, Bargh's and Dijksterhuis's idea of the smart non-conscious, where highly complex operations take place automatically within the confines of System 1, if we just distract the System 2 for a moment; Gigerenzer's position, where simple and common Type 1 processes generate gut feelings when triggered by an environmental event or another thought; and Klein's position where complex strategies committed to System 1 by experience are triggered by an environmental event or another thought.

All three positions can, however, be seen as variants of a common theme that was already reflected in the pragmatists's notion habits of action. This common ground can be found in interpreting intuition as a form of *skilled action*.

The gist here is that we generate a considerable amount of ontogenetic Type 1 processes, or habits, by exercise, deliberate practice and daily experience. These processes are, as Stanovich notes, “ballistic” in the sense that once they are triggered, they typically run their course, unless interrupted with (a reasonably effortful) “TASS override” or the reflective System 2’s interrupting the ongoing Type 1 process. (Stanovich 2009, p. 57.) Given the amount of sensory information we receive every moment, not to speak of the associative Type 1 processes taking place, such trigger events are, no doubt, abundant.

With an inexperienced person, such ontogenetic Type 1 processes or strategies are few, and therefore also the capacity to trigger viable strategies is low. Indeed, this was what Klein discovered in his studies: only when people were very inexperienced were they likely to resort typically to rational decision making schemes. The experts would use what he calls “naturalistic decision making,” a simple process of recognizing a possibly viable strategy, evaluating it by mental simulation and implementing it quickly. (Klein 1998 loc 652 ff.)

While the question of talent still draws the lines between nature and nurture, or genes and practice, much of research on expertise in the recent decades has started to emphasize the latter. Especially the research carried out by Anders Ericsson and his colleagues points out that top performers have consistently put in a tremendous amount of deliberate practice to acquire their skills. (Ericsson et al. 1993.) This is often quoted as the “10,000 h rule,” including Ericsson himself. As Ericsson points out, it takes about 10,000 h, or ten years, of deliberate practice to become an expert in a domain (Ericsson et al. 2007).

It takes a lot of time and a lot of experience to build the ontogenetic Type 1 processes that can be applied in the various situations in one’s domain of expertise: to recognize the various game strategies in chess, to be able to learn the correct moves in a game of tennis, or to learn to navigate a burning house. In other words, to commit to the automatic System 1 a sufficient amount of skills to navigate a demanding domain, such as chess, tennis or firefighting.

In a meta-analysis of research on intuition in the managerial context, organizational psychologists Erik Dane and Michael G. Pratt discovered, akin to Dijksterhuis, Bargh, Gigerenzer and Klein, that intuitive decisions are in a great many settings of higher quality than analytic ones (Dane and Pratt 2007, p. 33).

Dane and Pratt argue that the applicability of intuition is highly domain-specific. Those managers who trusted their gut feelings performed better in the areas they were experts in. Outside those areas, the value of the gut feeling was not much better than a guess (Dane and Pratt 2007.)

In the light of the above, it seems that intuition is a domain-specific capacity that is developed by experience and deliberate practice. In other words, intuition consists of a set of skills and heuristics used to navigate a complex environment. Experience and deliberate practice give rise to ontogenetic Type 1 processes in the System 1 and thus hone it to function better in the domain where the experience is generated. Such processes allow us to adapt to a culturally evolved environment to which our biological heritage could not have prepared us.

In construing intuition as skilled action, it differs in no way from the multitude of the other skills we acquire through experience and practice. Being able to intuitively discern a viable chess strategy or to quickly guide firemen from a burning house about to collapse is no more wondrous than learning to walk or read.

With enough practice, skilled action is committed to the System 1 or the non-conscious mind because we could not, owing to the limitations in working memory capacity, by any means be able to keep in consciousness all the phases a skill requires. Consider, for example, a top footballer or pianist thinking about every step or every move of fingers. The performance would become impossible. The difference between the smart unconscious and the skilled action view is the amount of complexity posited to the System 1 processes. Here, it is assumed that the mark of the expert is in fact not the non-conscious capability to complexity, but rather the capability to simplicity.

In having experienced a multitude of situations and scenarios that work within a domain, these experiences have given rise to ontogenetic Type 1 processes that are triggered with the right kinds of environmental cues. Add to this the associative power of the non-conscious mind, and the picture of intuitive thinking starts to clear.

Intuitive thought is based on experience- and expertise-generated ontogenetic Type 1 processes. These enable us to function well in a culturally evolved environment in which our genetically encoded phylogenetic Type 1 processes do not function very well.

For a great part, intuitive thought relies on acquired habits that are triggered by environmental cues or other cognitive processes. These processes may also combine following the associative nature of the System 1, which explains Dijksterhuis' results with the individuals whose System 2 was distracted generating more creative options than those who had their reflective System 2 online considering the problem.

In a typical situation that is recognized based on expertise, the viable strategy presents itself immediately and intuitively. The intuitive processes also enable us to identify atypical situations where the decision making can be committed to the algorithmic mind. Also here, intuitions can serve us in possibly providing functional rules of thumb to suit the situation, or in deferring the creation of potential new strategies of action to the System 1 by distracting the System 2 momentarily.

As Kahneman points out, expertise is not just one skill, but a huge collection of skills. (Kahneman 2011, p. 238.) One expert, for example a clinician, may have strengths in some areas of expertise and be weaker in others. Expertise could, indeed, be construed as a collection of micro-skills, each a kind of a micro-module or habit of action represented in an ontogenetic Type 1 process that can be triggered either by a recognition of a cue in the environment, or a non-conscious activation arising from the association of parallel processing in System 1.

These micro-skills allow us to navigate a highly complex and evolving environment and develop adaptive new strategies when old ones do not work. Thus, intuition is the capacity to produce viable domain-specific results in a context using

autonomous processes in System 1. Or to put it more simply, intuition is a form of skilled cognition, as differentiated from skilled action.

But while positioning intuitive thought into a domain-specific skill-set in the System 1, or a set of ontogenetic Type 1 processes, goes a long way, there is still a piece missing from the puzzle. Namely, the role of the environment in generating intuitive insight.

2.3 Intuition and the Environment

Roughly put, the processes that drive intuitive thought reside in the System 1. To a great extent, they should also correlate with various brain functions. As was argued in Sect. 1.3, much of neuroscientific research seems to warrant this assumption. Thus it would seem to be the case that intuition “resides” in the brain.

However, intuition research also seems to point towards another important factor to intuitive thought: domains, contexts and the environment. As Gigerenzer points out, “in order to understand behavior, one needs to look not only into the brain or mind but also into the structure of the physical and social environment.” (Gigerenzer 2007, p. 76.)

In the last few decades, various positions taking the influence of the environment seriously have arisen, ranging from embodied cognition in psychology to the extended mind hypothesis in the philosophy of the mind.

2.3.1 *The Extended Mind Hypothesis*

The philosophers Andy Clark and David Chalmers published in 1998 an influential paper called “The Extended Mind” (Clark and Chalmers 1998). In the paper, Clark and Chalmers argue that cognition can sometimes extend “beyond the head.” If an object, such as a notebook, can take a part of a process that would otherwise be considered cognitive, such as recollection, the notebook should be considered a part of the cognitive process just as we would consider a typical brain area, such as the hippocampus, a part of it.

Clark and Chalmers present a thought experiment concerning two people, Otto and Inga. Inga’s memory works normally. Otto, however, suffers from the Alzheimer’s, and cannot memorize new information. To overcome this handicap, Otto carries everywhere a notebook where he keeps important information. (Clark and Chalmers 1998.)

Now say Otto and Inga want to visit the museum on the 53rd street. For Inga, the matter is straightforward. She will simply consult her memory and find the proper way to get there. Otto, however, has no memory about a museum on the 53rd street. He can nonetheless look it up on the notebook. Both Otto and Inga arrive at the museum, safe and sound, despite the fact that for Inga, the memory was based on

her nervous system, and for Otto on his notebook. The question arises, shouldn't we now consider the notebook a part of Otto's cognition?

In the introduction to Clark's book *Supersizing the mind* (2011), Chalmers writes,

A month ago, I bought an iPhone. The iPhone has already taken over some of the central functions of my brain. It has replaced part of my memory, storing phone numbers and addresses that I once would have taxed my brain with. It harbors my desires: I call up a memo with the names of my favorite dishes when I need to order at a local restaurant. I use it to calculate, when I need to figure out bills and tips. It is a tremendous resource in an argument, with Google ever present to help settle disputes. I make plans with it, using its calendar to help determine what I can and can't do in the coming months. I even daydream on the iPhone, idly calling up words and images when my concentration slips. (Chalmers 2011, p. 1.)

Clark argues that "the material vehicles of cognition can spread out across brain, body and certain aspects of the physical environment itself" (Clark 2005, p. 1.) Chalmers, in turn, argues that "when parts of the environment are coupled to the brain in the right way, they become parts of the mind" (Chalmers 2011, p. 1.)

At the heart of the extended mind hypothesis is the *parity principle*: the idea that "if a process in the world works in a way that we should count as a cognitive process if it were done in the head, then we should count it as a cognitive process all the same" (Chalmers 2011, p. 2). Thus, if a calculator helps us do mathematical operations faster than we can do with our algorithmic mind, or if a web service can serve inspiration faster than associations in the System 1, these things should be considered parts of our cognitive architecture.

As Chalmers notes,

The dispositional beliefs, cognitive processes, perceptual mechanisms, and moods considered above all extend beyond the borders of consciousness, and it is plausible that it is precisely the non-conscious part of them that is extended. I think there is no principled reason why the physical basis of consciousness could not be extended in a similar way. It is probably so extended in some possible worlds: one could imagine that some of the neural correlates of consciousness are replaced by a module on one's belt, for example. (Chalmers 2011, p. 6.)

Perhaps the non-conscious mind—System 1—should be construed not only in terms of processes locally constrained to the thinking organism, but as incorporating also embodied and extended processes. It could be argued that any process that can in principle produce a conscious result should be incorporated as an element of System 1 thinking. For example, by using a cloud-based database, a person can significantly augment her memory capacity by being able to produce items of information at will by using a mobile device. Likewise, by using social media resources a person can boost her capacity in such cognitive processes as inference and problem-solving, and even creative inspiration

System 1 could be construed as incorporating all processes resulting in a System 2 input relevant to the cognitive organism, whether they originate in the brain or in the environment. Such a picture gets, however, too fuzzy, especially given the constantly growing evidence of neural correlations with System 1 functions.

Lumping together external influences into the System 1 is not a very viable position. A slightly more elaborate view is needed.

2.3.2 *Systems Intelligence*

For a large part of the 20th century, intelligence has been likened to the capacity to draw logical-analytic inference. It was thought for a long time that intelligence is a mostly fixed capacity that can be measured by, for example, the Stanford-Binet intelligence quotient test. Such attitudes gave rise to the idea that the measure of intelligence is primarily *psychometric*, i.e. measurable by a standardized test.

This view to intelligence has, however, been contested by many researchers. In particular, Howard Gardner's idea of *multiple intelligences* has given rise to a substantial literature where the existence of other kinds of intelligences, such as musical or kinesthetic intelligence are speculated. (Gardner 1983.)

An interesting addition to the idea of multiple intelligences is the *systems intelligence thesis* developed by Esa Saarinen and Raimo P. Hämäläinen. Saarinen and Hämäläinen argue:

The theory of systems intelligence claims that human beings do have 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. (Saarinen and Hämäläinen 2010, p. 9.)

Systems intelligence concerns the capacity to function well in complex systems, such as social interactions or complex environments, where the feedback loops between the cognitive agent and external factors are too complicated to be handled analytically. Saarinen and Hämäläinen define systems intelligence as follows:

By Systems Intelligence (SI) we mean intelligent behavior 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 a 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.)

As Jarno Rajahalme points out, “we are successfully participating in many systems simultaneously, even though we never fully know those systems and often are not even aware of them” (Rajahalme 2008, p. 29). The environment and other people are, in line with the extended mind hypothesis, seen to couple with the cognitive agent in ways that produce new emergent properties that would not take place without such coupling.

Some of the important background research for systems intelligence includes the intersubjective systems theory and infant research. In infant research, it has been shown that babies and mothers synchronize behavior at a very early age (See e.g. Reyna and Pickler 2009). In a sense, then the baby and the mother function as a

single system, or a dyad, coupled together through the sensory coupling transmitting expressions and emotions. The emotions shared by the mother and the infant are not the result of sensory input-output systems, but are co-created by the two participants in the systemic coupling.

Systems intelligence is about the ability to be sensitive to changes in social interactions and the environment, at times without being consciously aware of such changes. In this sense, the concept resembles the definition of intuition delineated above. Systems intelligence is about the (mostly) non-conscious ability to produce viable results, with the added determination that these results are produced in a co-creative setting within systems containing a multitude of feedback loops between various actors and objects.

At a central role to systems intelligence is the notion of engagement: the ability to action-orientedly, adaptively, holistically and contextually link to the environment as an ongoing process. (Hämäläinen and Saarinen 2008, p. vii.)

Martela and Saarinen delineate three principles of systems intelligence. First, we must see our environment as a system we are embedded in. Second, we need to understand that intelligent behavior cannot be traced back only to the capacities of an individual, but arise as features of the entire system in which the individuals operate. And lastly, intelligent behavior is always relative to a context. (Martela and Saarinen 2008, p. 196 ff.)

Imagine a completely car-illiterate quantum physicist visiting a car shop and participating in tuning up a sports car. She would probably not be considered very smart in that context. Conversely, a world class car mechanic with no grasp of mathematics beyond basic arithmetic visiting a physics lab at CERN would no doubt receive similar consideration. And yet, in their respective domains of expertise, both would be top performers, and considered intelligent by their peers.

Jones and Hämäläinen (2013, p. 168) determine eight different traits that can be used to evaluate systems intelligence. They are *Systemic Perception*, or understanding how we are embedded in systems; *Attunement*, or the capacity to connect with others; *Positive Engagement*, or the quality of our interactions; *Reflection*, or the ability to think about one's own thinking; *Positive Attitude*, or the capacity to approach things with a positive outlook; *Spirited Discovery*, or the tendency and willingness to creative engagement; *Wise Action*, or the ability to grasp situations; and *Effective Responsiveness*, or the skill to find the appropriate actions in a situation.

If we accept the role of the environment in producing intuitive insight, the borderline between systems intelligence and intuition becomes fuzzy. Systems intelligence is about the subject's ability to act constructively and productively in a system. Intuition is about the subject's ability to produce viable results non-consciously in a domain of expertise.

The two conceptual constructs do not quite exactly coincide. For example, while emotions and non-conscious processes figure as important to systems intelligence, they do not function as a demarcation criteria for it as they do for intuition. But one might argue that the capacity to intuitive thinking figures as a very important feature of being able to act system intelligently.

Intuition can be seen as a central systems intelligent capability that we can use to navigate complex systems. In terms of systems intelligence, Bargh's priming, Gigerenzer's environment-driven heuristics and Klein's recognition-primed decision making can be construed as cognitive events where changes in the environment reconfigure the System 1 to function better in the changed situation. The newly configured behavior in turn changes the environment, and thus a feedback loop is born.

We are not cognitively isolated individuals, but rather function in complex systems where the structure of ongoing cognitive processes changes constantly in accord with changes in the system. This gives rise to the question of what is the environment's role in generating cognition more generally, and intuition more specifically.

2.3.3 Intuition, Organism, and Environment

As the Nobel Laureate Herbert Simon put it, "Human beings, viewed as behaving systems, are quite simple. The apparent complexity of our behavior over time is largely a reflection of the complexity of the environment in which we find ourselves." (Simon 1996, p. 53.) Simon coined an apt analogy about the interactions of the mind and the environment. According to him, the interplay between the mind and the environment can be compared to the blades of a pair of scissors. One cannot quite understand how scissors work by looking at just one of the blade. Likewise, by just looking at the brain or the environment in isolation will not inform us of how human cognition works. (Simon 1990, p. 7.)

Bargh and Chartrand argue that "most of a person's everyday life is determined not by their conscious intentions and deliberate choices but by mental processes that are put into motion by features of the environment and that operate outside of conscious awareness and guidance" (Bargh and Chartrand 1999, p. 462). They hold that most of our daily actions are driven by mental processes that are stimulated by environmental features and events, not conscious choice and guidance. (Bargh and Chartrand 1999, p. 465.)

Cognition is directly dependent on elements in the environment. In addition to the literature on cognitive priming, the effect of the environment on cognitive function has been demonstrated on several occasions. Carver et al. (1983) exposed some participants in an experiment to hostility related words. The participants then took part in a supposedly separate electroshock experiment. Those participants who had been exposed to the hostile words gave longer shocks than the control group.

Leonard Berkowitz's electroshock experiment studied the effects of environmental elements on emotions (Berkowitz and LePage 1967). In the experiments, participants gave electroshocks in three different rooms. The first was decorated plainly. The second contained sports equipment. The third had a revolver and a rifle on display. The results were similar to Carver's experiment: those participants in the room decorated with guns gave larger shocks than the control groups. The

room's decoration alone made the participants feel more aggressive. The room changed their cognition and consequently their behavior.

Gigerenzer argues that automatic and flexible rules – in dual process terminology, Type 1 processes – are adapted to our past environment (Gigerenzer 2007, pp. 47–48.) Automatic rules are such that do not require a present evaluation of its applicability, such as many instant inferences about visual cues. This is aptly demonstrated by the Müller-Lyer illusion, where the two arrows appear to be of different sizes, while they in fact are not.

Flexible rules, in turn, involve an evaluation of which one to use. Gigerenzer argues that “rules of thumb are anchored not just in the brain but also in the environment” (Gigerenzer 2007, p. 49.) This is also the finding of Dane and Pratt, who point out that intuition “involves a process in which environmental stimuli are matched with some deeply held (non-conscious) category, pattern, or feature” (Dane and Pratt 2007, p. 37.)

Environment plays also an important part in the origin of both phylogenetic and ontogenetic processes. Phylogenetic processes have their origin in the biologically evolved environment that our species has lived in throughout the millennia, sculpting the phenotype.

Our phylogenetic reflexive behavior is well suited for the natural human state and is driven by a genetic code—what Stanovich calls “short leash” goals of the genes (Stanovich 2004). However, as cultural evolution has started to distance our daily environments from the biologically evolved ones, the plasticity of the ontogenetic processes has taken the task to adapt our capacities to function in such an environment. As Gigerenzer puts it, “capacities of the brain are always functions of both our genes and our learning environment” (Gigerenzer 2007, p. 58.)

In taking the environment into account, Type 1 processes can be divided according to a taxonomy where ontogenetic and phylogenetic processes can also be extended into the environment. An extended Type 1 process is such a process or habit of action that requires some kind of an environmental component to carry out.

Andy Clark offers an example of a phylogenetic extended process in the swimming activity of a bluefin tuna. The fish could not, of course, swim without the water, but furthermore, the tuna *employs* the water in a particular way to optimize its swimming patterns. (Clark 1999, p. 345.) Another example of a phylogenetic extended process can be found in the process of *stigmergy* employed by ants (Heylighen and Vidal 2008, p. 593). The ants instinctively leave pheromonal tracks in the nature that guides their activity. While individual ants are not very intelligent, the combination of the simple insects and their environmental cues enables them to perform quite impressive feats.

An example of an ontogenetic extended process could be writing on a word processor or playing a song on a piano. It is relatively difficult to keep a solid train of thought together for a very long time without using some kind of a writing aid. And of course, playing a song without the instrument present could be quite difficult. Even for a very experienced pianist, reproducing the finger movements of a piece of music accurately would be hard without the instrument.

To put the role of the environment in its proper place in the generation of intuitive thought, we can construe it as one further cognitive System, let us say, System 3.

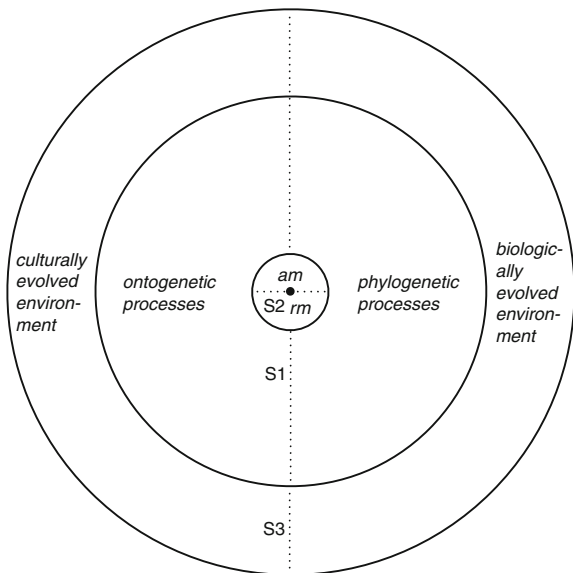
System 3 is responsible for generating the context for action, for the cues for Type 1 processes and it also participates instrumentally in extended Type 1 processes. While System 1 can be differentiated according to ontogenetic and phylogenetic processes, System 3 can be differentiated into the culturally evolved and the biologically evolved environments (See Fig. 2.4.). And similarly to the other two systems, we can to an extent affect the processes of System 3, for example by leaving visual cues in the environment, but we cannot entirely control them.

To summarize, intuitive processes are such Type 1 processes that have been acquired ontogenetically and vary from one individual to another. Instinctive processes are such Type 1 processes that have been acquired phylogenetically and are typical across the entire species. Extended processes are such Type 1 processes that have either an ontogenetic or phylogenetic component in the structure of System 1 but that also require an environmental element to carry out.

Type 1 processes take place in the Systems 1 and 3 and only post their results into the conscious System 2. The reflective mind of System 2 can then evaluate and decide depending on these results, and if need be, commit the intuitive and instinctive inputs for further scrutiny in the algorithmic System 2 mind, employing Type 2 (algorithmic) and Type 3 (reflective) processes in so doing.

All three systems form a nested hierarchy, at the center of which is the cognitive agent as a subject of experience. Subjective experience is determined by the locus of attention that is the center of the attention-driving, working-memory-limited conscious mind, or System 2. This, in turn, is fed by the various autonomous

Fig. 2.4 The three nested systems: System 1 (the non-conscious), System 2 (the conscious) and System 3 (the environment)



systems and processes of the non-conscious System 1, which in turn is constantly influenced by events and changes in the environment, or System 3.

In this light, intuition can be defined as *a domain-specific, context-sensitive capacity to produce viable results using both non-conscious and environmental cognitive processes*.

Or more simply put, intuition is the non-conscious ability to act systems intelligently in a domain of expertise.

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Decision Making

Järvilehto, L.

2015, XII, 86 p. 5 illus., Softcover

ISBN: 978-3-319-18175-2