How intuition contributes to high performance: An educational perspective

Christian Harteis, Tina Koch, Barbara Morgenthaler

(Institute for Education, University of Regensburg, Regensburg D-93040, Germany)

Abstract: Intuition usually is defined as the capability to act or decide appropriately without deliberately and consciously balancing alternatives, without following a certain rule or routine, and possibly without awareness (Gigerenzer, 2007; Hogarth, 2001; Klein, 2003; Myers, 2002). It allows action which is quick (e.g. reaction to a challenging situation) and surprising, in the sense that it is extraordinary in performance level or shape. This paper reports theories of intuition and their empirical evidence in the field of professional work. It aims at reporting the state of research on intuition, discussing the relevance of different approaches for analyzing work performance, and describing challenges for future empirical research in the domain of professional working life.

Key words: intuition; expertise; competence; decision making; rationality; information processing; cognition

1. Theories of intuition

Since it is plausible and usual to relate professional competence to knowledge (Gruber, Harteis & Rehrl, in press), it is appropriate to discuss the issue of intuition as a component of professional performance in a cognitive focus. Various authors dealt with intuition from a cognitive viewpoint recently: Gladwell (2005) might be the most popular of these, his book on intuitive decisions argues the significance of the first spontaneous impression in professional contexts, noting that it derives from implicit knowledge developed and enriched in years of experience. Without the requirement to balance alternatives, spontaneous impulses allow quick reactions to challenging situations. Hence, Gladwell's line of argument parallels the theory of fast and frugal heuristics (Gigerenzer & Todd, 1998) which also proclaims the superiority of simple but viable solutions as appropriate (but eventually not optimal) reactions to challenges. Myers (2002) discusses the ambivalence of intuition as the thinking style besides a conscious, analytic one. Intuition is in his understanding the use of implicit knowledge, which does not reach the level of awareness. The difference from frugal heuristic arises from the assumption that intuition grasps tacit or implicit knowledge and, thus, is based on complex cognitive patterns. Frugal heuristics, however, proclaims simple solutions. The basic assumption of two parallel thinking modes, operating simultaneously, also underlies the books of Hogarth (2001), Klein (2003), Davis and Davis (2003), three more recent monographs on intuition. The authors agree on the point that the human mind runs an analytic or rational and a heuristic or intuitive mode. Research on decision making supports this assumption, because recently developed theories on judgment indicate the intuitive and rational thinking modes are two parallel and permanent operating thinking systems (Kahneman & Frederick, 2002; Reyna, Lloyd & Brainerd, 2003; Sloman, 2002). They

Christian Harteis, Dr. phil. habil., Dipl.-Paed, University of Regensburg; research fields: professional learning, learning and instruction, cognition.

Tina Koch, cand. phil., University of Regensburg; research field: professional learning.

Barbara Morgenthaler, Dipl.-Paed., University of Regensburg; research field: professional learning.

share the idea with Hogarth and Myers that intuition utilizes tacit knowledge and is not dependent on awareness and concentration. Bastick (2003) and Myers (2002) describe another cognitive facet of intuition: The phenomenon of insight arises suddenly, especially in cases of longer, deliberate and unsuccessful thinking about a problem—and often after a period of incubation and rumination when thinking activities have been stopped. Finally, Bastick focuses on aspects of feelings and emotions in relation to intuitive decisions.

To sum up, three roots of cognitive perspectives on intuition can be distinguished and will be analyzed in the following: (1) spontaneous heuristics; (2) expertise including implicit knowledge; (3) two systems theories.

1.1 Spontaneous heuristics

The starting point of authors arguing spontaneous heuristics is the complexity of the world in general and professional working life in particular. Most of the decisions in working life must be made under the constraints of time or restricted information. Under such conditions the assumption of rational, logical inference as the basic principle of decision making seems not to be appropriate (Gigerenzer & Goldstein, 1996). Simon (1982) introduced the idea of bounded rationality as a model for decision making under constraint, and proposed the principle of “satisfying” as a contrast to optimization which was the idea of rationality. Satisfaction describes a blend of satisfying and sufficing, which means to come to a viable and satisfying solution within the parameters of certain constraints. As soon as satisfaction is the crucial criterion for decision making, individual preferences as the framework for satisfaction become relevant. People can differ individually in their judgment of a possible solution for a problem, and they may unconsciously refer to implicit criteria.

The idea of simple heuristics is that human decision behavior can be represented in a simple, frugal model which describes a search rule, a stopping rule and a rule for choice (Gigerenzer & Goldstein, 1996). The search rule describes the logic of discharging available options (e.g. increasing prices when comparing sales offers); the stopping rule addresses characteristics of the option which sufficiently discriminate the alternatives; the rule for choice is the consideration underlying the process of choice. Several of those fast and frugal heuristics can be found: A “take the best” heuristic (Gigerenzer & Goldstein, 1999) describes a reasonable decision strategy which refers to the stopping and choosing rules to considerations without necessarily connecting to the area of decision (e.g. recognition of relevant objects). Johnson and Raab (2003) could demonstrate in the domain of handball that the “take the first” heuristic—which means that one should trust the first idea—can generate good results. As if heuristics describe simple rules which lead to the same result as complex mathematical equations, e.g. the catching of a baseball can be described by a simple rule to keep the view-angle to the ball constant, but also by a complex physical equation (Shaffer & McBeath, 2002).

As the subjects have to be aware of these heuristics without necessity, and as they do not balance alternatives when applying these heuristics, the processes meet the definition of intuition given at the beginning of this paper. However, this approach to intuition contains a tricky problem: It is a crucial and basic question if one determines to describe human behavior with a (predictive) cognitive model as external attribution, which has no verifiable correlate with the subject’s internal processes. It is conceivable that the detection of a fast and frugal heuristic describes just an abbreviation of the cognitive pattern that influences an intuitive decision. This is the way the protagonists of fast and frugal heuristics practice, and they concede that they can “simulate people” (Gigerenzer & Goldstein, 1996, p. 655). On the other hand, there is no doubt that certain questions demand such a strategy of investigation. So Dhami and Ayton (2001) revealed while investigating 27 magistrates and finding that justice sometimes depends on individual biographies: Magistrates’ bail decisions can be modeled in a frugal heuristic which just considers whether a suspect has come in contact with the court before. However, it remains unclear if

the subjects are aware of that heuristic (they probably never would confess). Thus, doubts arise whether this fast and frugal heuristic really is an intuitive one.

Other viewpoints supplement the hesitation to apply the theory of fast and frugal heuristics as an explanation of professional work performance:

(1) In a comparison of stock market professionals with housewives, Borges, Goldstein, Ortmann and Gigerenzer (1999) attest that even ignorance-based frugal heuristics can perform better than that of sophisticated heuristics. However, the researchers construe an artificial competition which, on the one hand, has nothing to do with professional competition, because ignorance should not be a characteristic of professionalism; on the other hand, does not unveil for either the housewives or the experts to what extent the subjects decide intuitively.

(2) Another point is that the remaining on one (frugal) heuristic is not a characteristic feature of professional behavior. In the domains where fast and frugal heuristics have been tested, and expectations regarding professional performance indicate flexible responses (Ward, Hodges, Williams & Starkes, 2005; Agor, 1986a). It is unlikely that the repeated application of the same heuristic is a successful strategy for professional work life.

(3) A third disadvantage of the theories on fast and frugal heuristics consists in the lack of information on which ways heuristics are learnt and on what fundamental properties they rest. Though some authors refer to Simon's statement that "intuition is nothing more and nothing less than recognition" (Simon, 1982, p. 155) and, by that, imply that intuition is dependent on memory, most report nothing about the cognitive background. However, especially in the context of education, one needs a theory on which knowledge, competencies and capacities intuition refers, in order to develop instructional support for the training of intuition.

1.2 Expertise and implicit knowledge

Research on expertise usually describes the development of individual knowledge structures during the development from novice to expert. This approach dates from studies on chess which investigated the role of memory for extraordinary performances of perception and recognition (Chase & Simon, 1973a/b). Findings suggest that decision behavior in reality does not always completely follow rationality (Simon, 1955) and that experts recognize patterns in complex arrangements which enable them to respond spontaneously. On this basis arose the idea of intuition as recognition (De Groot, 1986). The tradition thinking of fast and frugal heuristics was discussed above. Dreyfus and Dreyfus (1986) developed a five-step model for the development of expertise in which the highest level of expertise is intuitive action that does not demand concentration, reflection or awareness. Their concept of expertise differs completely from fast and frugal heuristics, because in their model intuition uses rich knowledge of which people are not, or are no longer aware. However, this knowledge is acquired through experience and eventually by enculturation in a professional domain. A well-known example they quoted refers to chicken sexers, who work at chicken farms and can distinguish male and female chicken at the age of few days on a basis of which rational descriptions fail. Qualified sexers can find out the chicken sex of 2,000 chickens in one hour with 98 percent accuracy (Biederman & Shiffar, 1987), but they are unable to report their decision criteria, they are just doing it intuitively (Dreyfus & Dreyfus, 1986).

Eraut (1994) reviews research on professional expertise and notes that the developed structures of explicable (declarative and procedural) knowledge only describe one (important) aspect of professional performance; intuition is an important supplement. He defines intuition as "not only pattern recognition but also rapid responses to developing situations…based on the tacit application of tacit rules. These rules may not be explicit or capable of reasoned justification, but their distinctive feature is that of being tacit at the moment of use" (Eraut, 2000, p. 127). Intuition in this sense may allow performing a fast heuristic, but it is not frugal at all. It is rather a

condensate of complex knowledge patterns, developed by implicit learning during enculturation processes (Reber, 1993) or by automatization and development of routines (Eraut, 1994). Nonaka and Takeuchi (1995) describe the process of internalization as a way of transforming explicable knowledge into a tacit one, and enculturation as a way of mediating implicit knowledge in the context of professional working life within enterprises.

Klein (2003) suggests the effect of mental models when he tries to explain professionals' capacities to decide appropriately under constraint. These mental models are the result of mental simulations of action scripts that professionals' experience in their careers. If a simulation result is positive, a mental model develops that can guide future fast decisions. Intuition "is based on extensive experience both in analysis and problem solving and in implementation and to the extent that the lessons of experience are logical and wellfounded, then so is the intuition" (p. 19).

The expertise perspective on intuition is a clear learning perspective. Intuition is grounded on knowledge which is developed by explicit and implicit learning processes. Thus, expertise is an educational approach to intuition. Various researchers in the field of expertise investigate learning processes in professional domains, although not all of them consider intuition as a component of professional competence. However, they do address the issues of implicit learning and tacit knowledge, thus, they (implicitly) consider all prerequisites for the development of intuition. Eraut (2000) argues that professional learning occurs mostly informally at the workplace, but is influenced by formal learning settings in which the learner is involved previously. As he emphasizes the importance of tacit knowledge and intuition for professional performance, the informal learning processes are essential. Yet, those processes demand a social setting because they require somebody who gives feedback to the learner regarding his work performance which is the application of his learning. As former formal learning experiences can be interpreted as individual influences, professional informal learning can be interpreted as socially influenced learning. Sternberg, et al (2000) link intelligence as an individual factor with the sharing of experience and practice as a social factor for describing the development of intuitive capacities—"practical intelligence". In a similar way Salmela and Moraes (2003) argue the development of expertise in professional sport, by pointing out that besides individual talent and will, various social frameworks such as coaches, teams, families and society influence the presence or absence of a successful career. Systematic discussions of the role of individual and social influences for the development of professional competence are present by Eteläpelto, Collin (2004) and Billett (2006). These agree in the result of their analyses: both aspects (individual and social influences) are unshiftable and interrelated.

1.3 Two systems theories

According to the theories of brain hemispheres with differing working modes, some approaches to decision making research proclaim two parallel and permanent operating information processing systems (Bruner, 1962; Hogarth, 2005; Kahneman & Frederick, 2002; Sloman, 2002). Despite using different terminologies, in principle those approaches agree with the concept of one mode operating deliberately, rationally, and analytically while the other is working associatively, intuitively and tacitly. Hogarth (2001) proclaims that these two operation modes exist within a continuum of consciousness: The intuitive mode is on the unconscious side of the continuum and the rational mode on the conscious one; The location on the continuum of the border between these two modes varies, which means that intuitive decisions can be conscious (e.g. if somebody chooses to follows a gut feeling) and that rational decisions can be partly unconscious (e.g. if somebody automatically follows a given order).

An important and convincing reference to two systems theories consists in optical deceptions. The theory "that two independent systems are at work depends critically on the fact that the perception and the knowledge are

maintained simultaneously" (Sloman, 2002, p. 385). If observing pictures which pretend lines are of differing length only on the basis of three-dimensional illusions, subjects show a compulsion to agree with the information that the presented lines are of similar length, but simultaneously try to find reasons for the perception of differing lengths. Similar simultaneous beliefs of contradicting statements could be observed in arguing or concluding with probabilities (Tversky & Kahneman, 1983). In principle, all experiments on heuristics and biases (Gilovich, Griffin, & Kahneman, 2002) imply the existence of two processing systems, because all of them aim at proving mutual interference.

Bargh and Chartrand (1999) present a deeper analysis of the intuitive system and identify three different processes generating automatic or spontaneous decisions: They construe intuition as an automatic effect of perceiving action situations, which are permanently evaluated while the original action goal is followed. These components lead implicitly to enriched experience which can be used in later situations without demanding awareness and deliberate reflection.

Opinions differ on how the intuitive and the rational thinking modes influence human behavior. In one direction of interference, evidence could be found that the rational system can overrule the intuitive system in the case of reflecting failing actions expost (Epstein, Lipson, Holstein & Huh, 1992). In the other direction, Sloman (2002) argues that in each rational decision intuitive shares appear because the intuitive system works associatively, thus, it is quicker than the rational one. Hence, intuitive traces always influence perception, and through it, every decision is independent of the mode. Differences exist in views regarding eventual preferences. Allinson and Hayes (1996) develop a questionnaire intended to identify a general thinking style (Cognitive Style Index). Such a perspective assumes a general preference either for intuitive or for rational decision making. More test inventories exist following a similar idea: Epstein, Pacini, Denes-Rej, Heier (1996) and their REI-questionnaire, Agor's AIM (Agor, 1984), and the Myers Briggs Type Indicator (Briggs & Myers, 1976). In contrast to their stands the view that preferences—if existing at all—are always related to context. There is a lack of empirical evidence; studies of context specific preferences cannot be found in psychological research databases.

The two systems theories do not describe explicitly development processes. However, other authors reflected about ways of developing intuitive thinking. Sedlmeier (2005) proposed associative learning, which clearly was related to repeatedly appearing events, as a development mode for intuitive thinking. The precondition for successful learning is feedback—either self created by reflection or given by others in a social setting. Thus, individual and social influences on intuition are implicitly considered in two systems theories but not explicitly discussed, nor is their importance to the development of intuition analyzed.

2. Empirical evidence

As several theoretical approaches have been discussed, the question arises if there is empirical evidence gained from systematic studies in this field. The following empirical studies are to be found.

2.1 Effects of intuition

Glaser (1995) investigated the role of intuition for work in research and development. However, this study was not on the effects of intuition but on the intuitive potential of tested persons measured with the AIM survey (Agor, 1984).

Studies from the field of expertise research shows that experts can focus on a narrow choice of relevant

information when solving problems. De Groot (1986) found his chess masters considering just a small part of information when analyzing a chess board, but this usually led to satisfying and well regarded initial decisions for next moves (Klein, Wolf, Militello & Zsambok, 1995). Ettenson, Shanteau and Krogstad (1987) let accounting experts and novices audit business cases, and the experts' characteristic quality of professional performance was their capability to identify the crucial clue in the splash of presented information. Gaeth and Shanteau (1984) found similar expert capabilities in the domain of agriculture. Even if these studies did not investigate intuitive decisions, there was no hint that the experts deliberatively choose their focus on the data; hence, these examples could be seen as the indications for intuition.

Harteis and Gruber (in review) reported an experiment testing the superiority of intuitive forecasts in an expert-novice design. On a descriptive data level, intuitive forecasts were better than rational ones. Hence, they contrasted the findings of Keane and Runkle (1998) who found empirical evidence for the view that professional stock market analysts decide rationally when predicting stocks.

Davis and Davis (2003) found out that school principals tend to decide intuitively, especially in situations which offer plenty of alternatives and in situations under constraint, e.g. if information is not reliably verifiable. Khatri and Ng (2000) presented similar findings from the domain of business management.

2.2 Influences on intuition

Bolte, Goschke and Kuhl (2003) investigated with two experiments on the influence of good and bad mood on the capability to detect clues in word triads. Though delivering empirical evidence that good mood supports intuitive capabilities, there is limited connection to professional performance. This also applied to the experiment of Masters (1992), in which persons learned under varying conditions motor skills (golf putting) which were tested under stress. In stress situations, subjects with a larger amount of explicit knowledge, who were explicitly instructed, performed worse than subjects who learned golf putting implicitly without rule based knowledge. The conclusion suggests that implicitly learnt lessons can be applied under constraint more easily than explicitly learnt lessons. In this way this study confirmed the findings that Reber (1989) reported on a more general level of cognitive performance. Recent research investigation on teaching strategies of integrated explicit and implicit learning (Sun, Slusarz & Terry, 2005), does not neglect the power of implicit learning for intuitive performance.

Davis and Davis (2003) report, as one important finding of their large survey and interview study with Californian school principals, that feelings of stress or anger are the biggest obstacles to intuitive decision making.

2.3 Intuition as bias

Following the perspective of Brunswik (1956), who regarded intuitive estimations as only approximating correctness, and therefore highly erroneous, plenty of studies existed, which proved the negative effect of intuitive decision because of bias implemented in the empirical design. Peters, Hammond and Summers (1974) let subjects guess mathematical functions on the basis of various kinds of presenting stimuli. In their studies intuitive estimations were more erroneous than analytical ones. Jacowitz and Kahneman (1995) let subjects estimate several quantities (height of Mr. Everest, number of bars in Berkeley, etc.) and presented an anchor to measure its influence on the estimating performance. Interestingly they found stronger effects for high anchors than that for low ones. Kahneman and Tversky (1973) initiated a whole series of experiments testing people's capacities to interpret and express the meaning of conditional probabilities (Bayesian probability). Subjects normally overestimate conditional probabilities presented in quantitative word tasks (Eddy, 1982; Gigerenzer, 2002). However, Christensen-Szalinski and Beach (1982) emphasized the dubiety of the application of word problems in those tasks, because they could show that the experience of base-rates supported estimations close to Bayesian

outcomes, even though subjects were not aware of the Bayesian formula. Then again, experiments with choosing tasks between candidates showed that overestimation biases were not necessarily related to beliefs on probability, but also on plausibility (Sanbonmatsu, Posavac & Stasney, 1997): Subjects neglected alternatives as soon as they perceived a situation as plausible.

Another source for bias in estimation performance is confidence. Fischoff, Slovic and Lichtenstein (1977) conducted several experiments in which subjects had to estimate the validity of statements where the subject had not complete information, e.g. “more people die by homicide than suicide”, and coevally had to declare their confidence regarding their judgment. False estimations often came along with high confidence. An explanation was presented and empirically firmed up by Gigerenzer, Hoffrage and Kleinbölting (1991) who developed the theory of probabilistic mental models.

In contrast to these findings, a study in the professional domain of clinical assessment revealed that the subjective confidence of clinicians’ predictions about patients’ potential for violence was “an important moderator of the predictive validity of those evaluations” (McNiel, Sandberg & Binder, 1998, p. 664). These findings are consistent with research on the superstition of a “hot hand” or streak shooting success in the domain of sport: Subjects tend to overestimate highly even short sequences of success and failure while predicting the success of subsequent free throws in basketball. In reality, the previous sequences only influence the predictions, not the performance of the players (Gilovich, Vallone & Tversky, 1985).

The preference for rationality had a long tradition in decision making research and guided empirical studies, e.g. in the field of business management, where a limited number of cues were regarded as significant for the decision processes (Mintzberg, Raisinghani & Theoret, 1976).

2.4 Two systems theory

Bargh (1982) investigated the cognitive theories of two separate processing operations by applying acoustic stimuli, and produced findings consistent with approaches proclaiming the existence of automatic (intuitive) and control (aware) processes. Isenberg (1984) studied twelve top executive managers and found that they did not follow precise goals or objectives when solving business challenges, but relied on a mix of intuition and rational analyses to work out a pragmatic solution.

An early empirical study was conducted by Westcott (1968), who presented test persons a bundle of problems to solve, which did not require specific subject-matter knowledge but addressed logical thinking. He investigated the amount of information that the subjects used for successful solutions and distinguished four groups of thinkers. One of these groups was defined as “intuitive thinkers” and when it correlated with psychometric features that group had a high correlation with introversion.

Allinson and Hayes (1996) developed their instrument CSI and proceeded with empirical studies in the field of business management, where they compared senior and junior managers. Their results indicated that intuition characterizes successful managers (Allinson, Chell & Hayes, 2000). They viewed intuition more as a general tendency of preference rather than interpreting it as a domain specific issue. The same assumption guided the development of the Myers Briggs Type Indicator (MBTI) and the Agor Intuitive Management survey (AIM).

2.5 Fast and frugal heuristics

Many empirical studies were done to investigate the fast and frugal heuristics approach in the context of the Gigerenzer group (Gigerenzer & Goldstein, 1996; Gigerenzer, Todd & the ABC Research Group, 1999). A currently published series of experiments delivered evidence for (a) the use and (b) the efficiency of fast and frugal heuristics (Bryant, 2007). In reaction to the fast and frugal heuristic approach, Spellman (1996) proved that

individuals consider a multiple pattern of potential causes instead of just applying a simple heuristic.

Krabuanrat and Phelps (1998) investigated, in an explorative qualitative study of managers' heuristics, underlying decision making processes in dynamic environments, and came clearly to the conclusion that rational decision making models were not appropriate for designing decisions. Moreover, managers developed (implicit) mental models, partly in social interaction with the enterprise environment.

2.6 Summary

Considering the studies mentioned in this section, there is an obvious emphasis on studies of decision making. Here, two roots exist: The approach of intuition as bias, decreasing the decision quality, and the approach of fast and frugal heuristics, which normally lead to viable decisions even when coping with challenging situations. The second approach deals with intuition as a complementary or supplementary information processing mode for rationality.

Only a few studies are located in professional domains. However, indicators for the importance of intuition to professional performance, although limited on theoretical assumptions, are supported by—mostly explorative—empirical findings, too. This applies for the studies in the field of business management, adult education, and investment.

3. Individual and social influences on professional performance

Current research on the development of professional competencies increasingly considers individual and social influences on professional learning. Whereas research formerly focused mainly on either the individual or the social determinants of professional learning, the latest approaches attempt to construe the interrelation of both, because the exclusive perspectives describe insufficiently learning and performance processes. This paper instead deals with a specific form of professional performance which is driven by intuitive actions.

Individual influences on intuition driven professional performance are undoubtful. Tacit and implicit knowledge determine professional performance, along with mood and motivation as a result of an individual's perception of the conditions in the working environment.

Less consideration goes to social influences, because intuition primarily refers to intrapersonal cognition. However, intuition utilizes knowledge which is developed subject to external influences. It is moreover plausible and proven by Reber (1993) that social influences crucially influence the development of tacit knowledge. Implicit learning is suggested to be learnt by doing, creating procedural knowledge and scripts beyond the level of awareness. As several studies show, such learning processes mainly occurred in a social setting, by learning on a model or learning from experience (Kessels & Korthagen, 1996).

In cases of quantitative research, the operationalization of intuition normally refers to the two systems theories. On the one hand, studies are based on the application of standardized instruments. The AIM as well as the Myers Briggs Type Indicator and the REI imply (a) the parallel coexistence of a rational and an intuitive cognitive mode, and (b) a general tendency for one of these modes. These items address mainly attitudes and self-estimations which are individually developed. Social influences do not play an important role here. On the other hand, quantitative studies from the field are of fast and frugal heuristics. These heuristics are also thinking mechanisms which are developed individually. Hence, quantitative research focuses on individual determinants of intuitive decision making and does not consider social influences. The reason is that these research approaches investigate the consequences of intuition not its development.

In qualitative research approaches, conversely, studies which operate with “think aloud” strategies and justification tasks open the opportunity to address social influences. Agor (1986b) asked managers about the basis of decision making in important cases. In interviews, the managers reported that intuition is very important for their professional life because rationality and logical reasoning do not lead to satisfying and practical results. They described developing intuition by individual reflection as well as debating opinions with colleagues.

From an educational perspective the process of (supporting) the development of intuition as a component of professional competence is relevant. Klein (2003) construed intuition to be superior in relation to knowledge because he proclaimed that intuition is “built up through repeated experiences…unconsciously linked together to a form of pattern” (p. 11). The more patterns are available, the easier a sense of familiarity arises in challenging situations and, thus, the more opportunities exist for an intuitive decision. Patterns are considered as chunks of information and clues which represent meaningful solutions for challenging situations. Klein argued in the line of Simon’s pattern recognition approach to explain quick decisions without deliberate reflection (Simon, 1982). In his analyses of professional performance, Klein detected that the firemen he investigated in times outside emergency operations consciously reflected on critical situations and evaluated them in mental simulations. That way, the stock of action patterns increased permanently. In about 80 percent of the toughest incidents the firemen built their decisions in the hot situations on those mental models (Klein, 2003). In a similar logic but using differing terminology, Hogarth (2001) described the framework for the development of intuition. He calls processes which Klein (2003) describes as mental simulations “learning” and understands learning as a process of observing facts, speculating about untested ideas, which are mentally tested against alternative ideas. If speculations survive the attempts of falsification, they can be generalized and build an action model for hot situations. Finally, Hogarth (2001) proclaimed permanent mental training and practice as a prerequisite for the development of intuition. Gladwell (2005) also followed a knowledge based approach in his understanding of intuition. Most researchers on intuition, thus, agree that intuition can be learned by perceiving situations, consciously analyzing, and reflecting on them, in order to generate mental action models which are the basis for intuitive decisions in challenging situations. Acquiring intuition is a way of developing procedural knowledge appropriate for professional performance.

The traditions of constructivism, situated learning, and socio cultural approaches of learning all consider individual and social influences on the development of competencies (Bereiter, 1997; Billett, 2006; Lave & Wenger, 1991). The central idea of the cognitive apprenticeship model (Collins, Brown & Newman, 1989) is to introduce learners into experts practice and experts’ action strategies. This form of introduction to a community of practice not only imparts declarative and explicit knowledge but also implicit knowledge and cultural standards. Billett (2006) developed a system which distinguishes different levels of individual and socially embedded knowledge. In the concrete action of an individual, knowledge from different levels of genesis is “reconstructed” and simultaneously the individual creates practical knowledge and influences cultural knowledge. This pattern can be helpful for analyzing the development of intuitive capabilities between individual and social influences. In their review article, Shirley and Langan-Fox (1996) reported social and acquired variables associated with intuition in literature, as well as individual and situational variables, whereby they identified many more social variables than individual ones.

4. Research challenges

In general a lack of empirical evidence in the field of professional domains must be acknowledged, especially referring to the effects of intuitive decision making or intuitive action. Generally, for research on intuition, the basic problem of verbalisation still remains apparent—either with reference to the inaccessibility of implicit and intuitive cognitions (Kahneman & Tversky, 1982; Nisbett & DeCamp Wilson, 1977), or to the distortion effects on performance when subjects try to make internal processes explicit (Schooler & Engstler-Schooler, 1990; Schooler, Ohlsson & Brooks, 1993). Harteis and Gruber (in press) reported difficulties for appropriate item formulation which can be traced to misinterpretations by the subjects.

The two systems approach suggests research strategies that eliminate rational considerations as far as possible. Several studies were conducted, which utilized time pressure to force subjects to intuitive decisions. Bowers, Regehr, Balthazard and Parker (1990) reported a series of studies based on the remote associates test, which originally was developed to assess creativity (Mednick, 1962). They presented their subjects word triads in which just one triad contained words with only remote relations. The task was to detect this triad from among various triads in just a few seconds. There was no rational solution available in the test situation, so that the subjects had to decide intuitively. The subjects were able to solve this task at rates significantly greater than chance, which documented human intuitive capabilities. However, the test situation is artificial and its significance for professional work performance is unclear. Harteis and Gruber (in review) induced subjects working in the financial sector to forecast stock market courses; some of the forecasts had to be made under time pressure, others had to be legitimized rationally. On a descriptive data level, the majority of the intuitive forecasts were better than the rationally legitimized ones. This study was the first attempt to investigate intuition in a field study with an authentic task, thus the sample was very small.

Even if Cosmides and Tooby (1994) strictly rejected the appropriateness of intuition for cognitive sciences, intuition had become a well-regarded topic in scientific and popular literature. However, systematic field studies on the effects and the development of intuition are still lacking-perhaps due to the difficulties of measuring intuition. The challenge for educational research remains to deliver empirical evidence for the vivid debate about intuition as a component of professional competence.

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