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Concepts without intuition lose the game: commentary on Montero and Evans (2011)

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Abstract In several papers, Hubert Dreyfus has used chess as a paradigmatic example of how experts act intuitively, rarely using deliberation when selecting actions, while individuals that are only competent rely on analytic and deliberative thought. By contrast, Montero and Evans (Phenomenology and the Cognitive Sciences 10:175–194, 2011) argue that intuitive aspects of chess are actually rational, in the sense that actions can be justified. In this paper, I show that both Dreyfus's and Montero and Evans's views are too extreme, and that expertise in chess, and presumably in other domains, depends on a combination of intuitive thinking and deliberative search, both mediated by perceptual processes. There is more to expertise than just rational thought. I further contend that both sides ignore emotions, which are important in acquiring and maintaining expertise. Finally, I argue that experimental data and first-person data, which are sometimes presented as irreconcilable in the phenomenology literature, actually lead to similar conclusions.

Keywords Action · Chess · Deliberation · Expertise · Hubert Dreyfus · Intuition · Skill

Intuition has always been a favorite theme in cognitive science (De Groot 1965, 1986; Dreyfus and Dreyfus 1988; Simon 1995) and has recently become the topic of much discussion in the field (e.g., Kahneman and Klein 2009; Marewski et al. 2010). Interestingly, and in spite of fundamental differences in the type of theories proposed, the game of chess has been at the center of discussion in many of the publications on intuition. This is perhaps because chess is a counterintuitive candidate given that it is a game typically seen as "logical" and "cold," and thus unlikely to require much intuition.

In a recent paper, Montero and Evans (2011, thereafter M&E) made a valuable contribution to this issue: a cogent and insightful discussion of the role of intuition

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and other processes in chess. They submit Hubert Dreyfus's theory of expertise and intuition (Dreyfus and Dreyfus 1988, 2005; Dreyfus 2007a)[1] to a razor-sharp analysis. As they note (M&E, p. 177), "to a degree, [their] arguments support John McDowell's (1994, 2007a, b) theory of rationality." I agree with much of what M&E have to say, but I also believe that they have missed central aspects of expert intuition in chess and other domains. This is an important issue because these omissions directly relate to their discussion of Dreyfus's theory and the question of human rationality. It is important to evaluate their import.

Given that this journal is devoted to phenomenology, I will not refrain from occasionally using a first-person account. This seems particularly appropriate for two reasons. First, I am a cognitive psychologist having studied expertise and intuition, with a special focus on chess, for more than 25 years. Second, I am also a (retired) international chess master, having played with the Swiss national team on numerous occasions. Like most chess players, I am interested, if not fascinated by intuition. How is it that grandmasters often find good moves easily and rapidly, while weaker players can make sense of a board position only painfully and slowly? Why is it that the same grandmasters sometimes also seem to struggle, just like their weaker counterparts? Why is it that the same term—intuition—is used to qualify the style of players as opposite as that of former world champion Tigran Petrosian (who strove for quiet, solid, and strategic positions) and that of former world champion Mikhail Tal (who enjoyed wild tactical melees with speculative sacrifices)? Were my own personal difficulties, and ultimately failure, to become a grandmaster related to weaknesses in my own intuition? My early scientific interest in intuition, spurned by the question of whether computers can show it (Gobet 1986a), developed into an increasingly intense study. I had the good fortune of collaborating with two of the founders of modern cognitive science, Adriaan D. de Groot and Herbert A. Simon. Both had deep and partly contradictory views on intuition in general and in chess in particular.

A few comments about the term "rationality" might be appropriate at this point, given the interdisciplinary audience of this journal. M&E (p. 176) use the term in the same sense as Dreyfus, roughly meaning "our ability to justify our actions." This is the meaning I will use throughout most of this article. This meaning must be distinguished from another common meaning in cognitive science, where rationality is "the assumption that humans act optimally when trying to achieve their goals" (Gobet et al. 2011, p. 351). Finally, Dreyfus uses the term "arational" to mean "not grounded in reason." "Arational" is an etymological monster, as it combines a root from ancient Greek (the prefix *a*, α-, known as the privative alpha) and a root from Latin (the word *ratio*, meaning reason). A better term would be *agnomic*, using γνώμη, *gnomê*, meaning reason. (The more natural *alogic*, from λόγος, *logos*, also meaning reason, already has a technical meaning.) However, for consistency with previous literature, I shall use the term "arational." After briefly summarizing Dreyfus's

[1] Hubert Dreyfus and his brother Stuart have both contributed to this theory of expertise. However, to be consistent with M&E and given the recent exchange of papers on rationality and skill between H. Dreyfus and McDowell in *Inquiry* (Dreyfus 2007a, b; McDowell 2007a, b), and with apologies to Stuart Dreyfus, I will refer to this theory as (Hubert) Dreyfus' theory.

theory of expertise and intuition, I will organize my commentary using the same four questions as those used by M&E, as they nicely carve out the issues at hand.

A brief overview of Dreyfus's theory of expertise and intuition

Dreyfus and Dreyfus (1988, 2005) proposed a theory of expertise based on phenomenology, with a particular emphasis placed on the embodied, situated, and experiential nature of human cognition.[2] The theory states that there are five stages from novice to expert: "novice" stage, "advanced beginner" stage, "competence" stage, "proficiency" stage, and "expertise" stage. Moving from novice to expert requires substantial concrete experience with the domain of expertise. In general, as one progresses through these stages, decision making first moves from the conscious, analytic, and deliberate use of context-free and general rules to the use of rules taking the context and characteristics of the environment into account, to finally reach the expert level, where action selection is intuitive and fluid, and behavior is efficient and naturally fits the demands of the environment. To be precise, when they deal with typical situations, experts do not really make decisions, but simply act and carry out actions that are likely to be successful. Finally, Dreyfus emphasizes the holistic nature of expert behavior. For additional details on Dreyfus's theory and a discussion of its strengths and weaknesses, the reader is invited to consult Benner (1984), Dreyfus (2007a, b), Dreyfus and Dreyfus (1988, 2005), and Gobet and Chassy (2008, 2009).

Can expert chess players proceed just as well when they are not attending to the game?

Dreyfus argues that experts usually do not use attention and deliberation, and if they do so, they regress to the performance level of the merely "competent" individuals. M&E criticize this stance. I do not have much to add to M&E's treatment of this issue because it is close to the way we addressed this question in a recent discussion of Dreyfus's theory (Gobet and Chassy 2008, 2009). In particular, I agree that the experimental data mentioned by M&E clearly show that attention is necessary for experts to play chess well, and that distracting concurrent tasks hamper the quality of play. An interesting point is that the deficit is higher with tasks that interfere with visuospatial processing and the so-called central executive processing (i.e., processes such as monitoring and planning) than tasks interfering with verbal processing (Saariluoma 1992; Robbins et al. 1996). I shall take up the results with visuospatial interferences and processing later in this article. My only other comment is that Dreyfus's way of dealing with attention is slightly ambiguous. In some places, his treatment seems to mean that players pay attention to the board and pieces (they are aware of them). In other places, Dreyfus appears to be using a more specific

[2] It might be pointed out that not all phenomenologists agree with Dreyfus's analysis. In particular, with respect to embodiment, Selinger (2008, p. 66) notes that "human interaction is, de facto, interaction between *agents in culturally marked bodies*."

meaning: that players pay attention to the fact that they think about a chess position (a metacognitive stance).

Do chess experts rely on neither rules nor standards to decide on or justify their actions?

According to Dreyfus, experts do not rely on rules to make a decision or justify their choice. They just act. M&E agree with Dreyfus that there are two types of rules (rules of the game and heuristics rules), and that following rules of either type counts as rational action. Where they disagree with Dreyfus is with his statement that experts do not follow any rule, not even unconsciously. Instead, they correctly argue that experts do remember the rules of the game and can state them in detail if asked to do so. They also state that experts do know basic heuristic rules explicitly, although they might not use them because they often are not predictive enough, in that several basic heuristic rules might conflict one another. M&E also argue that experts use specific, advanced heuristic rules, and that these are used consciously.[3] I agree with their analysis of the rules of the game and basic heuristic rules, but not with their analysis of specific heuristics. This is a major source of discord between our views.

M&E's analysis of the rules of the game and simple heuristics can be linked to the distinction in philosophy and psychology between declarative and procedural knowledge (Ryle 1949; Fitts 1964). With practice, rules that are initially known declaratively become automatized so that they can now be used without attention (i.e., procedurally). Why advanced heuristics rules cannot be proceduralized with sufficient practice is not clear from M&E's account, but my main point is different. M&E do not consider the possibility of rules that are never stated explicitly and thus never conscious. However, I believe that a considerable body of empirical evidence, including data from my own research, precisely points to this direction (e.g., Gobet and Waters 2003; Campitelli et al. 2007; Wan et al. 2011). The key idea, already present in Simon and Chase's (1973) seminal study, is that expert players have learned, through extensive practice and study of the game, numerous perceptual "chunks" of information. (In chess, these chunks are likely to encode patterns of pieces on the board.) Possible actions get attached to these chunks, such as "the bishop should be moved to a specific square" or "white should try to counter-attack in the center." Together, the chunk and the action form what is known as a *production* (Newell and Simon 1972). The point is that these productions do not need to be encoded declaratively and the evidence suggests that many are not (see the discussion below on intuition). The fact that chess

[3] On p. 182, M&E write that "although grandmasters can usually beat international masters or weaker players without ever relying on anything beyond heuristics, it is times where specific heuristics are flouted which decide who wins in games between grandmasters." I take exception with the first part of this statement. Without any look-ahead search, even a top grandmaster would risk losing against an international master or even a weaker player because of the risk of overlooking "cheap" tactics. In fact, M&E seem to agree with this conclusion in the paragraph that follows the quotation, where they write that "merely learning a grandmaster's repertoire of heuristic rules may not turn a competent player into a grandmaster not because the grandmaster never relies on heuristic rules when deciding on a move, but rather because in addition to heuristic rules, calculating out the consequences of moves and intuition and [sic] plays a role."

is a visuospatial game makes the presence of automatic pattern recognition, without any recourse to language, even more plausible. Thus, while there is no doubt that some of the experts' actions are determined by the large number of heuristics they know, others are determined by subtle perceptual differences that are not encoded declaratively.

In addition, a limit of conceptual rationalization is that the same type of evidence can lead to opposite conclusions. M&E (p. 186) discuss a position with an "isolani" (isolated central pawn; see also position A of De Groot 1965), and this provides a good example. The isolani, which is at the same time a static weakness but a dynamic strength, can be used as a justification for either white's advantage or black's advantage. Typically, the ultimate evaluation of the position hinges on a complex interrelation of factors, and often depends on the calculation of concrete variations. Here, the search tree and the corresponding evaluations are the justification for a chosen move. This is different from conceptual justification. Coincidentally, the dual role played by the isolani is well illustrated by Gobet and Retschitzki's (1991) study, which used it to create ambiguous positions that were employed to induce a mild form of learned helplessness.

Thus, while Dreyfus places too much emphasis on nonrational or arational thought, E&M accord too much importance to conscious and rational thought. Granted, rational thought is part of expertise, both through the use of concepts and deliberation. However, there is more to expertise than just rational thought. Perceptual knowledge based on pattern recognition plays an essential role, in particular with respect to intuition. Indeed, the fact that nonverbalizable knowledge influences behavior constitutes an important part of common definitions of intuition (De Groot 1993; Richman et al. 1996; Klein 2003; Gobet and Chassy 2008). Another piece of evidence that experts' behavior is not only directed by declarative rules is provided by the fact that emotions can play an important role in their decisions (Tikhomirov and Vinogradov 1970; Benner et al. 1996). While this is adaptive, in that emotions play the role of a quick and efficient alert system, this clearly happens beyond the realm of conscious thought.

A summary of this section might be appropriate at this stage. To *justify* their actions, experts use a combination of conscious rules and validations based on the analysis of the partial tree of possible moves. To *decide* on these actions, they rely on a combination of search (cf. my discussion of deliberation below) and conscious and unconscious rules. Some of the unconscious rules are the product of conscious rules having been automatized, while others are never encoded consciously and declaratively. They are the product of perceptual and/or emotional cues being paired with possible actions. While the output of this pairings might be verbalizable, the pairing itself is not.

Do chess players proceed without deliberation?

There is no doubt that chess players carry out look-ahead search (deliberation), and I agree with most of M&E's discussion, in particular with respect to the example of Kaplan discussed at length by Dreyfus in several publications (e.g., Dreyfus and Dreyfus 1988). Dreyfus's negation of chess players' search behavior is very

surprising, because the empirical evidence for this is overwhelming in the verbal protocols presented and analyzed in De Groot (1965), and has been amply confirmed by later studies (e.g., Charness 1981; Gobet 1986b, 1998; Saariluoma 1995).[4] Where there has been a debate is about the respective roles of pattern recognition and search in the acquisition of chess expertise (e.g., Holding and Pfau 1985; Gobet and Simon 1996a; Chabris and Hearst 2003). Recent data actually indicate that players at master level and above do not carry much search in simple, strategic or familiar positions, but that there can be enormous skill differences in complex, tactical, or unfamiliar positions (Campitelli and Gobet 2004; Bilalić et al. 2009). Thus, strong players seem to be able to adapt their search strategy as a function of the type of position at hand and also as a function of the time available for thinking.

How is anticipation carried out? While language seems to play a supporting role, much of it is visuospatial, presumably carried out in the mind's eye. Support for this view comes from the fact that problem solving is seriously hampered by the presence of visuospatial interfering tasks, but less so by the presence of verbal tasks (Saariluoma 1992; Robbins et al. 1996). At the same time, the hypothesis of an "inner dialogue" is supported by the analysis of verbal protocols of players trying to find a good move in an unfamiliar position.

M&E argue that experts can carry out limited search when playing rapid transit games. Although I do not think there is experimental evidence on this, this conclusion fits my own experience of playing such games and I would guess that this must be even more the case with top-level grandmasters.

M&E "see no reason to think that chess players are radically mistaken about what goes on in their minds during games" (p. 188). Retrospective verbal protocols can be a reliable source of information about thought processes, but this is less the case in domains that are visuospatial or where actions are happening rapidly (Gobet 2009). There is in fact ample experimental evidence showing that conscious thought, as reported by verbal protocols, can be sometimes be dissociated from the actions actually carried out (Nisbett and Wilson 1977; Gobet 2009). One of the best examples of this with respect to chess is a series of experiments on the Einstellung ("mind set") effect (Bilalić et al. 2008b, c). Bilalić and colleagues constructed chess problems that had two solutions: a familiar solution that was non-optimal and a less familiar solution that was optimal. The first key result was that the familiar solution induced the Einstellung effect even with experts, which prevented them from finding the optimal solution. The second key result was that experts' verbal reports were not reliable. Experts reported that, after they had found the familiar but non-optimal solution, they were searching for a better one. But their eye movements told a different story: they showed that the players kept looking at features of the problem that were important for the solution that initially came to their mind and not at features relevant to the optimal solution. We have here a clear dissociation between where attention was actually directed to and the thoughts that were later reported. Thus, contrary to M&E's assertion, there are at least some cases where chess

[4] The example given by M&E (p. 186–187) does not do full justice to the amount of search carried out by strong players. Evans notes that "after carefully analyzing I discovered the winning sequence, reproduced below […]." Based on the extant scientific literature, it is likely that finding this winning sequence was no trivial matter and demanded extensive search in the jungle of possible moves and counter moves.

players' reports about what is going on in their mind are mistaken and where their reasons for a chosen move is affected by post hoc rationalization.

One minor point of disagreement concerns the statement that strategic thinking, *unlike* tactical deliberations, "is based on past experience and pattern recognition" (M&E, p. 188). While it is true that tactical deliberation involves search characterized by statements "if white plays this, black plays that, and so on," it is also the case that experience and pattern recognition are important in tactical thinking. In fact, strong players, not to mention former world champion Mikhail Tal, show a remarkable ability to discover potentially winning combinations very rapidly, although establishing the correctness of their choice requires further look-ahead search.

Are chess players' actions based on intuitive, arational responses to a situation?

Intuition is central in Dreyfus's view of expertise, and indeed, according to him, true expertise relies only on intuition and definitively not on deliberation. M&E take issue with this view and argue that "the psychological data on the relative importance of intuition for players of different strengths is mixed." In this section, I first deal with the question of the empirical support for the phenomenon of intuition; then I discuss the issue of whether expertise relies more on intuition or deliberation; finally, I address the question of whether intuition is rational, as argued by M&E.

Empirical support for expert intuition

Dreyfus obviously adopts an extreme position, but he has got a point. When an amateur asks the reason for the choice made by an expert, she often receives answers such as "it's obvious" and "it's the normal thing to do in this situation" and avoids further questions lest she looks like an idiot for not seeing the "obvious." Anecdotal examples of expert intuition abound, from a physician diagnosing a common ailment in a matter of seconds to a construction engineer correctly identifying the cause of a wall crack without much thinking. Importantly, the role of intuition has been empirically documented in a number of domains. Experts in physics can solve routine problems within seconds (Larkin et al. 1980). In highly dangerous situations and under extreme time pressure, firefighter commanders often carry out the appropriate behavior without even considering other options (Klein 1998). Empirical support for intuition has also been found with other types of experts, such as sportspeople (Johnson and Raab 2003), battle commanders (Klein 1998), business people (Prietula and Simon 1989), managers (Patton 2003), and intensive-care nurses (Benner 1984; Crandall and Getchell-Reiter 1993; McCormack 1993). There is also considerable evidence for intuition in chess. For example, strong players home in rapidly on the relevant moves and search the problem space highly selectively (De Groot 1965). The first move that players generate is usually good enough (Klein et al. 1995). In a study by Campitelli and Gobet (2004), a chess grandmaster correctly solved about 50% of problem situations within 10 s; in comparison, a weak club player managed less than 5%.

Theories based on pattern recognition (Simon and Chase 1973; Gobet and Simon 1996a, b) propose that reasons for a choice are often difficult to articulate because information was encoded nonverbally in the first place. In some cases, of course, the reason was very clear and thus verbalizable; for example, a player might have played a given move to create a weakness in the opponent's pawn structure. In other cases, the reason might not have been very clear originally, but the later course of the game provided a justification for the move, as an "obvious" plan later emerged. As noted above, there are also cases where the only justification of the move is to go through the search tree, essentially a proof by minimax. I do not count this as a conceptual explanation, although it is certainly verbalizable. Whether the move in this case was found only through verbal reasoning is however debatable, since, as we have seen earlier, visuospatial processing in the mind's eye is important in chess. (Note that chess is no exception; think of domains such as design, engineering, and science, where visuospatial processing is similarly important.)

The intuition vs. deliberation debate

Even after the reality of intuition as a scientific phenomenon has been established, there remains the question of the relative importance of intuition vs. deliberation as expertise increases. According to Dreyfus, one essentially moves from pure deliberation as a novice to pure intuition as an expert. In chess, this issue roughly maps into the debate of pattern recognition and search, about which much has been written. This debate got off to a bad start, as De Groot's (1965) study has often been incorrectly interpreted—among others by Dreyfus—to mean that there are no differences in search ability between *beginners* and top-level grandmasters. As documented in Bilalić et al. (2008a), this is (unfortunately) a very common error both in scientific articles and in textbooks. Actually, what De Groot found was that there are few differences in the macrostructure of search between *candidate masters* (i.e., fairly good players) and top-level grandmasters. As noted above, later research has shown that better players are in fact better at carrying out search when this is necessary.

When put together, the available data show the following (see Gobet et al. 2004 for a review). First, as seen earlier, stronger players anticipate better. They can search deeper and wider, and make fewer mistakes when doing so. Second, as discussed in this section, there is clear evidence for the role of pattern recognition and intuition. Third, it is possible to reject the extreme hypotheses that skill in chess is due only to intuition (Dreyfus's hypothesis)—see above—or only to search and general knowledge (Holding 1985); this is what my paper with Herbert Simon on Kasparov's simultaneous matches against national teams did (Gobet and Simon 1996a). Fourth, although this has been considerably debated in the literature, I would argue that it is possible to conclude that knowledge and pattern recognition (which makes access to knowledge possible) are more important than search in expertise in chess and in other domains. (Note that this does not directly translate into the statement that intuition is more important than deliberation, as some of the knowledge might be accessible consciously; however, this certainly supports the view that intuition is important in expertise.) What is the scientific support for this conclusion? The direct support is provided by the data on pattern recognition and the

data showing that strong players perform well against weaker players even when their thinking time is limited, for example when they play against several opponents at the same time (Gobet and Simon 1996a). The indirect support is that agents carrying out great deals of search but using relatively little knowledge—e.g., computer chess programs—do not perform well unless they explore massive search spaces, the size of which is larger by several orders of magnitude than the search spaces explored by humans. Thus, the point of Gobet and Simon's article (1996a) is that strong players still play well in spite of limited search. It is actually possible to see knowledge as "compiled search"—the necessity for search is cut down by the knowledge acquired through years of practice and study.

While making decisions by pure intuition is possible in simple problems or under great time pressure, expertise is normally characterized by a combination of intuition and deliberation (which includes both search and conceptual thinking). An important theoretical point is that pattern recognition and search are not an either/or question, but are interleaved (Gobet 1997; Gobet and Simon 1998). During look-ahead search, pattern recognition suggests possible moves not only with respect to the current board position, but also with respect to the positions that are anticipated. Thus, intuition characterizes experts' thinking not only at the beginning of the decision process—which is what is typically emphasized in the literature on intuition—but during the entire thought process. In that respect, I agree with Dreyfus that intuition is essential to expertise.

Is intuition rational?

Is intuition rational, as defended by M&E, or arational, as proposed by Dreyfus? I tend to side with Dreyfus on this issue, in particular with respect to domains that are visuospatial in nature or where emotions affect decision making—probably most domains. As noted above, the fact that experts cannot articulate the reasons for a choice or how they arrived at this choice was one of the criteria often used to define intuition (De Groot and Gobet 1996; Klein 2003; Gobet and Chassy 2008, 2009; Chassy and Gobet 2011). To argue for the rational nature of intuition, M&E give the following example: "I saw that the position was a Dragon Sicilian Yugoslav Attack, and so I instantly saw that sacrificing on the h-file would lead to checkmate, as it inevitably does in those kinds of positions" (p. 191). The problem with this example is that, in this type of position, sacrificing on the h-file sometimes works, and sometimes does not. The reason might be clearly verbalizable (e.g., the black king can escape), can be ascertained only after analyzing numerous variations to great depths, or can even sometimes rely only on the player's "gut feelings" (intuition). The technical chess literature abounds of examples where players made their final choice essentially on such hunches (O'Kelly de Galway 1963; Tal 1997; Beliavsky and Mikhalchishin 2002). But this example also beautifully illustrates the idea that perception, and hence intuition, precedes conceptualization, *pace* M&E, and McDowell (1994). The example uses twice "I saw," indicating an immediate and perceptual act. As de Groot and Gobet (1996, p. 1) noted it, "… the two areas of thinking and perception are hardly ever separable, and in many cases even indistinguishable. 'Pure' thinking—human information processing without any perceptual intake in the process—is extremely rare. In problem solving tasks, the

problems are necessarily presented in perceivable form; but in most cases they are also operated upon perceptually."

I disagree with M&E's conclusion that "a study by de Groot and Gobet (1996) supports the idea that the chess expert's perception of the board is conceptualized." The standard explanation for the experiments on chess memory recall, initiated by De Groot (1946/1965), is that players use perceptual chunks, which are not necessarily verbalizable and conceptual. Having been my own and only subject in an experiment where the aim was to memorize as long a sequence as possible of briefly presented chess positions, and having memorized about 1,800 positions in total, I do have some expertise on this subfield of chess skill (Gobet and Simon 1996b; Gobet 2011). While some positions clearly can be conceptualized (e.g., a "Dragon Sicilian Yugoslav Attack with opposite castles," to use our old friend), and while some can even be fully recognized as part of a known game, other positions simply cannot be coded that easily. And even when they elicit a concept, this concept sometimes characterizes the position so poorly that it becomes essentially useless. Thus, the claim that intuitions are rational and conceptual is not defensible empirically.

Conclusion

This paper has discussed the diverging views of Dreyfus, M&E, and myself on the role of intuition in expertise. On a continuum going from pure intuition without deliberation to pure deliberation without (arational) intuition, Dreyfus would be located at the first extreme, and M&E at the second. I would be located somewhere in the middle. Perhaps, rather than a continuum, it might be better to represent the different positions on a Cartesian plane with two orthogonal dimensions (intuition and deliberation), where the two dimensions can vary independently. Dreyfus's theory would be high on intuition but low on deliberation, while M&E's and McDowell's theory would be high on deliberation but low on intuition. My own theory would be nearer the top of the diagonal with a slope of one. This conceptual space could be used for locating experts in a specific domain as well. For example, in chess, a player such as Tal would be high on intuition and search, while a player such as Petrosian would be high on intuition but low on search. (This is obviously a simplification, as Petrosian was an excellent tactician when needed.) Of course, using such a conceptual space would raise new questions and spurn new research, as the mapping is not perfect between search, on the one hand, and deliberation and concepts, on the other.

Going beyond expertise narrowly defined, M&E raise an important question: "However, it may be that everyday coping and expertise are two very different ways of being in the world" (M&E, p. 192). Obviously, some skills have been honed by millions of years of evolution (e.g., walking, breathing, language) and others have not (e.g., solving algebraic equations, chess playing). Interestingly, many everyday actions (e.g., reading, crossing the road, driving) can be explained by mechanisms used to account for how some individuals reach high levels of expertise. In particular, in all these cases, chunking and pattern recognition seem to a key ingredient of automatization. Even language, which seems to be a skill apart, shares mechanisms used by expertise acquisition. As shown by recent modeling work on

language acquisition, chunking plays a key role in the acquisition of both syntactic structures (Freudenthal et al. 2007, 2009) and vocabulary (Jones et al. 2007; Tamburelli et al. 2011).

Dreyfus is partly right, but only partly, when he argues that arational intuition distinguishes expert chess players from proficient ones. He is right because (visuospatial) pattern recognition, and thus intuition, is more developed in expert players. But he is also wrong, because other factors such as amount of declarative knowledge (e.g., knowledge of opening and endgame theory, knowledge of key concepts, typical tactical and strategic maneuvers) and ability to look ahead also distinguish these two types of players.

Thus, I disagree with Dreyfus that, in chess and in other domains of expertise, deliberation is present only in sub-optimal situations. In all these domains, including nursing about which much has been written (e.g., Benner 1984; McCutcheon and Pincombe 2001; Gobet and Chassy 2008), expertise is the product of a combination of intuition and analysis, pattern recognition and search. But I also disagree with M&E that intuition is conceptual and rational. The empirical support for intuition characterized by nonconscious and thus not verbalizable mechanisms is simply overwhelming, and only a small part of this evidence has been discussed in this paper. Humans are not rational in the sense of optimizing behavior, as shown by Simon (1982), nor are they rational in M&E's and McDowell's sense of always being able to (correctly) conceptualize what they are doing and why they do it. In this respect, concepts without intuition lose the game.

Finally, it is worth making a meta-point, which might have been easily missed from this debate: as shown in this article, first-person accounts and data from experimental research can lead to similar conclusions. Of course, the agreement is not perfect; but nor is the agreement between first-person accounts always perfect (M&E give a few examples of first-person accounts defending different views) and nor is the agreement between experimental results always perfect (for example, the literature in cognitive psychology is replete with papers discussing the outcomes of experiments, the results of which appear inconsistent). The fact that agreement is possible refutes the strong view, sometimes articulated in phenomenologist circles (Dreyfus and Dreyfus 1988; Benner et al. 1996), that first-persons accounts and experimental data belong to different, irreconcilable planes.

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References

Beliavsky, A., & Mikhalchishin, A. (2002). *Secrets of chess intuition*. London: Gambit.

Benner, P. (1984). *From novice to expert: excellence and power in clinical nursing practice (vol. 3)*. Menlo Park, CA: Addison-Wesley.

Benner, P., Tanner, C., & Chesla, C. (1996). *Expertise in nursing practice: caring, clinical judgment, and ethics*. New York: Springer.

Bilalić, M., McLeod, P., & Gobet, F. (2008a). Expert and 'novice' problem solving strategies in chess—sixty years of citing de Groot (1946/1965/1978). *Thinking and Reasoning, 14*, 395–408.

Bilalić, M., McLeod, P., & Gobet, F. (2008b). Inflexibility of experts—reality or myth? Quantifying the Einstellung effect in chess masters. *Cognitive Psychology, 56*, 73–102.

Bilalić, M., McLeod, P., & Gobet, F. (2008c). Why good thoughts block better ones: the mechanism of the pernicious Einstellung (set) effect. *Cognition, 108*, 652–661.
Bilalić, M., McLeod, P., & Gobet, F. (2009). Specialization effect and its influence on memory and problem solving in expert chess players. *Cognitive Science, 33*, 1117–1143.
Campitelli, G., & Gobet, F. (2004). Adaptive expert decision making: skilled chessplayers search more and deeper. *Journal of the International Computer Games Association, 27*, 209–216.
Campitelli, G., Gobet, F., Head, K., Buckley, M., & Parker, A. (2007). Brain localisation of memory chunks in chessplayers. *International Journal of Neuroscience, 117*, 1641–1659.
Chabris, C. F., & Hearst, E. S. (2003). Visualization, pattern recognition, and forward search: effects of playing speed and sight of the position on grandmaster chess errors. *Cognitive Science, 27*, 637–648.
Charness, N. (1981). Search in chess: age and skill differences. *Journal of Experimental Psychology: Human Perception and Performance, 7*, 467–476.
Chassy, P., & Gobet, F. (2011). A hypothesis about the biological basis of expert intuition. *Review of General Psychology, 15*, 198–212.
Crandall, B., & Getchell-Reiter, K. (1993). Critical decision method: a technique for eliciting concrete assessment indicators from the "intuition" of NICU nurses. *Advances in Nursing Science, 16*, 42–51.
De Groot, A. D. (1965). *Thought and choice in chess (first Dutch edition in 1946)*. The Hague: Mouton Publishers.
De Groot, A. D. (1986). Intuition in chess. *Journal of the International Computer Chess Association, 9*, 67–75.
De Groot, A. D. (1993). Intuition as a dispositional concept. In G. L. van Heck, P. Buoanito, J. J. Deary, & W. Nowack (Eds.), *Personality psychology in Europe (vol. 4)* (pp. 7–50). Tilburg: University Press.
De Groot, A. D., & Gobet, F. (1996). *Perception and memory in chess*. Assen: Van Gorcum.
Dreyfus, H. L. (2007a). Response to McDowell. *Inquiry, 50*, 371–377.
Dreyfus, H. L. (2007b). The return of myth of the mental. *Inquiry, 50*, 352–365.
Dreyfus, H. L., & Dreyfus, S. E. (1988). *Mind over machine: the power of human intuition and expertise in the era of the computer* (2nd ed.). New York: Free Press.
Dreyfus, H. L., & Dreyfus, S. E. (2005). Expertise in real world contexts. *Organization Studies, 26*, 779–792.
Fitts, P. M. (1964). Perceptual-motor skill learning. In A. Melton (Ed.), *Categories of human learning* (pp. 243–285). New York: Academic.
Freudenthal, D., Pine, J. M., Aguado-Orea, J., & Gobet, F. (2007). Modelling the developmental patterning of finiteness marking in English, Dutch, German and Spanish using MOSAIC. *Cognitive Science, 31*, 311–341.
Freudenthal, D., Pine, J. M., & Gobet, F. (2009). Simulating the referential properties of Dutch, German and English Root Infinitives in MOSAIC. *Language Learning and Development, 5*, 1–29.
Gobet, F. (1986a). D'indiscutables progrès dans les micro-ordinateurs d'échecs: Quand la machine se met à ruser. *La Liberté*, April 13.
Gobet, F. (1986b). *Effets de l'incontrôlabilité sur la résolution de problèmes d'échecs [Effects of uncontrollability on chess problem solving]*. Unpublished Master's thesis, University of Fribourg, Switzerland.
Gobet, F. (1997). A pattern-recognition theory of search in expert problem solving. *Thinking and Reasoning, 3*, 291–313.
Gobet, F. (1998). Chess thinking revisited. *Swiss Journal of Psychology, 57*, 18–32.
Gobet, F. (2009). Protocol analysis. In T. Bayne, A. Cleeremans, & P. Wilken (Eds.), *The Oxford companion to consciousness* (pp. 538–540). Oxford, UK: Oxford University Press.
Gobet, F. (2011). Chunks and templates in semantic long-term memory: The importance of specialization. In J. Staszewski (Ed.), *Expertise and skill acquisition: the impact of William G. Chase*. New York, NY: Psychology Press (in press).
Gobet, F., & Chassy, P. (2008). Towards an alternative to Benner's theory of expert intuition in nursing: a discussion paper. *International Journal of Nursing Studies, 45*, 129–139.
Gobet, F., & Chassy, P. (2009). Expertise and intuition: a tale of three theories. *Minds & Machines, 19*, 151–180.
Gobet, F., & Retschitzki, J. (1991). Détresse apprise et jeu d'échecs: rôle de la familiarité et de la similitude des tâches. *Revue Suisse de Psychologie, 20*, 97–110.
Gobet, F., & Simon, H. A. (1996a). The roles of recognition processes and look-ahead search in time-constrained expert problem solving: evidence from grandmaster level chess. *Psychological Science, 7*, 52–55.
Gobet, F., & Simon, H. A. (1996b). Templates in chess memory: a mechanism for recalling several boards. *Cognitive Psychology, 31*, 1–40.

Gobet, F., & Simon, H. A. (1998). Pattern recognition makes search possible: comments on Holding (1992). *Psychological Research, 61*, 204–208.
Gobet, F., & Waters, A. J. (2003). The role of constraints in expert memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 29*, 1082–1094.
Gobet, F., de Voogt, A. J., & Retschitzki, J. (2004). *Moves in mind*. Hove, UK: Psychology Press.
Gobet, F., Chassy, P., & Bilalić, M. (2011). *Foundations of cognitive psychology*. Maidenhead, UK: McGraw Hill.
Holding, D. H. (1985). *The psychology of chess skill*. Hillsdale, NJ: Erlbaum.
Holding, D. H., & Pfau, H. D. (1985). Thinking ahead in chess. *The American Journal of Psychology, 98*, 271–282.
Johnson, J. G., & Raab, M. (2003). Take the first: option-generation and resulting choices. *Organizational Behavior and Human Decision Processes, 91*, 215–229.
Jones, G., Gobet, F., & Pine, J. M. (2007). Linking working memory and long-term memory: a computational model of the learning of new words. *Developmental Science, 10*, 853–873.
Kahneman, D., & Klein, G. (2009). Conditions for intuitive expertise: a failure to disagree. *American Psychologist, 64*, 515–526.
Klein, G. A. (1998). *Sources of power: how people make decisions*. Cambridge, MA: MIT Press.
Klein, G. A. (2003). *Intuition at work*. New York, NY: Currency Doubleday.
Klein, G. A., Wolf, S., Militello, L., & Zsambok, C. (1995). Characteristics of skilled option generation in chess. *Organizational Behavior and Human Decision Processes, 62*, 63–69.
Larkin, J. H., McDermott, J., Simon, D. P., & Simon, H. A. (1980). Expert and novice performance in solving physics problems. *Science, 208*, 1335–1342.
Marewski, J. N., Gaissmaier, W., & Gigerenzer, G. (2010). Good judgments do not require complex cognition. *Cognitive Processing, 11*, 103–121.
McCormack, B. (1993). Intuition: concept analysis and application to curriculum development. *Journal of Clinical Nursing, 2*, 11–17.
McCutcheon, H. H. I., & Pincombe, J. (2001). Intuition: an important tool in the practice of nursing. *Journal of Advanced Nursing, 35*, 342–348.
McDowell, J. (1994). *Mind and world*. Cambridge: Harvard University Press.
McDowell, J. (2007a). Response to Dreyfus. *Inquiry, 50*, 366–370.
McDowell, J. (2007b). What myth? *Inquiry, 50*, 338–351.
Montero, B., & Evans, C. D. A. (2011). Intuitions without concepts lose the game: mindedness in the art of chess. *Phenomenology and the Cognitive Sciences, 10*, 175–194.
Newell, A., & Simon, H. A. (1972). *Human problem solving*. Englewood Cliffs, NJ: Prentice-Hall.
Nisbett, R. E., & Wilson, T. D. (1977). Telling more than we know: verbal reports on mental processes. *Psychological Review, 84*, 231–259.
O'Kelly de Galway, A. (1963). *Pétrossian, l'intuition à l'affût [Petrossian, intuition on the lookout]*. Madrid: Castilla.
Patton, J. R. (2003). Intuition in decisions. *Management Decision, 41*, 989–996.
Prietula, M. J., & Simon, H. A. (1989). The experts in your midst. *Harvard Business Review*, Jan–Feb. pp 120–124.
Richman, H. B., Gobet, F., Staszewski, J. J., & Simon, H. A. (1996). Perceptual and memory processes in the acquisition of expert performance: the EPAM model. In K. A. Ericsson (Ed.), *The road to excellence* (pp. 167–187). Mahwah, NJ: Erlbaum.
Robbins, T. W., Anderson, E. J., Barker, D. R., Bradley, A. C., Fearnyhough, C., Henson, R., et al. (1996). Working memory in chess. *Memory and Cognition, 24*, 83–93.
Ryle, G. (1949). *The concept of mind*. New York: Barnes & Noble.
Saariluoma, P. (1992). Visuospatial and articulatory interference in chess players' information intake. *Applied Cognitive Psychology, 6*, 77–89.
Saariluoma, P. (1995). *Chess players' thinking: a cognitive psychological approach*. London: Routledge.
Selinger, E. (2008). Chess-playing computers and embodied grandmasters: in what ways does the difference matter? In B. Hale (Ed.), *Philosophy looks at chess* (pp. 65–87). Chicago: Open Court Press.
Simon, H. A. (1982). *Models of bounded rationality: behavioral economics and business organization*. Cambridge, MA: MIT Press.
Simon, H. A. (1995). Explaining the ineffable: AI on the topics of intuition, insight and inspiration. In *Proceedings of the Fourteenth International Joint Conference on Artificial Intelligence* (pp. 939–948).
Simon, H. A., & Chase, W. G. (1973). Skill in chess. *American Scientist, 61*, 393–403.
Tal, M. (1997). *The life and games of Mikhail Tal*. London: Everyman Chess.

Tamburelli, M., Jones, G., Gobet, F., & Pine, J. M. (2011). Computational modelling of phonological acquisition: simulating error patterns in nonword repetition tasks. *Language and Cognitive Processes* (in press).

Tikhomirov, O. K., & Vinogradov, Y. E. (1970). Emotions in the heuristic function. *Soviet Psychology, 8*, 198–203.

Wan, X. H., Nakatani, H., Ueno, K., Asamizuya, T., Cheng, K., & Tanaka, K. (2011). The neural basis of intuitive best next-move generation in board game experts. *Science, 331*, 341–346.