Nursing’s ways of knowing and dual process theories of cognition

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Abstract

Title. Nursing’s ways of knowing and dual process theories of cognition

Aim. This paper is a comparison of nursing’s patterns of knowing with the systems identified by cognitive science, and evaluates claims about the equal-status relation between scientific and non-scientific knowledge.

Background. Ever since Carper’s seminal paper in 1978, it has been taken for granted in the nursing literature that there are ways of knowing, or patterns of knowing, that are not scientific. This idea has recently been used to argue that the concept of evidence, typically associated with evidence-based practice, is inappropriately restricted because it is identified exclusively with scientific research.

Method. The paper reviews literature in psychology which appears to draw a comparable distinction between rule-based, analytical cognitive processes and other forms of cognitive processing which are unconscious, holistic and intuitive.

Findings. There is a convincing parallel between the ‘patterns of knowing’ distinction in nursing and the ‘cognitive processing’ distinction in psychology. However, there is an important difference in the way the relation between different forms of knowing (or cognitive processing) is depicted. In nursing, it is argued that the different patterns of knowing have equal status and weight. In cognitive science, it is suggested that the rule-based, analytical form of cognition has a supervisory and corrective function with respect to the other forms.

Conclusions. Scientific reasoning and evidence-based knowledge have epistemological priority over the other forms of nursing knowledge. The implications of this claim for healthcare practice are briefly indicated.

Keywords: Carper, cognition, evidence, integrative review, nursing, patterns of knowing, psychology

Introduction

Ever since Carper’s (1978) classic paper, it has been taken for granted in the nursing literature that there are ways of knowing, or patterns of knowing, which are not scientific, and possibly not empirical. Carper herself distinguished between ‘empirics’, or scientific knowledge, on the one hand, and ‘aesthetic knowing’, ‘personal knowing’ and ‘moral knowing’ on the other, but subsequent authors have varied the roll-call. Some add further patterns to Carper’s list: for example, ‘unknowing’ (Munhall 1993) and socio-political knowing (White 1995). Others draw attention to comparable distinctions, such as that between knowledge derived from scientific research and knowledge derived from clinical experience, patients and local contexts (Rycroft-Malone et al. 2004). In formulating these distinctions, the authority
of philosophers has often been invoked (Polanyi 1998 and Merleau-Ponty 2002), and these sources are sometimes reflected in the labels used to identify the various non-scientific ways of knowing in nursing: ‘embodied knowledge’, ‘intuitive knowledge’, ‘experiential knowledge’, ‘tacit knowledge’ and ‘professional craft knowledge’ (Titchen & Ersser 2001).

For the purposes of this paper, there is no need to determine exactly how many non-scientific ways of knowing there are, or to specify them precisely. It is enough to observe that the literature has arrived at a broad consensus which says: there is a scientific form of knowledge, but there are also other forms of knowledge, which are characteristic of nursing and equally significant. From here on, we will refer to this as Carper’s thesis, despite the numerous variations introduced later. It is neatly expressed in a remark by Stein et al. (1998), p. 43, who suggest that Carper ‘not only highlighted the centrality of empirically derived theoretical knowledge, but...[also]...recognised with equal importance and weight knowledge gained through clinical practice’.

One point of clarification is necessary. With Benner (1984), we can distinguish between propositional knowledge and non-propositional knowledge: that is, between ‘knowing that’ and ‘knowing how’. We can also distinguish between two different kinds of propositional knowledge, the scientific and the non-scientific, where ‘scientific knowledge’ is the sort which is produced by applying canonical methods of enquiry, including protocols for data collection, analysis and inference (Mayo 1996, Humphreys 2004). Both distinctions merit discussion, but this paper is concerned only with the second. The key question concerns the alternative means by which nurses arrive at an explicitly formulated judgment: as a result of scientific enquiry, or as a result of non-scientific ways of knowing.

The concept of evidence

In recent years, Carper’s thesis has been deployed in the debate about evidence-based practice (EBP). ‘Inclusionist’ writers (Paley 2006) have argued that the concept of evidence typically associated with EBP is inappropriately restricted because it is identified with scientific evidence – even more narrowly, quantitative and experimental evidence – and excludes precisely those alternative ways of knowing to which Carper and other writers have drawn attention. EBP would be all right, the argument goes, if it recognized the non-scientific patterns as legitimate sources of evidence, and did not limit the concept to evidence-derived-from-research. In other words, alternative ways of knowing in nursing should be included in the concept of evidence adopted by EBP.

For example, Rycroft-Malone et al. (2004, p. 83) observe: ‘The prominence ascribed to research evidence has meant the relative neglect of other forms of evidence...the nature of evidence is broader than evidence derived from research’.

With reference to Carper’s patterns of knowing, they add: there is still an underlying assumption in the field and practice of evidence-based health care that such sources of knowledge are idiosyncratic, subject to bias and, as a result, lack credibility. However, we propose that the delivery of individualized evidence-based health care...requires professional craft knowledge and reasoning. (Rycroft-Malone et al. 2004, p. 84)

Fawcett et al. (2001, p. 118) had previously made the same point: ‘evidence must extend beyond the current emphasis on empirical research and randomized clinical trials, to the kinds of evidence also generated from ethical theories, personal theories, and aesthetic theories’. There is also support for this view in the medical literature (Feinstein & Horwitz 1997, Sefton 2001, Upshur et al. 2001).

Dual process theories of cognition

Although some writers in nursing are sceptical about the value of cognitive science (Benner & Wrubel 1989), recent work in cognitive psychology appears to offer strong support for the idea that there are different patterns of knowing. More precisely, it suggests that there are two distinct cognitive systems, one of which is automatic, intuitive, holistic, parallel, implicit and fast, while the other is deliberate, rule-based, analytical, serial, explicit and slow. Researchers from several related areas of psychology have converged on this ‘dual process’ theory: learning (Reber 1993), attention (Schneider & Shiffrin 1977), reasoning (Stanovich 1999), social cognition (Chaiken & Trope 1999), judgment (Sloman 1996) and decision-making (Gilovich & Griffin 2002). It has become common to refer to the fast, automatic form of processing as System 1 (which we will abbreviate as S1) and to the slow, deliberate form as System 2 (S2), terms that were introduced by Stanovich and West (2000). Recent neuropsychological evidence, using functional magnetic resonance imaging, suggests that the two systems are neurally differentiated (Goel et al. 2000).

A debate about the exact nature of the differences between S1 and S2, and what architecture of mind is implied by dual process theory, is only just beginning (Carruthers 2006, Evans 2006), but the picture usually presented is as follows. S1 delivers judgments as a result of generally unconscious cognitive processes based on associative learning (Evans 2003) and/or innately channelled inferences (Carruthers et al. 2005); only the final product, the judgment itself, is ‘posted’
in consciousness. S1 is not so much a single system as a collection of sub-systems, or modules (Carruthers 2002), operating with relative autonomy [for this reason, Stanovich (2004) now refers to the autonomous set of systems, or TASS, rather than to System 1]. Each of these modules is, in psychological terms, domain-specific (i.e. context-dependent), although the learning mechanisms may be domain-general. According to some writers (for example, Papineau 2003), S1 is a product of natural selection, the human variant of a universal form of cognition shared with other animals. It is the system implicated in the majority of everyday judgments, ‘processing the most relevant information in the most relevant way’ (Sperber et al. 1995, p. 48).

In contrast, S2 is typified by controlled and conscious reasoning, phenomenologically associated with ‘thinking’. It permits abstraction, and makes it possible to analyse distant circumstances, hypothetical situations and future possibilities. If S1 is ‘on-line’ processing, S2 is ‘off-line’. It has the capacity to decontextualize, and to apply rules and protocols in accordance with explicitly formulated instructions. It makes essential use of central working memory (Gathercole 2003), copes efficiently with only one task at a time, and is strongly linked to measures of general intelligence (Stanovich & West 2000). The usual view is that it evolved more recently than S1, and is uniquely human (Evans 2003).

**Dual process accounts and Carper’s thesis**

The distinction between S1 and S2 provides a basis in cognitive psychology for Carper’s thesis. What Carper terms ‘empirics’ can be identified with S2, and the non-scientific patterns of knowing, however they are designated, can be identified with S1. It is true that several important questions about the dual process account have yet to be settled – whether, for example, S1 is exclusively the outcome of natural selection, or whether it has a cultural component; whether the learning mechanism of S1 is exclusively associative and domain-general, or whether it incorporates other, highly specialized and conceivably innate, mechanisms dedicated to particular functions. For the purposes of this paper, however, it is not necessary to answer these questions. The central claim, in both cognitive science and nursing, is that there are two distinct forms of cognition, holistic-intuitive and analytical-scientific, and that this distinction is theoretically significant – phenomenologically, and in terms of cognitive processing. In both cases, the holistic-intuitive system probably resolves into an indeterminate number of modules (or, in nursing, patterns), which may or may not share some of their mechanisms. In recognition of the fact that the two distinctions can plausibly be mapped on to each other, we will refer hereafter to S1 and S2 in the context of psychology, and to N1 and N2 in the context of nursing.

‘N1’ therefore becomes a generic way of referring to the non-scientific patterns of knowing, however many there are, and in whatever way they are otherwise identified. There appears to be no other generic term in widespread use, although Titchen and Ersser (2001) suggest ‘professional craft knowledge’. However, a generic term of some kind – more importantly, a neutral term – has a particular advantage: it avoids question-begging expressions such as ‘ways of knowing’ or ‘professional craft knowledge’. These terms are question-begging, because they imply that N1 judgments are inevitably accurate, or in correspondence with the facts, in a way that alternative expressions such as ‘ways of coming to believe’ or ‘professional craft beliefs’ would not. The use of neutral, non-committal terms, N1 and N2, means these patterns, along with S1 and S2, can now be treated as systems of cognition – i.e. cognitive processes – without the implication that either system necessarily results in knowledge, as opposed to sincere but false belief. Both systems have judgments as output; but using non-committal terms discourages the assumption that this output is perforce correct. In contrast, ‘ways of knowing’ is an invitation to fall into precisely this trap.

**The crucial difference**

There is, however, one major difference between the N1/N2 distinction and the S1/S2 distinction. The nursing literature regards N1 and N2 as equal partners: N1 has ‘equal importance and weight’ (Stein et al. 1998), ‘complements the role of scientific evidence’ (Rycroft-Malone et al. 2004, p. 83), and should be integrated with it, so that they can be ‘melded together’ (p. 88) in ‘the whole of knowing’ (Chinn & Kramer 2004, p. 12). Cognitive psychologists, on the other hand, emphasize that one principal function of S2 is to ‘override or inhibit default responses emanating from S1’ (Evans 2003, p. 456); to monitor and correct the intuitive judgments of S1 (Kahneman & Frederick 2002); to suppress S1’s disposition to ‘invalid inferences’ (Evans & Over 2004) as a result of ‘automatic contextualization’ (Stanovich & West 2003, p. 183). While the nursing literature places N1 and N2 on an equal footing, the psychology literature places S2 in a supervisory capacity with respect to S1. For cognitive psychologists, S2 clearly takes epistemological precedence.

**Heuristics and biases**

What lies behind the unequal status granted to S1 and S2 is the ‘heuristics and biases’ research tradition (Kahneman et al.
1982, Gilovich et al. 2002), which shows that people often succumb to error when S1 is not supervised by S2. They:

- assess probabilities incorrectly, they display confirmation bias, they test hypotheses inefficiently...they do not properly calibrate degrees of belief, they over-project their own opinions onto others...[and] they allow prior knowledge to become implicated in deductive reasoning. (Stanovich & West 2003, p. 171)

They do not correct for sampling bias (Fiedler & Justlin 2006), are over-confident in their mistaken assessments (Griffin & Tversky 2002), are highly likely to be wrong about their own attitudes and motivations (Wilson 2002), and ‘display numerous other information processing biases’ (Stanovich & West 2003). S1, having evolved to cope effectively with prehistorical situations, continues to function well in modern environments. However, there are important questions posed by contemporary life which it is badly equipped to answer (Stanovich 2004).

Although, as we have noted, there is some debate as to whether S1’s learning mechanism is exclusively associationist, few of the authors who adopt the dual process account dispute the view that associative processes characterize some S1 modules. Here are three simple examples of what that means, and how it can go wrong. They illustrate three variations on associative thinking: attribute substitution, structural availability bias and belief bias.

### Associative thinking

Consider the following statement: Rome is south of New York. Surprisingly, it is untrue: New York (40N45) is at a more southerly latitude than Rome (41N54). However, the reasons why most people assume the opposite are revealing. First, New York is a northern city relative to the United States; Rome is a southern city relative to Italy. Second, they are both famous for their respective climates: Rome is uncomfortably hot in the summer, while New York can have extremely cold winters. Cold is generally associated with northern latitudes (in the northern hemisphere at least), heat with southern latitudes. The assumption that Rome is south of New York is cognitively tied to this association. So, in effect, when estimating latitude, climate is used as a proxy measure, or a ‘fast and frugal heuristic’ (Gigerenzer et al. 2002). This use of a proxy, termed ‘attribute substitution’ by Kahneman and Frederick (2002), is obviously useful, and it frequently produces the right answer; but it is also apt, on occasion, to produce the wrong one. Scientific thinking, S2, provides a check (in this case, by calculating actual latitudes, or looking them up in an atlas).

A second example: a disappointed candidate for the Doctor of Nursing programme at a United Kingdom (UK) university made enquiries, and discovered that all of the applicants who had not been offered places were ‘hands-on’ nurses. She concluded that the course team were biased against such nurses, and lodged a complaint to that effect. She was obviously unaware (and apparently did not think it relevant) that all the applicants who had been offered places were also ‘hands-on’ nurses. Here again, then, associative thinking, S1, leads to a mistaken conclusion. The association between application-refusal and ‘hands-on-nursing’ (in the candidate’s sample) implied a correlation which is, in fact, illusory (Myers 2002). This is an error which a more systematic sampling strategy, S2, would have avoided. The example is a homely one, but this type of mistake – structural availability bias – is very common, and usually more difficult to spot (Dawes 2006, Freytag & Fiedler 2006).

A third variation on the associative theme is called ‘belief bias’. It is usually illustrated by a syllogism such as the following (Stanovich 2003):

\[
\begin{align*}
\text{All living things need oxygen.} \\
\text{Roses need water.} \\
\text{Therefore, roses are living things.}
\end{align*}
\]

This is an invalid inference, although most people are initially inclined to think it valid, including 70% of university students (Sà et al. 1999). This is another example of attribute substitution, with believability being substituted for validity: people recognize the syllogism’s conclusion as something they already believe to be true, and on that basis assume that the inference is valid. If this syllogism is compared with another, the point becomes obvious:

\[
\begin{align*}
\text{All insects need oxygen.} \\
\text{Mice need oxygen.} \\
\text{Therefore, mice are insects.}
\end{align*}
\]

The form of inference is exactly the same as in the first example, but now the fallacy is easier to spot, because the believability of the conclusion is not a distraction. As Stanovich (2003, p. 292) puts it, ‘prior knowledge does not get in the way’.

The possibility of belief bias generalizes to other kinds of inference based on canonical procedures. For example, the methodological appraisal of scientific studies can be compromised by prior beliefs about the findings (Koehler 1993). This has been demonstrated in the context of clinical trials (Resch et al. 2000, Kaptchuk 2003), with well-designed studies being dismissed because they indicate that an unconventional treatment is effective (or an established treatment is ineffective), and poorly designed studies being accepted because
they appear to confirm widely held opinions. But it is not just experimental studies that are affected by belief bias: in general, any method is more likely to be regarded as valid if its conclusion is thought to be true, and more likely to be regarded as invalid if its conclusion is thought to be false (Fugelsang & Thompson 2000, Roberts & Sykes 2003, Fugelsang et al. 2004).

The celebration of error

Let us be clear about the implications of saying that the distinction between S1 and S2 maps on to the distinction between N1 and N2. It means that ‘aesthetic knowing’, ‘personal knowing’, ‘professional craft knowledge’, ‘clinical judgment’ and all the other non-scientific ‘patterns’, are likely to produce the errors attributable to S1 when it is unsupervised by S2. As a result of these errors:

- physicians choose less effective medical treatments; people fail to accurately assess risks in their environment; information is misused in legal proceedings; millions of dollars are spent on unneeded projects by government and private industry; parents fail to vaccinate their children; unnecessary surgery is performed; animals are hunted to extinction; billions of dollars are wasted on quack medical remedies; and costly financial misjudgments are made. (Stanovich 2003, p. 292)

So the authors who suggest that ‘tacit, experiential forms of knowledge are persuasive’, who argue that ‘knowledge accrued through professional practice and life experiences’ has equal status with research evidence, and who complain about the assumption that ‘such sources of knowledge are idiosyncratic, subject to bias and, as a result, lack credibility’ (Rycroft-Malone et al. 2004, pp. 84–85) are embracing attribute substitution, structural available bias, belief bias and various other information processing biases, and rebranding them as cognitive virtues. In promoting Carper’s thesis, in emphasising that N1 and N2 are equal partners, and in exalting nursing’s alternative ‘patterns of knowing’, the literature is celebrating the possibility of error.

Randomized controlled trials

The supervision exercised by S2 involves the application of logic, mathematics and/or the probability calculus. When these forms of analysis are systematically applied to particular problems and puzzles, as in scientific enquiry, the results are typically collected in academic journals, encyclopaedias, atlases, books and so on. The applications which consistently demonstrate their reliability in the production of informative and accurate results are eventually incorporated in the methodological canon (Mayo 1996).

In the nursing literature, the debate about EBP, and in particular about the status of randomized controlled trials (RCTs) as the gold standard for evidence, indicates that this dynamic is not widely understood. So let us briefly take that as an example. The design of an RCT – the random allocation of cases into experimental and control groups, the use of power calculations to determine sample size, the adoption of statistical procedures to test differences in outcome – measurably reduces the probability of an inferential error being made (for example, deciding that the experimental treatment is more effective than the control condition, when in fact it is not). This represents the application of probability theory to competing hypotheses and the extent to which the data is consistent with any of them (Shadish et al. 2002). The aim is not to achieve certainty, as some authors appear to believe (Van der Zalm & Bergum 2000, Northrup & Purkiss 2001, Hope & Waterman 2003, Flaming 2004); it is to minimize the risk of cognitive errors, especially those which S1, unchecked and unsupervised, characteristically makes.

So there are unimpeachable reasons for the appearance of RCTs at the top of the hierarchy of evidence. But that portion of the literature which is sceptical about EBP rarely mentions them. Instead, it attempts to convey the impression that the preference for experimental evidence is arbitrary (French 2002), dogmatic (Upshur 2002), positivist (Welsh & Lyons 2001), or an expression of the dominant medical perspective (Fawcett et al. 2001).

Other arguments against evidence-based practice

At any rate, that is one strategy, amounting to little more than argument by innuendo. Another strategy is argument by assertion. Here is an example: ‘The point is that there are many ways of knowing about the world. Quantification may be one way among others, but there is no reason in principle why it should always be valued above others’ (Draper & Draper 2003, p. 546). The claim is not elaborated, there is no attempt to justify it, and no effort is made to counter the argument that quantification (in the form of probability theory applied to clinical trials) must be regarded as privileged.

Some authors do provide something more than innuendo and simple assertion; but their arguments turn out to be fallacious. For example, Fawcett et al. (2001, p. 117) say: ‘Inasmuch as both patterns of knowing and theories represent knowledge, and are generated and tested by means of congruent, yet diverse processes of inquiry, we maintain that each pattern of knowing may be regarded as a type of theory’. More briefly: because patterns of knowing and theories both count as knowledge, each pattern may be regarded as a type
of theory. The form of argument here is equivalent to the claim that, because cats and cows are both mammals, cats may be regarded as a type of cow.

Here is another argument. The notion that we should – or perhaps even could – base our practice on ‘generalizable evidence’ demolishes our traditional practice. Such worldviews urge us to swap our ideas of crafting care around the unique complexity of the individual, for a generalization about what worked for most people in a study. (Barker 2000, p. 332)

The structure of this argument, which has been popular in the healthcare literature, is as follows: quantitative studies refer to populations; nurses care for individuals; therefore, quantitative studies are irrelevant to clinical practice. This is similar in form to: epidemiological studies of cancer refer to populations; individuals make decisions; therefore, epidemiological studies are irrelevant to my decision to smoke. Both of these arguments simply ignore the concepts of probability and risk, and would make nonsense of actuarial procedures and insurance. In any case, the experience on which the nurse draws when crafting individual care is also population-based: the population of clients she and her colleagues have previously seen. If the population defined by a research study is irrelevant to the unique individual, so is the population defined by clinical experience.

Recently, Freshwater and Rolfe (2004, p. 38) have claimed that EBP ‘appeals to an absence of evidence’. To understand their argument, it is necessary to recall that, in a clinical trial, the experimental treatment is taken to be more effective than the control condition when, on statistical grounds, the null hypothesis – the hypothesis that there is no difference in outcome between the two arms – can be rejected. In other words, when the trial has provided evidence against the null hypothesis. Freshwater and Rolfe, however, translate evidence against the null hypothesis into lack of evidence for it; and it is this translation which is offered in support of their claim that, at the centre of EBP, there is no evidence at all. This is a startling non-sequitur.

A division of labour?

The ‘equal partners’ understanding of the relation between N1 and N2 is reflected in the literature’s preference for metaphors such as ‘integrating’, ‘melding’, ‘balancing’, ‘combining’, ‘blending’ and ‘harmonizing’ (for example, Shaughnessy et al. 1998, Haynes et al. 2002, Kitson 2002, Upshur 2002). These are all attractive-sounding ideas, but it is not clear how they should be operationalized, and none of the cited authors makes any serious effort to explain. It is evident that none of the patterns should become ‘dominant’, or be used in isolation – something Chinn and Kramer (2004) describe as ‘the patterns gone wild’ – but otherwise there are few clues as to what the balancing, blending and melding look like.

However, the literature on decision-making suggests an account of the functions of S1 and S2 which does provide a possible alternative to dual process theory. This is the cognitive continuum (Hammond 1996), an idea which has been discussed in the context of health care (Hamm 1988) and, more specifically, nursing (Thompson 1999, Harbison 2001, Cader et al. 2005). Hammond does not regard intuition and analysis as distinct cognitive systems; rather, he locates them at either end of a cognitive continuum, in the middle of which are four other ‘hybrid’ modes of cognition. However, the key idea is that each cognitive mode is associated with a particular type of task, in such a way that objectively identifiable task characteristics will elicit a corresponding cognitive response. A more structured task, for example, which incorporates fewer pieces of information, is amenable to the analytic approach; while a less-structured task, incorporating more information, will elicit intuition.

Extrapolating from this idea, it becomes tempting to suggest that N1 and N2 could be ‘equal partners’ in this division-of-labour sense: N1 deals with complex, fuzzy, ill-structured tasks, N2 tackles simple and more well-defined ones. So N2 does not check up on N1; rather, they have different jobs to do.

Statistical prediction rules

The cognitive continuum theory deserves further consideration, but here it is possible to provide only a brief statement of why, at least in a clinical context, the ‘supervisory’ account of S2/N2 is preferable to the ‘division of labour’ account. The main reason is the large number of studies showing that, however complex the task, expert judgment (N1) is no more effective than an evidence-based decision rule (N2) and often much less effective. When the other ‘patterns of knowing’ are compared with empirically derived statistical prediction rules (SPRs), they frequently come off worse, and hardly ever do better (Meehl 1954, Marchese 1992, Dawes et al. 2002). A recent review of 136 studies in medicine, psychiatry and psychology concludes that ‘mechanical prediction is typically as accurate or more accurate than clinical prediction’ (Grove et al. 2000, p. 26). Clinical judgment surpassed the SPR in only eight of the studies, while the SPR did better in 63 of them. In the remaining studies, there was no difference.

Here are a few examples. SPRs predict neonates at risk of Sudden Infant Death Syndrome better than clinical experts (Golding et al. 1985). An SPR outperformed experienced clinicians and a prominent neuropsychologist in predicting
What is already known about this topic
- It is generally accepted in the nursing literature that there are several patterns of knowing, with scientific enquiry being only one.
- The most common view is that the various ways of knowing all have equal status and weight.
- This view has been evident in recent discussions of evidence-based practice, when it is argued that the relevant concept of evidence has been defined too narrowly.

What this paper adds
- There is a basis in recent psychology for the claim that there are cognitive systems other than the analytical-scientific.
- However, psychology represents the non-analytical cognitive systems, not as equal in weight and status to the analytical scientific system, but as subject to correction and supervision by it.
- It is difficult to activate the analytical scientific system, because non-analytical systems are the default response to most situations. This raises questions about how to motivate the use of the analytical scientific system in health care.

the presence, location and cause of brain damage (Wedding 1983). In the same way, SPRs have been shown to be more effective in the diagnosis of abdominal pain (Dickson et al. 1985), heart disease (Caceres & Hochberg 1970), thyroid disorder (Boyle et al. 1966) and low back pain (Mathew et al. 1988). As Meehl (1986) has observed, it is unusual to find an area of research in which the results of so many diverse studies are as consistent as this.

It is worth emphasising that SPRs outperform experts, not novices, and that they typically manipulate much less information than is available to the clinician. So the idea that N1 is better suited to complex, fuzzy, ill-structured tasks than N2, justifying the proposed division of labour, appears to be mistaken. The evidence suggests that picking out a small number of key variables from a complex situation, and applying an SPR to them, is often more effective than applying unaided clinical judgment to a greater number of variables (or, holistically, to the situation as a whole).

The supervisory function
Statistical prediction rules are so successful that they have given rise to a new epistemology, strategic reliabilism (Bishop & Trout 2005). There is, however, no prospect of formulating an SPR for every clinical situation one might encounter, although their use — in the form of decision aids, decision support systems and other decision tools — is increasing (Garg et al. 2005, Lui et al. 2006). Still, in the present context, this is not the main point. What we wish to emphasize instead is that the success of SPRs is an empirical indicator of the relation between S1 and S2. It would be difficult, on this evidence, to justify a division of labour of the kind suggested by the cognitive continuum theory, and it looks as if there is little alternative but to revert to the idea that S2 has a supervisory function with respect to S1.

It is necessary, then, to abandon the equal-partners view of the relation between N1 and N2, and accept the dual process view that S2 supervises and corrects S1. Of course, S1 is the default option for all of us, most of the time; but the essential point is that S2 monitors ‘the effectiveness of intuitively-driven behaviour’ (Degani et al. 2006). In the clinical context, this translates into EBP, and the kind of scientific reasoning which sceptically interrogates the other ‘ways of knowing’.

Recruiting System 2
One question, however, remains outstanding. How, in the clinical environment, can S2 be activated? The problem is a significant one in health care because there are at least three factors which inhibit the recruitment of S2 to clinical work. First, there is a natural psychological resistance to the idea that S1/N1 is subject to pervasive cognitive bias, and a concomitant reluctance to believe that evidence, even in the form of SPRs, can outperform expert judgment. Second is the fact that S2 processing does not come naturally, and that most of us find it hard to execute the appropriate procedures correctly (Gigerenzer 2000). Third, there are the issues of the pragmatics of time and space, which restrict access to the necessary resources.

There is, of course, no single answer to this question, and an adequate discussion of it would require a further paper. But in closing we will briefly draw attention to some of what has been learned during the past 10 or 15 years. First, that educational interventions — continuing professional development, courses of various kinds, the dissemination of educational material and so on — usually have, at best, a very modest effect (Grol & Grimshaw 2003). Second, that audits combined with systematic feedback to clinicians have mixed results, depending on the type of feedback and the frequency of presentation (Davis & Taylor-Vaisey 1997, Thomson et al. 1997). Third, that the use of reminders — strategically placed posters, coloured signs, labels with messages and patients being encouraged to
remind staff – does have a sustained effect, which seems to be greater than that of the other interventions that have been studied (Grimshaw et al. 2002). Fourth, that interventions are more likely to be effective if they are tailored to a specific clinical setting, sensitive to local practices and accessed at the point of decision-making (Haynes et al. 1995, Sim et al. 2001, Kawamoto et al. 2005). Fifth, that supporting and complementary measures at team, unit or organizational level are necessary if lasting change is to be effected (Grol & Grimshaw 2003).

Conclusion

All of this is a testament to the recalcitrance of S1 and the difficulty of recruiting S2 to the clinical environment. The idea that there are other ‘ways of knowing’, equal in weight and status to scientific evidence, is a persuasive one and not easily overcome. But we should not let this seductive narrative get in the way of delivering improved services to patients.

Author contributions

JP, HC, LD, ED and CN were responsible for the study conception and design and JP was responsible for the drafting of the manuscript. JP, HC, LD, ED and CN made critical revisions to the paper.

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