Consciousness increases the consistency of behaviour, but the correlate is that change becomes more difficult. The literature on transfer in problem-solving suggests the idea that the recognition of the analogy between a problem having a known solution and a new problem is more difficult when the solution of the first problem has been taught explicitly than when it has been discovered through errors and impasses (Gick & Mc Garry, 1992). Important semantic changes are probably made more easily on an implicit level than on the explicit level of consciousness. Consciousness is probably characteristic of phases of cognitive functioning that are stable: the subject is not aware of what happens in phases of change, especially of what happens during learning.

Becoming aware is a type of activity and we have to understand what are the conditions for this activity to take place.

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THE SYMBIOSIS OF SUBJECTIVE AND EXPERIMENTAL APPROACHES TO INTUITION

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We all have had convictions (i.e. a hunch about how to solve a problem, an inkling about the intents of another, or a wariness of a situation) that we were unable to substantiate on a purely logical basis. Such intuitive experiences have intrigued philosophers for centuries, although the construct of intuition as such has generally been given an undeserved cold shoulder by researchers. As Peugeot, in this issue, observes, 'It is therefore very surprising that so few studies have been dedicated to the

study of the subjective experience which is associated with it' (p. 43). Peugeot is correct in her observation that modern research has had little to say explicitly about intuition and its subjective concomitants. However, this omission may be as much a matter of terms as it is of fact. Specifically, if we consider the definition of intuition we see that a considerable amount of research that has been called by other names, actually reveals important insights into *both* the cognitive processes that lead to intuition and the subjective experiences associated with it. Moreover, because this research explicitly relates subjective experiences to more objective measures and methodologies, it circumvents a central criticism that can be levelled against the first-person phenomenological methodology used by Peugeot; namely that it may not reflect underlying processes, nor even necessarily the subjective experiences that it purports to measure.

The pertinence of recent research to the understanding of intuition becomes clear when we consider several of its standard definitions. According to Webster's Dictionary (1975) intuition involves 'the power or faculty of attaining direct knowledge or cognition without evident rational thought or inference'. A narrower definition of intuition, involves the 'quick and ready insight' experience that Peugeot and others consider in their analyses of creative illuminations. Although there are some important differences between these two characterizations, they both suggest that intuition involves *meaningful cognition that occurs without consciously mediated deliberation*. From this vantage, demonstrations of intuition require evidence of two distinct claims. First, an intuition must be shown to have transpired *without conscious deliberation*. Since the discernment of conscious deliberation is largely a phenomenological question, resolution of this issue must fundamentally rely on subjective reports. Although central to intuition, the demonstration of cognition in the absence of deliberation is not sufficient to provide a meaningful demonstration of intuition. In order to distinguish intuitive judgements from mere fancy, they must also be shown to be sensitive to some underlying truth or significance. Thus, the second claim is that demonstrations of intuition must provide evidence of *meaningful cognition*.

The above framework allows us to see how many domains of cognitive research, involving both subjective and objective measures, can be reconstrued as illustrating incidents of intuition. For example, consider Marcel's (1983) original demonstration of subliminal perception. Marcel flashed words at a rate at which participants reported no subjective awareness. Participants were then asked to identify which of three words was a synonym of the previously flashed word. Although participants found this task rather peculiar, they nevertheless were well above chance at identifying matching synonyms. This paradigm clearly fits with the above characterizations of demonstrations of intuition. Evidence for *nondeliberative processes* is provided by participants' subjective reports of being unaware when words were flashed. Evidence of *meaningful cognition* is provided by the objective finding of above-chance performance in identifying the appropriate matching word.

Another more recent example of intuition is provided by the research of Dunning and Stern (1994). In their studies, individuals witnessed a staged crime, attempted to identify the perpetrator in a line up, and then subjectively reported how they made the identification. Deliberative processes were indicated by the endorsement of statements such as 'I compared the photos to each other in order to narrow the choices'. Nondeliberative processes (what we would call intuition) were indicated by endors-

ing statements such as 'His face just popped out at me.' Strikingly, and in support of the meaningfulness of intuitive judgements, Dunning and Stern found that recognition judgements were actually *more* accurate when participants characterized their recognition decisions as relying on nondeliberative processes relative to deliberative processes.

One potential concern with the above characterizations of intuition is that the focus on subjective experience is rather modest. In the Marcel study, subjective reports were limited to a simple acknowledgement of awareness. In the Dunning and Stern study, subjective report was constrained by the specific alternatives that participants were given. On the one hand, such limitations clearly constrain the amount of information that can be derived about the subjective experience of intuition in these cases. On the other hand, it should be noted that even such relatively modest uses of subjective experience represent a departure from a strict positivistic approach and have consequently been viewed with some scepticism (e.g. Holender, 1986). Indeed concern regarding the applicability of subjective reports has some foundation, as without objective verification one cannot be certain whether they accurately reflect the contents of individuals' thoughts. Peugeot tacitly acknowledges the uncertainties surrounding self-report measures, by alluding to techniques such as subjects 'using the present tense' or 'letting go eye contact' for verifying 'if the subject is really reliving an experience' (pp. 46–7). However, no evidence is given for why we should trust such techniques as verifying individual reports. Moreover, recent research suggests that simply attempting to subjectively report on non-verbalizable intuitive experience may disrupt those very experiences.

There is now a growing accumulation of evidence that individuals' ability to employ nonverbal intuitive knowledge may be impaired as a result of self-report procedures (see Schooler *et al.*, 1997 for a review). For example, in one study (Schooler & Engstler-Schooler, 1990), participants viewed a bank robbery and then half described the appearance of the robber while the other half engaged in an unrelated activity. Finally, all participants were asked to identify the robber from a photo line-up. Strikingly, having verbalized the appearance of the robber actually interfered with participants' subsequent ability to recognize him. Since this original demonstration, comparable verbally-induced memory disruptions (termed 'verbal overshadowing') have been observed to occur with memory for: colour (Schooler & Engstler-Schooler, 1990), taste (Melcher & Schooler, 1996), visual forms (e.g. Brandimonte *et al.*, 1997) and audition (Schooler *et al.*, 1996). In addition, similar disruptive effects of verbalization have been found for a variety of other tasks that rely on non-verbalizable (intuitive) knowledge, including: affective decision making (Wilson & Schooler, 1991; Wilson *et al.*, 1993), analogical reasoning (Sieck *et al.*, in press) and (as will be discussed later) insight problem solving (Schooler *et al.*, 1993).

Although verbal overshadowing effects raise serious problems regarding the use of self-reports for articulating intuitive experiences, they at the same time help to reveal the nature of these experiences. Specifically, such effects can be readily understood as occurring because verbalization, by encouraging deliberation, impairs participants' ability to rely on their gut feeling; i.e. their intuitions. Consistent with this view, Schooler & Engstler-Schooler replicated the prior verbalization procedure with one modification; at the time of test half of the participants were forced to respond on the basis of their intuitions by requiring them to make speeded recognition decisions.

As predicted, when participants were forced to rely on their gut intuitions, the disruptive effects of verbalization were attenuated.

More recent research using the 'verbal overshadowing' paradigm (Schooler *et al.*, 1996) has added self-report measures to further document the impact of verbalization on the reliability of deliberative and intuitive judgements. Critically, however, rather than asking individuals to expound on their non-verbalizable experiences, participants were simply asked to indicate whether they had made a 'reason' based judgment (i.e. whether they had some specific reason for choosing the face that they did) or a 'just know' decision (i.e. they were unaware of any specific reason for choosing the face that they did). Cf. Gardiner (1988). In this study, verbalization was found to markedly disrupt recognition decisions classified as having been made on a just know basis, while if anything improving those decisions characterized as having been based on reasons. The fact that verbalization disrupted just know judgments but not reason-based judgments supports the contention that verbalization specifically hampers the use of intuition. It also simultaneously demonstrates that while invasive self-report measures (i.e. describing ones thoughts) are impairing intuitive processes, more modest subjective self-report measures can still reveal whether or not intuition is being employed. More generally, the systematic relationship between objective manipulations of deliberation and subjective reports of intuition illustrates the value of using both approaches in the investigation of intuition.

Intuition as illumination

One especially compelling example of intuition is the experience of illumination in which the solution to a problem seems to come out of the blue. Consistent with our more general characterization of intuition, such experiences are (1) not precipitated by explicit deliberation and (2) often associated with meaningful (indeed even profound) cognition. Contrary to Peugeot's claim in this issue, however, quite a few researchers have amassed retrospective accounts of the subjective stages associated with illumination (e.g. Csikszentmihalyi & Sawyer, 1995; Ghiselin, 1952; Hadamard, 1949; Shrady, 1972; Wallas, 1926). Although some of these investigations were more anecdotal than the approach described by Peugeot, others (at least from the perspective of this reader) were comparably rigorous. For example, Csikszentmihalyi & Sawyer (1995) interviewed nine creative individuals who reported at length their phenomenological experiences of discovery. Some examples of their reported subjective experiences included 'suddenly in the middle of the night while we were going through Kansas, the whole picture became crystal clear, the eureka experience or whatever you like to call it' (p. 351) and 'You have these ideas . . . as you work on them you get new ideas . . . If you don't work on it they hide in there . . . Something has begun to work and you continue it, you feel the singing inside you' (p. 352). Clearly such descriptions, though admittedly not in the present tense, convey much of the same type of observations as those reported by Peugeot.

In addition to deriving similar types of subjective reports, these other analyses also identified four subjective stages of intuition not too dissimilar from those described by Peugeot. These include preparation, incubation, illumination, and verification. Preparation involves the gradual, deliberative accumulation of knowledge as a result of attempting to solve the problem. Incubation refers to a period in which all conscious deliberative mental processing devoted specifically to solving the problem is

stopped. Illumination corresponds to the flash or moment of 'aha' in which the problem solution appears in consciousness. Finally, verification denotes the process of determining whether the solution gained through illumination is valid.

Such subjective case analyses have done much to flesh out the phenomenology of illumination, and in particular the suggestion that the hallmark of the illumination experience is the point at which unconscious, non-deliberative processes become conscious. Nevertheless, they are susceptible to the same concerns as the subjective self-report measures described earlier; i.e. they do not necessarily reflect the actual underlying processes involved in the task. Moreover, because such retrospective analyses typically occur well after the fact, they run the additional risk of being biased by memory distortions (e.g. Dunbar, 1995; Ericsson and Simon, 1980). For example, Dunbar sat in on laboratory meetings in which major scientific insights were made. Subsequently he queried participants of the groups regarding their recollections of when particular insights occurred. On several occasions he observed critical disparities between individuals recollections of their insights, and what he had witnessed actually occur (Dunbar, December 1996 personal communication). Finally, as will be described shortly, extensive self-report procedures can actually interfere with the successful implementation of insight processes.

Because of the inherent limitations of retrospective case analyses of real world discoveries, it is important to complement such approaches with more controlled laboratory investigations that combine subjective reports with objective measures. Towards this end, Metcalfe (1986 — all Metcalfe references are to this work) had participants characterize their subjective feeling of warmth (i.e. how close they are to the solution) as they tried to solve 'insight' riddle problems known to induce aha experience. Interestingly, Metcalfe found that in insight problem solving, continuously increasing feeling of warmth (FOW) ratings actually predicted erroneous solutions. However, an abrupt increase in FOW rating just prior to solution predicted correct solution. This finding provides an example of how intuitive hunches can be misleading. At the same time, it validates the phenomenological suddenness of illumination.

Using a somewhat different paradigm, Bowers *et al.* (1990 — all Bowers references are to this work) provided evidence that hunches prior to the moment of illumination can reflect actual progress towards the solution. Their procedure used a 'remote associate' paradigm (Mednick & Mednick, 1967) in which individuals see a three word triad (e.g. playing, credit, report**)** and must identify a single word corresponding to all three (e.g. card). In the Bowers paradigm, individuals were simultaneously given two triads, only one of which had a solution. Interestingly, Bowers found that subjects were above chance at guessing which triad had a solution even if they could not solve it. Thus, in contrast to Metcalfe, the Bowers procedure revealed that individuals can possess some intuitions prior to actually seeing the solution.

There are several important implications of the disparities between the Bowers and the Metcalfe findings. From a conceptual perspective, the two approaches highlight differences between two manifestations of intuition. Bowers' research demonstrates intuition in the sense of *possessing a hunch* without being able to rationally substantiate it. Metcalfe's research demonstrates intuition in the sense of *recognizing a solution* without any awareness of the cognition that led to it. Although these two manifestations of intuition are clearly related, the rather different findings of Metcalfe and Bowers also help to illustrate their disparities. From an empirical perspec-

tive, the disparity of the Metcalfe and the Bowers results suggest that the way in which intuitive hunches are measured may have important implications for the meaningfulness of the intuitive experience. In Metcalfe's experiments subjects were directly queried about the quality of cognitive processes that clearly were not readily available to consciousness. In contrast, Bowers merely asked participants to make a gut judgement about which of two alternatives was likely to have a solution. It is thus possible that Metcalfe's participants, in their effort to deliberately gaze into their unconscious percolation, may have lost sight of the very intuitions they were seeking.

Research by Schooler *et al.* (1993) adds credence to the potentially disruptive effects of explicitly focusing on the intuitive processes leading to sudden aha experiences. They found that thinking aloud while trying to solve problems actually disrupted participants' ability to correctly solve insight problems while having little effect on more logical analytical types of problems. (Similar findings were also observed when participants were interrupted in the middle of their solution attempts and asked to retrospectively report on the processes that they were using.) In this study, participants were engaged in first-person self-report very much like that reported by Peugeot; nevertheless, the central finding of this study was that attempting to articulate the contents of inner thought fundamentally disrupted the process of intuition, i.e. participants were markedly less successful at reaching insightful solutions.

Further support for the inherently non-verbalizable quality of the intuitive processes comes from Schooler and Melcher's (1995) in depth analysis of the think aloud protocols generated in the Schooler *et al.* study. In effect this content analysis mirrors that provided by Peugeot, and is arguably more valid as individuals were reporting thoughts as they occurred rather than trying to reproduce thoughts that happened sometime ago. However, the central finding of Schooler and Melcher's analysis was that subjective first-person protocols revealed very little about the processes that lead to insights. It is not that such protocols are inherently meaningless, since for logical problems there were various elements of individuals' think-aloud protocols (e.g. the use of logical arguments) that were highly predictive of whether or not a participant ultimately solved a problem. In contrast, for insight problems there was very little in individuals' reports that predicted whether or not they were making progress toward a solution. Instead participants were much more likely to comment on the ineffability of their thoughts with observations such as 'there is nothing that's going through my mind that's really in any kind of — that's in a verbal fashion' or 'There is not a whole lot that I can say about this while I am trying to figure it out' or 'I know I am supposed to keep talking but I don't know what I am thinking' (p. 115). When considered together with the fact that thinking aloud interferes with insight problem solutions, such protocols clearly illustrate the limitations of relying exclusively on first-person think aloud techniques for gaining insight into intuition.

The clear limitations of first-person think aloud reports for revealing insight processes illustrates the importance of alternative empirical approaches to document the nature of the intuitive insight processes that are vulnerable to verbalization. For example, using a split visual field priming paradigm Fiore & Schooler (1997) found evidence that insight processes may be specifically associated with the right-hemisphere. Using an individual differences paradigm, Schooler & Melcher (1995) found that the ability to solve insight problems is highly correlated with that of recog-

nizing out-of-focus pictures, suggesting that the intuitive processes associated with insight may be similar to basic perceptual pattern recognition processes (cf. Schooler, Fallshore & Fiore, 1995.) Finally, using the 'just know'/'reason' self-report measure (described earlier), Schooler *et al.* (1996) found that the disruptive effects of verbalization were again exclusively associated with solutions reached on a 'just know' basis. Methodologically, this latter finding illustrates the value of combining objective manipulations of intuition with subjective measures of it. Conceptually, it suggests that intuitions, like faint stars, may vanish if scrutinized too closely.

Conclusion

A complete understanding of intuition will necessarily require both subjective and objective techniques within both naturalistic and laboratory settings. Alone, each of these approaches has significant limitations. Subjective measures may misrepresent the processes contributing to intuition, whereas objective methodologies alone fail to illuminate underlying phenomenology. Naturalistic studies can introduce hindsight biases, whereas laboratory studies must necessarily rely on relatively mundane intuitions. Despite their individual weaknesses, the convergence of techniques holds great promise. Regrettably most researchers have been reluctant to integrate approaches. Researchers studying subjective experience rarely examine how their measures interact with more objective manipulations and measures, while experimental researchers tend to dismiss the importance of subjective experience. In most domains, these alternative tacks have progressed independently, however the inherent properties of intuition require that they be synthesized. Ultimately, intuition must be defined in terms of subjective conscious experience, and indeed, recent research indicates that individuals can report when they are making intuitive 'just know' judgments. At the same time however, the validity of an intuitive judgment depends on the objective assessment of its products. Moreover, the very act of subjective scrutiny can hamper the intuitive processes under investigation. Such reactive effects pose very serious problems for analyses such as Peugeot's that exclusively rely on participants' *attempts* to provide extensive first-person reporting of their intuitive thought processes. Although problematic from the vantage of a purely subjective analysis, the disruptive effects of verbalization on intuition highlight the value of integrating subjective and experimental approaches. Specifically, by encouraging verbal introspection we can manipulate access to intuitive knowledge, and thereby assess the role of such knowledge in cognition. Thus, a fundamental limitation of subjective introspection (i.e. its reactivity) can actually serve as an experimental tool for illuminating the otherwise mysterious qualities of intuition.[26]

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DISTINGUISHING INSIGHT FROM INTUITION

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As Peugeot says, the subjective experience of intuition has received remarkably little attention, so her paper is a valuable start to a systematic study of this important phenomenon. There are a number of possible meanings of 'intuition', for example, authors such as Bowers *et al.* (1990), use it to mean a feeling of being close to solving a problem before the solution is consciously available (similar to tip-of-the-tongue