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A phenomenological solution to the measurement problem? Husserl and the foundations of quantum mechanics

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Abstract

The London and Bauer monograph occupies a central place in the debate concerning the quantum measurement problem. Gavroglu has previously noted the influence of Husserlian phenomenology on London's scientific work. However, he has not explored the full extent of this influence in the monograph itself. I begin this paper by outlining the important role played by the monograph in the debate. In effect, it acted as a kind of 'lens' through which the standard, or Copenhagen, 'solution' to the measurement problem came to be perceived and, as such, it was robustly criticized, most notably by Putnam and Shimony. I then spell out the Husserlian understanding of consciousness in order to illuminate the traces of this understanding within the London and Bauer text. This, in turn, yields a new perspective on this 'solution' to the measurement problem, one that I believe has not been articulated before and, furthermore, which is immune to the criticisms of Putnam and Shimony. © 2002 Elsevier Science Ltd. All rights reserved.

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1. The measurement problem in quantum mechanics

The measurement problem runs like a crack through the foundations of quantum mechanics (QM). Briefly put, the problem is the following. According to the formalism, if two systems interact, the state of the joint system will be a superposition of states of each system and, as the joint system evolves in time, its joint state will remain a superposition. If the formalism is taken to apply to all

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physical systems, including measurement apparatuses, then when such an apparatus interacts with another system, the joint state should be a superposition. Yet the problem is that we never observe such superpositions.

The Copenhagen, or ‘orthodox’, solution¹ is typically understood as having proposed that something non-physical—namely, the mind or consciousness—must ‘reduce’ the superposition to give what we observe. This came under criticism in the late 1950s and early 1960s both for its apparent mind–body dualism and for setting the observer beyond the reach of QM. My intention in the present paper is to suggest that this typical understanding has failed to grasp the historical origins of the orthodox solution in *phenomenology*, and hence these criticisms fall wide of the mark.

The structure of the paper is as follows. In the following Section I will briefly outline the orthodox solution, emphasizing the way in which the London and Bauer monograph went beyond the work of von Neumann in bringing the role of consciousness to the fore. Then in Section 3, I will consider Putnam’s and Shimony’s criticisms of this solution, together with the responses of Margenau and Wigner. Again, I shall highlight the importance of London and Bauer’s work in ‘shaping’ this debate. London’s philosophical roots in Husserlian phenomenology will be presented in Section 4. This will lead to an extensive discussion of the phenomenological approach to consciousness, and to the ego in particular, in Sections 5–7. This will provide the philosophical background necessary for understanding London and Bauer’s analysis of measurement, which is presented in Section 8. There, I shall also return to Putnam’s and Shimony’s criticisms, and I shall indicate just how wide of the mark they are. Section 9 is concerned with London and Bauer’s account of objectivity in quantum physics, where this is also to be understood phenomenologically. Finally, Section 10 concludes with some remarks on the overall character of this revised understanding of the ‘orthodox’ solution.

2. The von Neumann–London–Bauer ‘solution’

The orthodox solution can be decomposed into two aspects: the formal and the philosophical. The formal is represented by von Neumann’s division of all processes into the following (see, for example, Jammer, 1974, pp. 474–479; Barrett, 1999, pp. 30–37):

Processes of the first kind: these are the processes involved in measurement (von Neumann referred to them as ‘arbitrary changes’) and are discontinuous, non-causal, and irreversible;

¹ According to Chevalley, reference to the ‘Copenhagen interpretation’ emerged only in the mid-1950s in response to criticisms from proponents of hidden variable interpretations, such as Bohm, and Marxist critics, such as Blokhinzev. None of the founders of QM used the phrase before that time, “Nor did other major contributors to quantum mechanics such as H. Weyl or F. London and E. Bauer refer to a ‘Copenhagen Interpretation’ ” (Chevalley, 1999, p. 62).

Processes of the second kind: these are the processes (or ‘automatic changes’) described by the equations of motion and are continuous, causal, and reversible.

According to von Neumann, processes of the first kind cannot be reduced to processes of the second kind, and the relationship between the two constitutes the heart of the measurement problem. The philosophical aspect now emerges upon consideration of the questions: Where and how do processes of the first kind take place?

According to the ‘received view’ of these matters (Jammer, 1974, pp. 479–481), an answer to the first question is provided by the famous ‘chain’ argument. Unlike Bohr, von Neumann accepted that the measurement apparatus can also be treated as a quantum system. But then it will be subject to processes of the second kind, and the superpositions will propagate from the system being measured to the measurement apparatus itself. And this will also be true of any physical system brought into interaction with the measurement apparatus in order to determine the latter’s state; thus, an infinite regress will inevitably arise. However, a measurement is a finite process yielding—or at least it would *seem*—a definite result. Therefore—or so the account goes—the chain has to have a non-physical terminus, namely, the mind or consciousness of the observer.²

As to *how* this process occurs, the formal side of the response is represented by the projection postulate³—much debated, of course—but the philosophical correlate remained obscure. By introducing consciousness in this manner, von Neumann apparently reduced a solution to the measurement problem in quantum mechanics to the solution of the mind–body problem in general.⁴

However, von Neumann himself actually says very little about the nature and role of consciousness or the ego.⁵ As Gavroglu notes,

Von Neumann did not include the consciousness of the observer to [sic] the measuring chain. The novelty of the London–Bauer treatment was the explicit claim that the reduction of the wave function was the result of the conscious activity of the human mind. (Gavroglu, 1995, p. 171; cf. Shimony, 1963, p. 758).

² von Neumann cites Bohr and conversations with Szilard in this context. As Jammer notes, Szilard had recently published his paper on thermodynamics in which he concluded that the Second Law could be violated by an intelligence with knowledge of the instantaneous state of a system (Jammer, 1974, p. 480). According to Jammer, this effectively created a space for consideration of the ‘physical intervention’ of consciousness upon physical systems. However, Heisenberg had earlier—in 1928—stressed the role of the observer in the reduction (see the discussion in Barrett, 1999, pp. 26–27).

³ The term was introduced by Margenau, who argued—in the 1930s—that the process it represented was, in fact, unnecessary and dispensable (Jammer, 1974, p. 481, fn. 17). Even if this ‘absurdity’, as he called it, were justified by the introduction of consciousness or the ego, Margenau insisted that quantum mechanics would have to show rather more competence in the psychological realm before the proposal could be taken seriously (Margenau, 1937).

⁴ Thus, von Neumann’s theory is often described as dualistic (see Jammer, 1974, p. 482).

⁵ Jammer notes that von Neumann was ‘rather reticent’ when it came to the details of processes of the first kind (1974, p. 481). For further discussion of von Neumann’s psycho-physical parallelism, see Barrett (1999, p. 47).

In other words, it was the London and Bauer treatment that effectively cemented consciousness into the ‘received view’. However—and this is my principal thesis—the role of consciousness in their account was *not*, in fact, to effect a reduction.

This treatment featured in what was presented as a simplified version of the formal aspect of von Neumann’s work,⁶ in which London and Bauer undertook to ‘analyze further the role of the observer which von Neumann had not fully elaborated’ (Gavroglu, 1995, p. 171). Their monograph, *La Théorie de l’Observation en Mécanique Quantique* (London & Bauer, 1939; for an English translation, see London & Bauer, 1983) was referred to by Wigner as, ‘...a very nice little book...which summarizes quite completely what I shall call the orthodox view.’ (Wigner, 1963, p. 7; in Wheeler & Zurek, 1983, p. 325).⁷

Wigner himself incorporated the London and Bauer analysis into his own, well-known argument of ‘Wigner’s friend’ (Wigner, 1961; Wheeler & Zurek, 1983, pp. 168–181). Here, Wigner suggested the replacement of the measurement apparatus with a (conscious) ‘friend’. The system under consideration is assumed to have only two eigenstates, with corresponding eigenvalues. After interaction with the system being observed, Wigner asks his friend whether he saw eigenvalue x , corresponding, say, to a flash of light, and the orthodox understanding gives the well-known probabilities for a positive and negative answer. If Wigner then asks his friend what he saw before he was asked, his friend, Wigner insists, will say ‘I already told you. I saw eigenvalue x ’, since ‘...the question whether he did or did not see the flash was already decided in his mind before I asked him’ (Wheeler & Zurek, 1983, p. 176). It is at this point that Wigner cites a crucial phrase from London and Bauer: ‘He possesses a characteristic and quite familiar faculty which we can call the ‘faculty of introspection.’ He can keep track from moment to moment of his own state.’⁸ The nature of this ‘familiar faculty’ is philosophically problematic and, indeed, as I shall argue later, it was originally understood by London and Bauer in phenomenological terms.

Since the issue as to what he saw was already decided in his friend’s mind before the question was asked, Wigner concludes that the state immediately after the interaction between his friend and the system cannot be a superposition. He wrote: ‘‘It follows that the being with a consciousness must have a different role in quantum mechanics than the inanimate measuring device ...’’ (Wheeler & Zurek, 1983, p. 177); and, as is well-known, Wigner went on to pursue the issue of the interaction between consciousness and physical systems (Wigner, 1964).

As we shall now see, it was also Wigner who responded to important criticisms of the orthodox solution that took the London and Bauer treatment as their target.

⁶ von Neumann’s book was regarded by many as highly technical and difficult. Jammer notes that, with the exception of reviews by Margenau and Bloch, both in 1933, it was not reviewed until 1957, two years after the publication of the English translation (Jammer, 1974, p. 272).

⁷ Later Wigner wrote that London and Bauer introduced the collapse postulate ‘with even greater clarity than von Neumann’ (Wigner, 1971, p. 15).

⁸ Jammer, at least, acknowledges that Wigner incorporated the London and Bauer treatment into his own account (1974, p. 499), but Barrett, for example, cites the passage where Wigner makes reference to their work without noting this reference at all (1999, p. 53).

3. Putnam's and Shimony's criticisms

The early 1960s saw the publication of two sets of criticisms of the above 'orthodox' solution that came to be seen as definitive.

The first criticism originated with Putnam, who expressed concern about the central role given to the observer in this solution to the measurement problem, and argued that quantum mechanics could not jointly incorporate two conditions: first, that a measurement requires an interaction with an 'outside' system; and, secondly, that the 'whole universe' can be treated as a quantum system⁹ (Putnam, 1961). In their reply, Margenau and Wigner insisted that,

According to von Neumann and London and Bauer, who gave the most compact and the most explicit formulations of the conceptual structure of quantum mechanics, every measurement is an interaction between an object and an observer. (Margenau & Wigner, 1962, p. 292)¹⁰

Hence, the object could not be the whole (physical) universe because the observer is distinct. At this point, they repeat the argument of the von Neumann 'chain' to conclude that such a chain must terminate in the consciousness of the observer. They continue:

This point, which may be unpleasant from the point of view of certain philosophies, has been clearly recognised by both von Neumann and London and Bauer. As they express it, one must introduce a cut between the object and the observer and assume that the observer has a 'direct knowledge' of what is on his side of the cut [and here they refer to the London and Bauer monograph]. (Margenau & Wigner, 1962, pp. 292–293)

However, Putnam persisted (Putnam, 1964), and referred to London and Bauer's treatment as 'highly subjectivistic'.¹¹ They would like to reduce the observer to a disembodied consciousness, he claimed, but Margenau and Wigner themselves admitted that this was not yet successful. Furthermore, London and Bauer's treatment was subject to defects: first of all, the interaction between the measurement apparatus and the system must be ignored by such a treatment; and, secondly, the reduction of a wave packet depends on a measurement, which boils down to simply the "direct awareness" of a fact by a "consciousness". Hence, Putnam continued, according to this treatment,

Subjective events (the perceptions of an "observer") *cause* abrupt changes of *physical* state ("reduction of the wave packet"). *Questions*: what evidence is there that a "consciousness" is *capable* of changing the state of a physical system except

⁹It was, of course, precisely such concerns that motivated Everett's 'relative state' formulation of 1957 which, however, remained comparatively unknown until DeWitt's work in 1970 (see Jammer, 1974, pp. 507–519).

¹⁰Of course, both Margenau and Wigner had well-known reservations about some of the details of the orthodox solution (see, for example, Jammer, 1974, pp. 496–500 and pp. 486–488, respectively).

¹¹Jammer also calls it the 'London and Bauer subjectivist interpretation of measurement' (1974, p. 499).

by interacting with it physically (in which case an automatic mechanism would do just as well)? By what *laws* does a consciousness cause “reductions of the wave packet” to take place? By virtue of what *properties* [and here in a footnote he acknowledges Shimony as raising this question] that it possesses is “consciousness” able to affect Nature in this peculiar way? No answer is forthcoming to any of these questions. (Putnam, 1964, p. 5)¹²

In the paper referred to by Putnam (Shimony, 1963), Shimony interprets London and Bauer as proposing that the (mental) states of the observer obey the vector relations required by quantum mechanics, and hence can be in superposition states, but without the usual temporal evolution. Two psychological questions must then be investigated:

...whether mental states satisfy a superposition principle, and whether there is a mental process of reducing a superposition. (Shimony, 1963, p. 760)¹³

He then considers whether a range of psychological phenomena, such as perceptual vagueness, indecision, or conflict of loyalty, could be interpreted as instances of superposition, or whether superposition holds in the unconscious, and concludes that the answer is ‘No’. Regarding the second question, Shimony first of all claims that the London–Bauer proposal implies that the evolution of the combined system including the observer must be a stochastic process. From this perspective, the reduction could be seen as a result of the non-causal, mental creative activity of the observer. However, he argues: (a) no more creativity is felt in the case of a quantum measurement than in the case of a ‘fully determined’ classical one; and (b) evolutionary theory makes it difficult to understand how irreducibly stochastic behaviour could occur in complex organisms and not in the ‘primitive entities’ at the base of the whole process.

Kantian idealist and phenomenalist approaches are also considered, but Shimony rejects these on the grounds that the construction of physical entities from ideas of the mind or groupings of experience has proven incredibly difficult. Furthermore, even if it were to be achieved, the final description would be horribly complex and, he claims, incompatible with the simple but exact laws of physics (Shimony, 1963, pp. 762–763).

Margenau and Wigner replied to Putnam by claiming that the chief error in his argument stems from a reluctance to accept the impossibility of describing the last

¹²Similarly, Jauch subsequently cited London and Bauer, together with Wigner, as attributing a special role to consciousness in quantum physics, which, he wrote, “somehow is made responsible for the change of the state vector during the measurement process” (Jauch, 1971, p. 42). Needless to say, this is a view Jauch himself rejects.

¹³Thus, recalling Margenau’s concerns, as expressed in fn. 3, Shimony views London and Bauer as suggesting that quantum mechanics *does* have some ‘competence’ in the psychological realm, insofar as it applies to mental states but not, of course, to the ego itself.

part of measurement by Schrödinger's equation. The reduction of the wave packet, they write,

...when properly understood, takes place when the observer interacts with the measurement apparatus and somehow obtains cognizance of its state. The impossibility of describing this part of the measurement process by means of the equations of quantum mechanics was clearly recognised already by von Neumann as well as London and Bauer. (Margenau & Wigner, 1964, pp. 7–8)

However, despite Margenau and Wigner's protestations, the Putnam–Shimony critique of the 'orthodox' approach appears to have won the day.

My intention at this stage is simply to remind the reader of the central importance of the London and Bauer monograph in shaping the character of the debate. In effect, this work functioned as a lens through which the 'orthodox' solution came to be viewed. The philosophical shape of that lens has not been fully appreciated, however; either by the critics of this solution, such as Putnam and Shimony, or by recent commentators, such as Esfeld (1999), as we shall now see.

4. London's philosophical roots

London was,¹⁴ of course, an important physicist who produced a series of notable applications of quantum mechanics to a range of phenomena. Significantly, he brought to this work an acute and well-formed philosophical sensitivity that he had begun to develop prior to his studies in physics (for further details, see Gavroglu, 1995, and also Jammer, 1974, pp. 482–483). His early essays, written over a period covering his final year of school and the first year of University, reveal Kantian and phenomenological themes (Gavroglu, 1995, esp. pp. 8–23). While at Munich university, where he had gone to study with Sommerfeld, London met Pfänder, the leader of the Munich group of phenomenologists and second only to Husserl within

¹⁴ I shall not say much about Bauer because it appears that there is not much to say: both his entry in the *Dictionary of Scientific Biography* (Massignon, 1970) and his obituary in *Physics Today* (Darrow, 1964) provide only sketchy biographies. Bauer wrote his dissertation on luminescence and black-body radiation under Langevin in 1912, and in 1913 published a paper on the quantum theory of Planck and Einstein in a volume that included contributions from Bloch, Curie, Langevin, Perrin, and Poincaré (Bauer, 1913). He subsequently wrote a book on Bohr's theory, and in 1933 published an introduction to group theory and its application to quantum mechanics (for further details, see Massignon, 1970). The latter is significant, of course, because of London's involvement with group theory in the late 1920s (Gavroglu, 1995, pp. 53–57). In 1928, Langevin asked Bauer to be 'sous-directeur' of the former's laboratory at the Collège de France (Massignon, 1970, p. 519), and in 1936 London moved to Paris, where he held a research position at the Institut Henri Poincaré (Gavroglu, 1995, pp. 129–135). Although it is noted that '[t]hroughout his life, Bauer was keenly interested in the origin and development of the fundamental notions of physics' (Massignon, 1970, p. 519), and that he also wrote a number of books on the history of science (Massignon, 1970, p. 520), there appears to be no evidence that he was particularly interested in philosophical issues. According to Gavroglu, Bauer never addressed any of the issues raised in the monograph with London, either before or after the collaboration (Gavroglu, 1995, p. 175). Finally, it appears that the crucial section I shall be concerned with ('Mesure et observation. L'acte d'objectivation') was written primarily by London (Jammer, 1974, p. 483).

the phenomenological movement (Gavroglu, 1995, pp. 11–12). London showed Pfänder an untitled essay on the ‘logical interpretation of deductive theory’, and Pfänder was evidently so impressed that he urged him to write it up and submit it as a dissertation in philosophy.¹⁵

According to Jammer, Pfänder was greatly influenced by Lipps’ psychological theory of empathy, and he claims that this notion “was influential on London’s ideas about the measurement process in quantum mechanics” (Jammer, 1974, p. 483). Furthermore, while at Munich, London took classes from Becher, who insisted that the mind–body problem was central to metaphysics (Jammer, 1974) and advocated a form of mind–brain ‘interactionalism’ (Jammer, 1974, p. 484). Jammer concludes that “London thus found in quantum mechanics a field where he could meaningfully apply Lipps’ and Becher’s philosophy”.¹⁶

However, Gavroglu has vigorously rejected these claims (1995, p. 36 and 179), arguing that by the time London and Pfänder met, the latter had rejected Lipps’ psychologism and secondly, there is no evidence that London adopted Becher’s ‘interactionalism’. As Gavroglu points out, the explicit philosophical attributions in the London and Bauer monograph are rather different (but, as I shall argue, they are more extensive than even Gavroglu realizes). Finally, as Gavroglu again notes, London’s dissertation was published in 1923 in the *Jarbuch für Philosophie und phänomenologische Forschung*, which was co-edited by Pfänder with Husserl as editor-in-chief. There is, hence, good reason to conclude that “[t]he dominant features of Fritz London’s thesis place it within the phenomenological movement...” (Gavroglu, 1995, p. 15).¹⁷

Gavroglu gives a nice account of the London–Bauer analysis of the measurement problem (1995, pp. 169–175), but the importance of London’s philosophical background in understanding his use of certain crucial terms in the monograph is not fully brought out. Furthermore, Gavroglu concedes too much to Shimony’s criticism above, repeating the latter’s conclusion that the London and Bauer approach “rests upon psychological presuppositions which are almost certainly false” (Shimony, 1963, p. 772). However, in his drawing on the ‘results’ of introspection, Shimony has assumed a naively realist view of consciousness in general and the relationship between the observer and the world in particular. It is precisely such a view that phenomenology rejects.¹⁸

¹⁵ According to Gavroglu, ‘What London was thinking programmatically in 1921 was very close to Husserl’s thoughts. In this sense London’s problematique was not marginal at all.’ (1995, pp. 13–14).

¹⁶ Here Jammer cites the passage from London and Bauer also cited by Wigner in his ‘friend’ paper, concerning the ‘quite familiar’ faculty of introspection (Jammer, 1974, p. 484).

¹⁷ It is also worth recalling Gavroglu’s note on the contents of London’s personal library, which included the *Collected Works of Leibniz*, Husserl’s *Logical Investigations* and *Ideas*, Cassirer’s *Substance and the Conception of Matter* and *The Philosophy of Symbolism*, as well as works by Russell and Hegel among others (Gavroglu, 1995, p. 36).

¹⁸ It is worth noting that in a comment on Shimony’s discussion of realist and idealist tendencies in the quantum context, Ehlers suggests that a Husserlian account of the relation between knowledge and being might be applicable here (Ehlers, 1971, p. 478). He does not mention the London and Bauer monograph, however. Interestingly, Shimony confesses his ignorance of Husserl’s philosophy. Instead, he draws on the work of Merleau–Ponty and claims that it demonstrates that phenomenology collapses into either

5. The phenomenological construction of the ego

There is, of course, an enormous body of literature on phenomenology in general and Husserl's work in particular. Here I simply want to emphasize certain important points, particularly regarding the conception of the ego, that will help illuminate the London and Bauer analysis.

As Smith and Woodruff Smith suggest, a 'preliminary orientation' of Husserl's work can be obtained by conceiving of it as evolving through three stages: the first consists in the rejection of the psychologistic understanding of logic and mathematics; the second sees the elaboration of phenomenology as the 'science' of consciousness; and the third involves the further development of this philosophy as underpinning inter-subjectivity and being extended to cover culture, history, and the 'life-world' in general (Smith & Woodruff Smith, 1995). Such an account is useful in the present context since it enables us to situate London's dissertation, for example, in the Husserlian first stage, whereas, as we shall see, the considerations of consciousness and objectivity that we find in the monograph with Bauer span the second and third stages. Nevertheless, as Smith and Woodruff Smith emphasize, it can only be preliminary, since Husserl's views in particular, and phenomenology in general, evolved through the years, incorporating new insights and moving in new directions but—and this is the crucial point that has been brought out in recent re-appraisals (see Mohanty, 1995)—in ways that reveal more continuity than discontinuity.¹⁹ This latter point will be crucial to our understanding of the phenomenological treatment of the ego.

A quick and crude, ten-words-or-less characterization of phenomenology would be as 'an enquiry into the essential structures of consciousness'. The method by which such an enquiry is to be conducted has, at its heart, the 'epoché', in which one must effectively bracket off, or refrain from positing, the existence of the 'objective' world around us. In this manner, one can develop a science free from ontological presuppositions. Such a 'bracketing off' will then reveal the essences of the objects of mental acts, irrespective of whether the objects themselves actually exist or not, and thus one can focus on consciousness itself, together with its acts and objects (see, for example, Bell, 1990). Within such a framework, of course, the ego occupies a central place. How is this ego to be regarded from the phenomenological perspective?

We can begin to answer this question by noting that for Husserl, the relationship between the experiencing ego and its experience of itself is not in any way phenomenologically peculiar or different from the relationship between the experiencing ego and its experience of any other object. Let us consider, then, the latter relationship. Here it is important to make a distinction between the

(footnote continued)

Lockean realism or a form of constructivism. According to Shimony, what Merleau-Ponty exemplifies is the fundamental weakness of phenomenology by rendering perception as primary instead of—as Shimony prefers—the end-point of evolution (Shimony, 1971, pp. 478–480).

¹⁹ 'Excepting possibly the discovery of the *epoché* in 1905, no major shifts characterize the development of his thought—there is rather a continuous, unceasing attempt to think through the same problems at many different levels' (Mohanty, 1995, p. 74).

‘appearance’ of a thing as a subjective connection between such appearance and an experiencing ego and as an objective connection between the appearances and the thing or object itself:

The appearing of the thing (the experience) is not the thing which appears (that seems to stand before us in *propria persona*). As belonging to a conscious connection, the appearing of things is experienced by us, as belonging in the phenomenal world, things appear before us. The appearing of the things does not itself appear to us, we live through it. (Husserl, 1970a, p. 538)

That is, we do not experience experiences, as such, we live through them. What our experiencing ego finds in itself, when it reflects upon the experience, are the relevant acts of perceiving, judging, and so forth (Husserl, 1970a, p. 540).

This analysis can then be applied to our experience of ourselves: the appearing of I myself must not be confused with the ‘I’ that appears. The relation of myself, as a phenomenal object, to myself as a phenomenal subject, must be kept distinct from the relation of an experience, as a conscious content, to consciousness in the sense of a unity of such conscious contents (which Husserl calls the ‘phenomenological subsistence of an empirical ego’; 1970a, p. 539). In common discourse, the ego is also treated as an empirical object and, from this perspective, however much of our scientific understanding of it may change, it will remain “...an individual, thinglike object, which, like all such objects, has phenomenally no other unity than that given it through its unified phenomenal properties, and which in them has its own internal make-up” (Husserl, 1970a, p. 541).²⁰ If we approach the ego phenomenologically, then it is reduced to nothing more than a ‘unity of consciousness’ or a ‘real experiential complex’. Husserl concludes that,

The phenomenologically reduced ego is therefore nothing peculiar, floating above many experiences: it is simply identical with their own interconnected unity. In the nature of its contents, and the laws they obey, certain forms of connection are grounded. They run in diverse fashions from content to content, from complex of contents to complex of contents, till in the end a unified sum total of content is constituted, which does not differ from the phenomenologically reduced ego itself. These contents have, as contents generally have, their own law-bound ways of coming together, of losing themselves in more comprehensive unities, and, in so far as they thus become and are one, the phenomenological ego or unity of consciousness is already constituted, without need of an additional, peculiar ego-principle which supports all contents and unites them all once again. Here as elsewhere it is not clear what such a principle would effect. (1970a, pp. 541–542)

From the phenomenological perspective, the ego—as something over and above the complex of conscious contents—has effectively evaporated away.

²⁰ Here, we see an analogy with the analysis of the individuality of physical objects that rejects the positing of some underlying substance in favour of a conception of such individuality in terms of a set or bundle of properties.

However, if this is the case, how is that our ‘inner consciousness’ or ‘inner perception’ appears to possess what Descartes called a ‘self-evident’, or, as Husserl prefers, an ‘adequate’, quality? A perception achieves adequacy if the object of the perception is actually and *exhaustively* present within it. Does not the self-evidence or adequacy of the Cartesian ‘sum’ restore the ego that has phenomenologically evaporated? No; what the quality of adequacy ultimately attaches to are only the judgments of inner perception themselves (Husserl, 1970a, p. 544). The Cartesian primary and absolutely certain focus is thus constituted only by what is adequately perceived; and this, in turn, is nothing more than the end result of the phenomenological reduction of the empirical ego. There is no Cartesian, substantial ‘kernel’ over and above this.

Nor is there any Kantian ‘pure ego’, understood as the ‘unitary centre of relation’ to which all conscious content must be referred. This ego, as the subjective centre to which all the contents of consciousness are related, cannot be or resemble such a content. Hence it cannot be described, since any such description would render the ego as an object—yet to be the pure ego in this Kantian sense is precisely *not* to be an object, but to be that which is opposed to all objects.²¹ Husserl’s opinion is blunt:

I must frankly confess...that I am quite unable to find this ego, this primitive, necessary centre of relations. The only thing I can take note of, and therefore perceive, are the empirical ego and its empirical relations to its own experiences, or to such external objects as are receiving special attention at the moment, while much remains, whether ‘without’ or ‘within’, which has no such relation to the ego. (1970a, pp. 549–550)

Thus, the Kantian ego goes the way of the Cartesian ego: reduced to data that are ‘phenomenologically actual’ (Husserl, 1970a, p. 550) so that all that we have is the ‘complex of reflectively graspable experiences’ (1970a). From this phenomenological perspective, the conscious intentional relation between the ego and its objects is simply that between the ‘total phenomenological being of a unity of consciousness’ (1970a, p. 550) and the intentional experiences, whose object, in this case, is I, myself.²²

From such a perspective, how are we to conceive of the relationship between the ego, phenomenologically reduced, and objects? Husserl insists that it is always questionable to say either that objects ‘enter consciousness’ or that the ego ‘enters into a relation’ with such objects (Husserl, 1970a, p. 557). Such expressions are misleading in two respects: they suggest, first of all, the existence of real events or real relations taking place between the ego, on the one hand, and the object on the other;

²¹ Again, drawing on the analogy with material objects, this pure ego is like the substance, famously characterized by Locke as ‘something we know not what’, which must underlie, support, or whatever, the properties of the thing.

²² Of course, Husserl’s approach can be sharply distinguished from the phenomenalism of, say, Berkeley. Indeed, Husserl argues that the phenomenalist reduction of bodies to mere bundles of ideas fails to do justice to the fact that physical bodies possess aspects—having to do with their spatial character, for example—which cannot be adequately intuited in consciousness. It is precisely such aspects which take us beyond sensations to ‘objective features’ (Husserl, 1970a, p. 546).

and secondly, that there exists a relation between two things—an act and an intentional object—that are both present within consciousness in equally real fashion. As Husserl says, if we must talk of relations in this context, we should try to do so in a way that avoids the temptation of giving such relations psychological reality. With regard to the second misunderstanding in particular, Husserl notes that it is suggested by the phrase ‘immanent objectivity’, used to express the ‘peculiarity’ of intentional experiences, that they are directed towards or ‘aimed at’ their objects. However, he cautions, they do so in an *intentional* sense: that is, to say that the experience is aimed at ‘the object’ means nothing more than that certain experiences are present (which may then differ in character as to whether the object is aimed at presentatively, or judgingly, or desiringly, or whatever). The point is, there are not two things present in experience—the object and the intentional experience directed upon it—there is only the intentional experience (Husserl, 1970a, p. 558). If the intentional experience is present, then, Husserl insists, ‘eo ipso and through its own essence’ (1970a), the intentional relation is ‘achieved’, or, equivalently, the object is ‘immanently present’.

With regard, now, to the first misunderstanding, where it is imagined that consciousness or the ego and the ‘matter in consciousness’ become related in a real sense, Husserl writes that,

In natural reflection, in fact, it is not the single act which appears, but the ego as one pole of the relation in question, while the other pole is the object. If [sic] one then studies an act-experience, which last tempts one to make of the ego an essential, selfsame point of unity in every act. This would, however, bring us back to the view of the ego as a relational centre which we repudiated before. (1970a, p. 561)

When we simply ‘live in the act’, when we are absorbed in the perception itself, then the ego, as a relational centre, is ‘quite elusive’. The idea of the ego may be waiting in the wings, as it were, ready to appear on stage, or rather, “to be recreated anew” (Husserl, 1970a, p. 561), but it is only when it is so recreated that we refer to the object in a ‘descriptively ostensible’ way. In that description, what we then have is a complex act that presents the ego, on the one hand, and the presentation, or judgement, or whatever, together with its relevant subject matter, on the other. Of course, in each act there is an ego that is intentionally directed to some object; but this is not to say that there is some thing, some ‘essential, selfsame point of unity’, present in every act. It is only in such a description, performed after an act of reflection, that the ego emerges:

The sentences ‘The ego represents an object to itself’, ‘The ego refers presentatively to an object’, ‘The ego has something as an intentional object of its presentation’ therefore mean the same as ‘In the phenomenological ego, a concrete complex of experiences, a certain experience said, in virtue of its specific nature, to be a presentation of object X, is really present’. ...In our *description* relation to an experiencing ego is inescapable, but the experience described is not itself an experiential complex having the ego-presentation as its part. We perform

the description after an objectifying act of reflection, in which reflection on the ego is combined with reflection on the experienced act to yield a relational act, in which the ego appears as itself related to its act's object through its act. Plainly an essential descriptive change has occurred. The original act is no longer simply there, we no longer live in it, but *we attend to it and pass judgment on it*. (Husserl, 1970a, pp. 561–562; Husserl's emphasis)

6. The re-discovery of the ego

As we shall see, the passages above provide the key to understanding the London and Bauer account of the measurement situation. There is a problem, however, and it is summed up in a footnote, inserted by Husserl in the second edition of *The Logical Investigations* and attached to the above claim, that he is "...quite unable to find this ego, this primitive, necessary centre of relations":

I have since managed to find it, i.e. have learnt not to be led astray from our grasp of the given through corrupt forms of ego-metaphysic... (Husserl, 1970a, p. 549)

And earlier, in another footnote, he records that,

The opposition to the doctrine of a 'pure' ego...is one that the author no longer approves of, as is plain from his *Ideas*... (Husserl, 1970a, p. 542)

This apparent recantation of his earlier view threatens to bring the ego back on to centre stage. That it does not can be seen if we consider more closely the phrase 'corrupt forms of ego metaphysic'. What Husserl meant by this is "...the tendency to conceive of a pure ego as a *substantive* res cogitans of some sort, something which is substantial independently of our constitution of it' (Taylor, 1998, p. 241). At no point does Husserl posit *that* sort of ego. Rather what Husserl has managed to find is a kind of phenomenological pure ego "...as a descriptive principle relating to the nature of experience" (Taylor, 1998, p. 242). This is the subject of his later work, the *Ideas*, in which the ego is understood as a kind of posit required by a certain kind of mental act, known as the 'reflective regard', or 'regard' for short. Let us consider the latter in more detail, since it will turn out to be an important component of London and Bauer's analysis.

The 'reflective regard' is a form of 'directedness-to' that arises when a mental process is 'actional' in the sense of being effected in the manner of the cogito:

To the cogito itself there belongs, as immanent in it, a "regard-to" the Object which, on the other side, wells forth from the "Ego" which therefore can never be lacking. This Ego-regard to something varies with the act: in perception, it is a perceptual regard-to; in phantasying, an inventive regard-to; in liking, a liking regard-to; in willing, a willing regard-to; etc. This signifies that this having the mind's eye on something, which pertains to the essence of the cogito, of the act as act, is not itself, in turn, an act in its own right and especially must not be

confused with a perceiving (no matter how broad a sense) nor with any sorts of acts akin to perceptions'. (Husserl, 1982, pp. 75–76)

When one is 'living in' the cogito—that is, *not* reflecting upon it—we are not conscious of the 'cogitatio' as an intentional object, but we become conscious of it through a "reflective turning of regard" (Husserl, 1982, p. 78).

Consider, as an example, a piece of paper, lying in front of me (Husserl, 1982, pp. 69–71). In perceiving the paper, "I seize upon it as this existent here and now" (Husserl, 1982, p. 70) and this seizing-upon involves the singling out of the paper from the 'experiential background' consisting of other objects—books, pens, Pepsi Max cans, etc.—that are not seized upon. Thus, every perception of a physical thing has a "halo of *background-intuitions*" (Husserl, 1982, his emphasis) and by a "free turning of 'regard' " (Husserl, 1982, p. 71), we can turn our mental attention, as it were, to these other objects so that they become intended to explicitly rather than implicitly. Physical objects cannot be the subject of this regard without being seized upon, but this is not the case with mental processes. This 'regard to' that distinguishes actionality, in the above sense, does not coincide with the 'heeding' of an object of consciousness in which it is seized upon and picked out (Husserl, 1982, p. 72). Consider the act of valuing, for example (Husserl, 1982, pp. 76–77): in such an act, we have *regard to* the valued, but we do not seize upon it as somehow separate from the thing itself. It is the thing, *as a valued thing*, that we seize upon, but only after an 'objectifying turn'.

Using this distinction, we can get a grip on the different kinds of being possessed by 'immanent' mental processes and 'transcendent' physical objects: when we perceive something immanent, rather than transcendent, this perception, as a reflective regarding of, *guarantees* the existence of its object. Even if what 'hovers' before one is a figment of one's imagination, still the hovering itself, as a hovering, cannot be invented but, as with any other mental process, must exist absolutely (Husserl, 1982, p. 101). Hence, the perception of something immanent is indubitable, in the sense that there can be no failure of reference. This is not so for something transcendent, of course. This then leads to a further difference between the physical and mental, that bears on the apparent retention of the pure ego: the positing of things in the world is always a contingent positing, but the positing of my 'pure ego', as—crucially—the subject of mental acts, is necessary and absolute in a sense I shall further explore shortly.

All of this seems deliberately and explicitly Cartesian,²³ but now Husserl adds the phenomenological attitude that excludes, or 'parenthesizes', the whole 'psychophysical world of Nature', leaving only the field of absolute consciousness. What we do when we adopt this attitude is to "...direct our seizing and theoretically inquiring regard to *pure consciousness in its own absolute being*" (Husserl, 1982, p. 113; Husserl's emphasis). Instead of 'living in' our mental processes, with their cogitative positings, we effect acts of reflection directed to them. What we are now living in,

²³ Husserl remarks that the above inferences will do justice, 'at least', to a core of Descartes' *Meditations* "...which only lacked a pure, effective development" (Husserl, 1982, p. 104). It is this pure, effective development that the phenomenological attitude provides.

when we have adopted the phenomenological attitude, are these acts of reflection themselves. These have as their datum, the “infinite field of absolute mental processes” (Husserl, 1982, p. 114). It is this which is the fundamental field of phenomenology, and which is left as the ‘phenomenological residuum’.²⁴

7. The reconciliation

The ‘reflective regard’, then, is a kind of tool for exploring the ‘infinite field of absolute mental processes’, and it is only through using this tool, through effecting acts of reflection, that we arrive at the field of phenomenology in the first place (Husserl, 1982, p. 174). All such acts necessarily have the form of the ‘cogito’, and it is of the nature of such acts of reflection that they are not only directed towards some object, but that they include a reference to an ego (otherwise, how could they be of the form ‘cogito’?). If the ego *in this sense* were to be excluded, then phenomenology could not avail itself of the very tool it needs; it would be, effectively, impotent.

However, it is not the case that we posit the ego first and then consider the ‘welling forth’ of the regard as some kind of property of it; but, rather, we start with the *regard*, which is at the heart of phenomenology, and conclude the presence of an ego as that from which the regard wells forth. But just because we need to refer to it, insofar as we need acts of reflective regard in order to have phenomenology, does not mean that the ego is not relative to such acts, much less some sort of Cartesian substance. This is clear when Husserl writes that when we effect the epoché, not only is the whole natural world excluded or parenthesized, but so also is the ‘I, the human being’ (Husserl, 1982, p. 190). What is left is the ‘pure act-process’ with its own essence including, by necessity, the pure ego as the subject of the act.

What is it then? The ‘Ego’ has no ‘explicatable content’ and is indescribable ‘in and for itself’ (Husserl, 1982, p. 191). It has no properties, ‘does not harbour any inner richness’ (Husserl, 1982, Book II, p. 111), and is absolutely simple and undivided. As such, it can be understood as nothing but a ‘place holder’, a ‘that which’ is intending (Taylor, 1998, p. 277). We recall that in the *Logical Investigations*, Husserl described the ego as a pole that stands in relation to the object-pole.²⁵ Just as the bearer or substrate of the ‘exact determinations ascribed in

²⁴ Of course, as Husserl notes, anyone can effect a reflection and bring consciousness ‘within the sphere of his seizing regard’, but effecting a reflection is not necessarily to effect a phenomenological reflection, nor is the consciousness seized upon necessarily pure consciousness. ‘Radical considerations’ such as are involved in the parenthesizing of the natural world and the dropping of the natural attitude, are needed in order to arrive at the cognition that there is this pure field of consciousness which is not a ‘component part’ of nature (Husserl, 1982, pp. 114–115).

²⁵ In a supplement to Book Two of the *Ideas* Husserl writes, “Just like any object-pole, the Ego-pole is a pole of identity, a centre of an identity, and is an absolutely identical, *though non-autonomous*, centre for affects and actions” (Husserl, 1982, Book 2, p. 324; my emphasis). Again a comparison with physical objects is made: “Just as an object has its identity as a pole of relatively or absolutely permanent properties, and just as every property is something identical though non-autonomous (*in the pole*), so the same holds for the Ego.” (*ibid.*, Husserl’s emphasis), although the Ego is a pole of acts rather than properties. See also Husserl (1970b, p. 171).

physics' (Husserl, 1982, p. 119; see also p. 85) is an 'empty X',²⁶ so likewise is the ego. The perception of something is "...an empty looking at the Object itself on the part of an empty 'Ego' ..." that seizes upon the object (Husserl, 1982, p. 83). Thus, "To say that all reflected upon experiences are ego related is merely to say that they 'appear as' originating from an ego, and directed towards an object. That ego qua subject-pole has no properties, no personality, it is simply the putative subject of experience" (Husserl, 1982, p. 277).

But what about those dramatic footnotes in which Husserl claimed to have found the ego again? According to Taylor,

What Husserl means when he says that he has learnt not to be led astray by corrupt ego metaphysics is that he has learnt that to say that there is in fact an ego in consciousness is not to posit some substance which is unknowable in itself. Husserl is in *Ideas* still denying that there is an ego substance or an ego "in itself". He is still saying that it is absurd to make claims for an ego which has a certain nature independently of points of view or context. However in *Ideas* he recognises that to say that every time we reflect on our consciousness we find an ego, just is to say that there is an ego from the phenomenological point of view. The fact that the act of reflection is in part responsible for the appearance of that ego does not militate against its existence. Put another way, to say that the act of apprehending an object is at least in part responsible for the properties that object has is not to say that the object does not really have those properties. The intuition that we really ought to say that the object does not "really" have those properties relies on a notion of substance, or a notion of the object "in itself". If this notion is surrendered the intuition loses its force altogether. (Taylor, 1998, p. 282).

Hence, the pure ego of the *Ideas* should be understood as the phenomenological ego of the *Logical Investigations*, that is, as standing for the unity of a particular stream of consciousness, but reconceived according to the dictates of the epoché.

8. London and Bauer revisited

Let us finally turn to the London and Bauer analysis of measurement, which begins in what appears to be traditional fashion (London & Bauer, 1983, p. 250) by considering the measurement of some quantity $F(x, p)$ of a system in the state $\psi = \sum_k \psi_k u_k(x)$, where u_k is an eigenfunction corresponding to the value f_k of F . The system is then coupled with an apparatus capable of measuring F , where $G(y, p_y)$ is the coordinate specifying the position of the apparatus 'needle', and g_0, g_1, \dots, g_ρ its eigenvalues, with corresponding eigenfunctions $v_0(y), v_1(y), \dots, v_\rho(y)$. In order for there to be a measurement, rather than merely an interaction, the values of the g_ρ must be set in a 1–1 relationship with the f_k , so the index $\rho_{(k)}$ can be replaced by k .

²⁶This 'empty X' is the bearer of "mathematical determinations and corresponding mathematical formulae" (Husserl, 1982, p. 85) and exists in the 'objective space' of physics, of which 'perceived space' is merely a sign.

After the measurement, then, the wave function of the combined system + apparatus will be $\Psi(x, y) = \sum \psi_k u_k(x) v_k(y)$. However, London and Bauer write, such a coupling does not yet a measurement make. “A measurement”, they write, “is achieved only when the position of the pointer has been *observed*.” (London & Bauer, 1983, p. 251). But then they continue,

It is precisely this increase of knowledge, acquired by observation, that gives the observer the right to choose among the different components of the mixture predicted by theory, to reject those which are not observed, and to attribute thenceforth to the object a new wave function, that of the pure case which he has found. (London & Bauer, 1983)²⁷

The sense of this curious phrase, ‘the right to choose’, will become clear shortly.

It is at this point that London and Bauer note “the essential role played by the consciousness of the observer in this transition from the mixture to the pure case” (London & Bauer, 1983). They now consider the ensemble of three systems composed of (*object* x) + (*apparatus* y) + (*observer* z), described by a global wave function analogous to that above $\Psi(x, y, z) = \sum \psi_k u_k(x) v_k(y) w_k(z)$, where the w_k represent the different states of the observer. They write, “Objectively—that is, *for us* who consider as ‘object’ the combined system x, y, z —the situation seems little changed to what we just met when we were considering only apparatus and object.” (London & Bauer, 1983) The function $\Psi(x, y, z)$ represents a maximal description of the ensemble such that we do not know in what state the system x is. However,

The observer has a completely different impression. For him it is only the object x and the apparatus y that belong to the external world, to what he calls “objectivity.” By contrast he has with himself relations of a very special character. He possesses a characteristic and quite familiar faculty which we can call the “faculty of introspection.” He can keep track from moment to moment of his own state. By virtue of this “immanent knowledge” he attributes to himself the right to create his own objectivity—that is, to cut the chain of statistical correlations summarized in $\Psi(x, y, z) = \sum \psi_k u_k(x) v_k(y) w_k(z)$ by declaring “I am in the state w_k ” or more simply, “I see $G = g_k$ ” or even directly, “ $F = f_k$ ”. (London & Bauer, 1983, p. 252)²⁸

In a typed note inserted by London in his own copy of the monograph, he writes

Accordingly, we will label this creative action as “making objective.” By it the observer establishes his own framework of objectivity and acquires a new piece of information about the object in question. (London & Bauer, 1983)

Furthermore, London and Bauer insist that,

...it is not a mysterious interaction between the apparatus and the object that produces a new ψ for the system during the measurement. It is only the

²⁷ It was standard practice at the time to use the term ‘mixture’ or ‘coherent mixture’ to refer to what we now call a superposition. I am grateful to Jeremy Butterfield for pointing this out.

²⁸ This is the passage cited by Jammer and Wigner, as noted previously.

consciousness of an “I” who can separate himself from the former function $\Psi(x, y, z)$ and, by virtue of his observation, *set up a new objectivity* in attributing to the object henceforward a new function $\psi(x) = u_k(x)$. (London & Bauer, 1983; their emphasis)

How are we to understand these passages? The reference to relations of a ‘very special character’, the phrase ‘immanent knowledge’, the role of the ‘I’, or ego, and the emphasis on the free creation of a new objectivity, all clearly demand a phenomenological reading. Note, first of all, that at the beginning of this characterization, the observer is not set outside the domain of quantum mechanics. She too is represented by a wave function within the superposition. But she, as an ‘I’ or ego, possessing this characteristic faculty of introspection, has ‘immanent knowledge’—that is, absolute and indubitable knowledge—of her own state by virtue of which she can, on the one hand (namely that of the ego), *separate herself* from the superposition and, on the other (namely that of the object in question), create or set up (in the French, it is ‘constituer’ or constitute²⁹) a ‘new objectivity’. This separation should not be thought of in terms of consciousness ‘causing’, in whatever sense, the wave function to collapse, but rather in Husserlian terms, as that of a *mutual separation* of both an Ego-pole and an object-pole through a characteristic act of reflection. The act of introspection, as a characteristic act of reflection on the observation, yields a relational act, in which, according to Husserl, ‘the ego appears as itself related to its act’s object through its act’. It is of the essence of such an act that the ego should appear but, as we have seen, this is not to suggest that the ego is something substantial, over and above this act. It is merely an empty, non-autonomous centre of identity or subject-pole engaged in a likewise ‘empty looking’ at the object. The latter is then objectified, or ‘made objective’, in the sense of having a definite state attributed to it, by this objectifying act of reflection. It is precisely through such a reflection that the ‘chain of statistical correlations’ is cut (an obvious allusion to the ‘von Neumann chain’).

The emphasis on the *creation* of this objectivity is also significant. In his Paris lectures of 1929, Husserl insists that,

...we persistently *create for ourselves* new configurations of objects...which have for us lasting reality. If we engage in radical self-examination—that is, return to our ego...—then all these forms are seen to be creations of spontaneous “I”-activity... There we also find all the sciences, which, through my own thinking and perceiving, I bring to reality within myself (Husserl, 1964, p. 30; my emphasis).

There is no absolute or prior given framework of objectivity residing in some ‘I’ that is somehow apart from the whole process of observation and which then, by reflecting on ‘its’ mental states, collapses the superposition of these states. Rather, the very act of observation itself is a creative construction of objectivity by which the

²⁹Book Two of *The Ideas* is subtitled, ‘Studies in the Phenomenology of Constitution’ and the first section is concerned with ‘The Constitution of Material Nature’.

observer separates both herself, as an ‘I’, and the object being observed. The state of the ensemble as a composite object is correctly described ‘externally’, via the formalism of quantum mechanics, in terms of a superposition; but from ‘inside’ that object, as it were, the observer in reflection upon, and keeping track of, her own state creates her own objectivity in the double sense of constructing the ‘I’ in the first place and in so doing, separating this ‘I’ from the composite and thus gaining ‘the right to choose’ among the different components of the mixture predicted by the theory.

Furthermore, between ‘living in’ the observation, as an experience, and describing it, as in the situation of Wigner’s ‘friend’ discussed above, ‘an essential descriptive change has occurred’, as Husserl put it. In making such a description, we are no longer ‘living in’ the observation, but ‘we attend to it and pass judgment on it’, and in doing so we cannot avoid reference to an ego or ‘I’. In such a description, performed after an ‘objectifying act of reflection’, the ego is ‘inescapable’ since it *necessarily* appears as related to the object of the act of observation. It is important to be clear about what is going on here: the reflection that takes place in the measurement situation is not itself a *phenomenological* act, in the sense that one must first undertake the epoché in order to perform it.³⁰ It is not being suggested that physicists have to be phenomenologists when they make observations! The reflection is a ‘characteristic’ act that we perform all the time, from moment to moment, as we observe the world around us. Normally we do not explicitly ‘keep track’ of our mental states, in the sense of making a note of them, say; but what the argument of ‘Wigner’s friend’ illustrates is that we do possess this ‘characteristic faculty’ and can say what our state is, if needs be. What phenomenology provides is an analysis of this act and the uncovering, as it were, of this separation. Further ‘radical considerations’, such as the ‘parenthesizing’ of the natural world, are required in order to generate the phenomenological attitude.³¹

We can now appreciate just how the London and Bauer analysis has been misinterpreted. First of all, the whole basis of Shimony’s criticism is erroneous, namely that when ‘I’ observe my mental states, no superposition can be found. Of course, no superposition can be found because an ‘I’, as a consciousness which is ‘in’ a certain state, can only be posited after the separation has occurred! The essential, and phenomenological, point has been missed. Likewise, the question whether there is a ‘mental process of reducing a superposition’ is inappropriate. Shimony does at least acknowledge the aspect of creativity in London and Bauer’s account, but fails to grasp its (phenomenological) nature.³² The issue as to whether there is any more ‘creativity’—understood in its typical, non-phenomenological sense—in quantum situations as compared with classical ones is irrelevant. In both cases, from the phenomenological perspective, the act of objectification is a creative act of the ego. And, again likewise, the point is missed when it is asked how irreducibly stochastic

³⁰We recall Husserl’s point above that effecting a reflection is not necessarily to effect a *phenomenological* reflection.

³¹I am grateful to Oliver Pooley for encouraging me to be clearer on this point.

³²As we have already noted (in fn. 18 above), Shimony was, by his own admission, ignorant of Husserl’s work.

behaviour could occur in complex organisms and not in the ‘primitive entities’ of which they are composed. The relationship between the ‘I’ and the object cannot be causal, not because it is stochastic yet still physical, but rather because this relationship cannot be described in physical terms at all. There is no causal relationship because the mental and the physical are different modes of being which are not akin and which cannot be set side-by-side, as it were. Any relationship that there is can only be a phenomenological one.

It is also clear how wide of the mark Putnam’s criticisms are. First of all, the interaction between the measurement apparatus and the system is *not* ignored by London and Bauer’s treatment. Secondly, and more importantly, this treatment does not involve ‘subjective events’ causing abrupt changes of *physical* state; hence, Putnam’s series of questions is entirely beside the point. We recall Husserl’s insistence that the ego and the given object are not related in a ‘real’ sense. Furthermore, if we consider Putnam’s original concern, then it is not the case according to this treatment that the observer is excluded from consideration by quantum mechanics. As we have seen, the formalism applies to the observer also—at least from the external perspective—who is included in the superposition. Internally, as it were, the observer, as an ‘I’ or ego, does become separated from the superposition, and in that separation is no longer described by the formalism; but this does not set the observer outside quantum mechanics, as a physical object which should be, but is not, described by the formalism. The observer, from this internal perspective, as an ‘I’ or ego, is not a ‘natural’ object at all, but rather a phenomenological one. There simply is no possibility of describing the observer in this sense in quantum-mechanical or any other physical terms—indeed, there never was. Thus, the phenomenological reduction has not somehow taken the observer outside the purview of quantum mechanics. We recall that this reduction is not to be conceived of as some sort of abstraction from the natural world, but as a much more radical and entirely different sort of process. The concern that the ‘traditional’ solution of the measurement problem somehow blocks the application of quantum mechanics at a cosmological level is therefore also misplaced.

9. Objectivity and the ‘Regard’

There is a further concern, however: In what sense can we now say that the process of measurement is objective? London and Bauer begin their final section, ‘Scientific Community and Objectivity’, by acknowledging that “At first sight it would appear that in quantum mechanics the concept of scientific objectivity has been strongly shaken” (London & Bauer, 1983, p. 258), and it looks as if quantum mechanics drives us towards solipsism. However, they insist, “No physicist has retired into a solipsistic isolation” because of quantum mechanics and, furthermore, there is still a “community of scientific perception” in the sense of agreement as to what constitutes the object of the investigation. How can this be so?

First of all, the act of observation is described as a ‘macroscopic’, non-quantal act (London & Bauer, 1983, p. 258). This may appear to be an appeal to something akin

to Bohr's view, where we must acknowledge our macroscopic situation within a classically described world. But consider the next sentence: "Consequently one always has the right to neglect the effect on the apparatus of the 'scrutiny' of the observer." (London & Bauer, 1983) The original French text is rather more revealing as the word 'scrutiny' is actually a translation of «regard», where the placing of this phenomenological term between «» reveals its significance. We recall that it is in the reflective regard-to that the ego emerges as one pole of the relationship with the object and, insofar as this regard is an aspect of a mental process, it cannot of course be described in quantum terms. We further recall that when the regard is directed to a physical object, the object is seized upon. This is not so for mental processes whose very *existence* is guaranteed by the regard. The existence of physical objects is not guaranteed in this way, of course, and hence the effect of the observer's 'scrutiny' can be neglected. Furthermore, this turning of the 'mind's eye' on something is not an act in its own right, and must not be confused with an act of perception, such as an observation. Thus, the regard does not change or affect the apparatus, as an object, in any way, and so a 'collective scientific perception' can be created in which a second observer, looking at the same apparatus, will make the same observations.

There is now the further concern that, given their account, the objects studied by this community are nothing but phantasms produced by the observer. As they point out, in classical physics the proof that we are dealing with something 'real', in the sense of existing—at least in principle—independently of all observers, is grounded on the possibility of continuous connection between the properties of an object and the object itself, even when it is not being observed. In quantum mechanics, there is no such possibility. Nevertheless, we are still able to interpret or predict experimental results (London & Bauer, 1983, p. 259) and "[i]t is enough, evidently, that the properties of the object should be present at the moment they are measured and that they should be predicted by theory in agreement with experiment" (London & Bauer, 1983). The earlier 'guarantee' of the objectivity of an object, understood in terms of the above possibility, has been lost. Hence, "[i]n present physics the concept of 'objectivity' is a little more abstract than the classical idea of a material object" (London & Bauer, 1983). Understanding this concept involves "... the determination of the necessary and sufficient conditions for an object of thought to possess 'objectivity' and to be an object of science" (London & Bauer, 1983, p. 259; the scare quotes are not given in the English translation but are present in the original). This problem, London and Bauer note, was perhaps first posed by such 'mathematicians' as Malebranche, Leibniz, and 'especially', Bolzano. More recently, however, "...Husserl...has systematically studied such questions and has thus created a new method of investigation called 'Phenomenology'"³³ (London & Bauer, 1983). The reference here is to both the *Logical Investigations* and the *Ideas*.

³³ At this point, they also cite Cassirer's 1910 *Substance and Function*, and his 1936 work *Determinism and Indeterminism in Modern Physics* (Cassirer, 1956). It is curious, however, that although in the French original Cassirer is mentioned only in a footnote, in the English translation he is elevated to the text alongside Husserl. Although this was perhaps done for purely editorial reasons, it may dilute the significance of the Husserl citation. Cassirer, of course, was no phenomenologist, but he also emphasized that it is not the case that first there is subject and object in terms of which experience is understood, but

Since it is an empirical science, physics cannot enter into such issues ‘in all their generality’. Nevertheless, it both uses philosophical concepts ‘sufficient for its needs’ (London & Bauer, 1983) and abandons those that come to be seen as unnecessary and as containing elements that are “...useless and even incorrect, actual obstacles to progress” (London & Bauer, 1983). Such obstacles are represented by the classical conception of objectivity, whereas it is the phenomenological concept which is now sufficient for the needs of physics.³⁴

10. Conclusion

London himself never elaborated any further on the ideas contained in the monograph and appears to have regarded the measurement problem as solved (Gavroglu, private email). Is it? Obviously ‘No’ if one insists that any putative solution must be broadly physicalistic. Everett, for example, in originally presenting his ‘relative state’ alternative to what he took to be the orthodox solution, characterized the observer as a physical system only, such as a photoelectric cell or a

(footnote continued)

rather that “...in one and the same process of objectification and determination the whole of experience comes to be divided for us into the ‘spheres within and without,’ into ‘Self’ and ‘World’ ” (quoted in Kaufmann, 1949, p. 810). Furthermore, Cassirer’s structuralist emphasis on an understanding of objectivity in terms of the invariance of certain universal relations (where this understanding is essentially neo-Kantian) can be related to Husserl’s investigation of the ‘essential forms’ (Kaufmann, 1949). His group-theoretical analysis of perception in ‘Group Concept and Perception Theory’ is very similar to a broadly Husserlian approach to perception. Finally, in *Determinism and Indeterminism in Modern Physics*, Cassirer insists that quantum mechanics is consistent with a broadly structuralist account in which the notion of an object is re-conceptualised, not in terms of individuality, but in terms of certain invariant structures (see, for example, Werkmeister, 1949, pp. 776–777 and Ihmig, 1999). As in Smith’s construal of Husserl, the object becomes nothing more than a node in a structure (Smith, 1995).

³⁴ It is significant that one of the very few critical analyses of the phenomenological approach to physics was offered by Margenau who argued that, whereas scientists adopt a fallibilist attitude towards empirical data (and have developed theoretical criteria for the rejection of illusory data), the phenomenologist is guilty of the uncritical admission of introspective evidence which is regarded as stable and indubitable, and thus has no similar criteria for excluding ‘abortive introspections’ (Margenau, 1950, p. 463; this is based on his earlier 1944 essay ‘Phenomenology and Physics’, reprinted in Margenau, 1978, pp. 317–328). Of course, for Husserl, no such introspections are truly ‘abortive’! Margenau records that his return to earlier philosophical interests was triggered by the arrival at Yale of Cassirer whom he describes as his ‘hero’ (Margenau, 1978, p. xxvi). Margenau was also involved in the preparation of the revised, English edition of *Determinism and Indeterminism in Modern Physics*—whose bibliography, prepared in 1945, included the London and Bauer monograph—and he supplied the preface after Cassirer’s death. It was Cassirer who stimulated the development of Margenau’s own epistemology of ‘constructionalism’ (Margenau, 1978, p. xxvii) which takes “...the reflecting (not experiencing) ego [to be] initially a construct to be verified, a construct of remarkable universality, enabling a self-reference of every part of experience. That such self-reference is possible, and hence that the ego construct can be verified, is noteworthy enough, may indeed be the most noteworthy fact of our experience; but it is not thereby exempt from rational and empirical examination” (Margenau, 1950, p. 455). This does not appear to be so far removed from the phenomenological conception that I have suggested underpins the London and Bauer solution.

photographic plate “...and similar devices where a mechanistic attitude can hardly be contested” (Everett, 1957, p. 454).³⁵ His motivation is revealing: Everett thought it “...unreal that there should be a ‘magic’ process in which something quite drastic occurred (collapse of the wave function), while in all other times systems were assumed to obey perfectly natural continuous laws’ (letter to Jammer, 1974, p. 508). The relative state formulation is then put forward as an attempt to resolve this apparent inconsistency in the orthodox solution.³⁶

But of course, according to the London and Bauer approach, as interpreted here, there is no inconsistency because the ‘collapse’ of the wave function is not a physical process at all. Neither is it ‘magical’, since it occurs all the time and not only in quantum situations. This, of course, can be viewed as a virtue of this approach: it resolves (or perhaps dissolves) the measurement problem in precisely the same way that it resolves all such problems that involve the relationship between the subject and the object. On the other hand, it will be viewed as a vice by those who think that the measurement problem should be solved in purely quantum-mechanical terms. This supposes that there is something relevantly different about quantum mechanics, as compared with classical physics, that has to be taken into account in such situations and which requires one to impose quantum mechanics on the form of the solution. However, from the phenomenological perspective, there just is no such relevant difference, when it comes to the issue of subjectivity in general and the relationship between the observer and the observed in particular (see Husserl, 1970b, pp. 52–53, for example).³⁷

As far as the phenomenologist is concerned, a physicalist solution of the measurement problem would be no solution at all, or, at least, no solution to the *real* problem.³⁸ The price of her solution, however, is an utterly radical reconception of the natural world and our place within it. My knowledge of phenomenology is not sufficiently deep to know for sure whether or not that price is too high; but I do think it is interesting, from the perspective of the entwined histories of physics and the philosophy of physics, that someone like London should have thought that it is not—and on those grounds alone, perhaps, the approach is worth pursuing further.

³⁵ As Lockwood has pointed out, Everett himself does not talk of his formulation in terms of ‘many-worlds’; this phrase appears to be due to DeWitt (Lockwood, 1996, p. 168). What features in Everett’s own work are ‘branches’, and Lockwood emphasizes that these are ‘irreducibly egocentric’ (Lockwood, 1996). The discussion here is in the context of the so-called ‘many-minds’ view, and there is an obvious point of (re-)connection with the phenomenological approach to consciousness.

³⁶ Hartle, in a discussion of quantum cosmology, refers to the London and Bauer monograph as falling within the general framework of ‘Copenhagen interpretations’, which he characterizes as dividing the universe into two, with quantum-mechanical rules applying in one part and classical rules in the other (Hartle, 1991, pp. 5–6).

³⁷ This is not to say that there is *no* difference between classical and quantum physics. As I have already indicated, London and Bauer took the difference to lie in the domain of objectivity, where classical physics understands this in terms of the continuous possession of properties by their objects and quantum physics rests content with prediction of the values of these properties in experimental contexts.

³⁸ “Only blindness to the transcendental, as it is experienceable and knowable only through phenomenological reduction, makes the revival of physicalism in our time possible...” (Husserl, 1970b, p. 265).

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