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Commentary

Sans subjectivity — ergonomics is engineering

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1. Introduction

We much admire and agree with many of the points and issues that Annett has raised and believe his work has great value for both researchers and practitioners in ergonomics and allied fields. We also believe that Annett's paper will join others in giving the lie to the frequent assertion that ergonomics is an atheoretical field, an 'appliance science' (Hancock 1997), not fit for the high company of theoretical psychology and at best a poor cousin to higher forms of engineering. Annett's rich theoretical observations, in contrast, begin to bring to the fore crucial philosophical questions that underpin the ergonomics enterprise.

Somewhat ironically, Annett highlights the central role of theory in ergonomics by discussing the use of subjective measures, which have often been criticized as being fundamentally flawed and *unscientific*, indeed even by some of the founders of the discipline, as Annett points out. We strongly agree with Annett's main points that all empirical observations have a subjective component, and that subjective methods, when developed and applied appropriately in accordance with accepted scientific criteria, have an important place in ergonomics. We raise two additional issues, however, where we believe Annett has not gone far enough and as commentators we solicit his further insight into these matters.

Is the attempt to provide scientific assessment of private experience a categorical mistake?

In the early decades of the 20th century, as Psychology was engaged in the desperate struggle for acceptance into the family of the so-called legitimate or 'hard' sciences, John Watson (1913) called for the suspension of any reference to internal mental states and to restrict psychological discourse to events that were externally observable. Nominally made in response to the mire of anchorless introspectionism, this radical behaviourist reformation excised from psychology the very pith and heart of conscious experience. Today, we still reel from this abdication. The distaste for subjective experience still rankles and periodically the argument resurrects itself in various guises. Here we see Annett engage once again in this struggle, expressed in the terms of ergonomics research. Like many of his forebears, Annett raises crucial ques-

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tions about how to expose private experience to public scrutiny such that acceptable 'intersubjective' levels of agreement are reached about the phenomena at hand. However, this very first step itself may be a categorical mistake. Consider, for example, the following line of argument. It may simply be a mistake to attempt the measurement of mind using the methods created to measure matter. If mind and matter are truly disparate in their very essence, the approach to understanding the one may very well be inappropriate for the other. If we accept the division of mind and matter, it may well be that we have to forego the envied appellation of 'science' and, rather, seek other but nevertheless mutually acceptable methods of evaluation to discover truths about the essential nature of mind. What those methods might be are difficult to conceptualize, but we should not be disheartened since science itself, in the form we know it, is barely five centuries old (Dee 1551, Bacon 1620).

There is, of course, a complete antithesis to the above proposition which is that mind is nothing more than the outcome of a specific arrangement of matter. This modern restatement of a materialist philosophy of mind argues that mental states 'emerge' when neural networks of a sufficient level of complexity and connectivity are activated. The revolutionary impact of cognitive neuroscience on psychology over the past decade is indicative of a similar influence in the years to come on other behavioural and social sciences, including ergonomics, so much so that we have endorsed the call for the development of the field of 'Neuroergonomics' (Parasuraman 2003, Hancock and Parasuraman 2001). Given the advances in today's sophisticated brain-imaging techniques, it may well be that in the foreseeable future we will be able to specify the neuro-physiological patterns that denote specified mental states. The cognitive neuroscience enterprise has already yielded dividends in our understanding of such mental constructs as *attention* and *consciousness*. For example, over a century ago the great German scientist Herman von Helmholtz (1894) showed that while pointing his eyes straight ahead at a single letter projected briefly to a point on a wall in front of him, he could nevertheless attend to and be aware of letters presented at other locations far removed from the fixation point. The subjective sense of watching out of the 'corner of one's eyes' is well known to anyone who has walked warily at night in a crime-ridden neighbourhood or to an animal drinking at a watering hole that is also frequented by predators. Modern cognitive neuroscience research has convincingly demonstrated that this subjective state of visual attention is associated with activation of a neural network involving specific cortical and subcortical brain structures. This in turn has led to improved theories of visual attention and stimulated new and far-reaching kinds of research (for a review, see Parasuraman 1998). Neural measures do not necessarily have primacy over performance measures or verbal reports in this kind of research, and the different measures may not always be correlated with one another. Rather, each type of measure has its uses. In some cases, the *softer* verbal report may even be *superior* to the *harder* neural measure. Consider the case of a stroke patient who as a result of damage to a component of the neural network cannot spontaneously attend to a particular portion of the visual field. While looking straight ahead (as in von Helmholtz's experiment), the patient cannot verbally report, nor is aware of, letters presented to their left while letters are shown to their right —

the neurological condition of neglect. In this case, the subjective state (and verbal report, or lack thereof) is a central feature of the condition at hand and is as important to the clinician attempting to diagnose neglect as is the neural measure to the scientist interested in a theory of neglect and attention.

It may well be that other multidimensional constructs such as fatigue, which have defeated our efforts at purely psychological definition (Muscio 1921, Broadbent 1979, Hancock and Verwey 1997), also turn out to be represented by specific neurophysiological activation patterns which change in understandable ways with variables such as task factors, the environment, etc., in short the global variable called 'The challenge' by Annett in his figure 2. This is not to say that psychological constructs will be reduced to neural measures, for a materialist philosophy of mind is not necessarily also a reductionist philosophy. Rather, theories of psychological constructs will be enriched through a better understanding of the neural systems that implement mental function. Further progress in neuroergonomics will therefore blur the distinction between so-called objective physiological measures and subjective measures. Furthermore, if a particular subjective state is a particular neural state, then it makes no sense to argue that one is superior to the other. Rather, measures of each must be used in the development of a comprehensive theory that can validly be applied in different situations.

This is essentially also Annett's position about the use of subjective methods in ergonomics. However, one's position on the materialist/non-materialist dichotomy predicates all subsequent discourse on the use and scientific status of subjective measures vis-à-vis so-called objective measures. We, as commentators, would liked to have seen Annett's explicit evaluation of these polar extremes. While not expecting him to resolve the mind–body problem, understanding his foundational perspective on a philosophy of mind would have helped frame the observations to come.

2. What is mind?—No matter. What is matter?—Never mind

(We have traced the origin of this phrase to T. H. Key, once Headmaster of University College School, on the authority of F. J. Furnivall (Bartlett 1919). The fact that it is probably best known as a pronouncement of Homer Simpson is a further tragedy of our times.)

Annett's commentary focuses on the problems of subjectivity. However, rather than lamenting the difficulties of this enterprise we embrace them, for without the necessary conscious experience of the individual involved, ergonomics devolves to engineering. Thus, while we do not deny the difficulties of assessment, we do note that, *sans* subjectivity the very notion of ergonomics itself is barren. Cloaked in the guise of these modern concerns of ergonomics applications, Annett touches on the fundamental question of philosophy concerning the nature of what can be known and the nature of that consciousness which can know it. This aspect of his work draws our highest praise because, at heart, ergonomics is concerned with the expression of intention as mediated by technical systems (Hancock 1997).

But Annett does not go far enough. If all measurement is subjective in nature, is not all experience subjective also? We believe that Annett navigates between the Scylla and Charybdis of such questions knowing that solipsism can appear initially to be a very slippery slope. We can be fairly certain there is no empirical resolution to the

proposition that Berkeley (1710/1974) set forth concerning the superfluous nature of matter. Not excepting some of the more delightful obfuscations of certain German philosophers, potential resolution of this issue on the nature of what is real can only be captured conjecturally. But let us not be so afraid of this putative Pandora's box! The eidetic reassurances of the American Pragmatic School have too long held sway. We have come to accept as given that objects and events occur 'out there' in a real world and have parsed consciousness and matter to accord with this notion. Only in our more outlandish movies do we now question the correctness of this assumption. While the foregoing are largely cryptic remarks founded upon the evolution of philosophical thinking, they are directly relevant to ergonomics in the modern world. We see ergonomics as intention in action. That action is mediated by the technologies we have built. If this is an illusion shared by collective minds, the locus of intention is still within the human being and the further exploration of affective states of mind is consequently critical. If the world is an illusion of a single mind, being either personal or deistic in foundation, the way that mind explores itself via the creation of external representations is itself also of value. Rejecting the comfort of pragmatism does not mean that even radical solipsism necessarily devolves to futilitarianism. Actually, such a proposition concerning the locus of intention has much to say about the way in which any reality (including a technologically replete one) can be organized. We applaud Annett's work on several levels. That it opens further discussion and consideration of the very foundations upon which our reality is based attests to the centrality of ergonomics to the human enterprise.

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