

Richard Allen¹

Michael Polanyi and the roles of emotion in natural science

Abstract

Michael Polanyi, using his experience as an internationally recognised scientist, showed that emotion has necessary and constructive roles in the life of scientific research, and thus, a fortiori, in all cognitive activities. He distinguished three functions of emotion in science: (1) the selective of what is of value to science; (2) the heuristic which sustains the effort of discovery; (3) the persuasive for gaining the agreement of one's colleagues. Implied is (4), that of satisfaction with positive results and dissatisfaction with negative ones; and explicitly but separate is (6) the valuing of science by society at large. These fit into, and add to, Stefan Strasser's scheme of the indispensable roles of emotion in all human activity. Like all the important domains of human culture, natural science seeks to inculcate certain emotions in its practitioners, for, as elsewhere, only the lowest and routine processes with them can be performed with almost no emotional engagement. Far from emotions inevitably disrupting cognition and rationality, they are essential to them.

Keywords

Emotion, Michael Polanyi, Science

1. Introduction

Although the intentionality of emotions, and hence their inherent rationality, is now more widely recognised within Anglophone philosophy than previously, there are still some who regard emotions as non-rational upsurges, and thus as either wholly irrational or tending to be irrational, and therefore to distort rational thinking and action. In particular, such a view has been and still is especially applied to the natural sciences, and, if they are taken to be the paradigms of knowledge, then *a fortiori* all the other intellectual disciplines and our

¹ rt.allen@ntlworld.com.

everyday thinking should also be freed from the distorting effects of emotions.

The thesis of this article is that Michael Polanyi, an internationally recognised full professor of physical chemistry, first at the Max Planck Institute in Berlin and then at the University of Manchester, with 218 scientific papers to his name, used his first-hand experience of scientific research and his knowledge of the history of science to show that emotions have essential and constructive roles in the natural sciences, and thus in other disciplines and by implication in life generally. In short, life and thought would be impossible without them. This can be developed by showing how Polanyi's three roles of emotion in natural science fit into an extended version of Stefan Strasser's scheme for them in action (Strasser 1956/1977), which itself is an extension of one by Aquinas, and which is set out in the Table below².

2. The intentionality and rationality of emotion

Before that it will be helpful to clarify the nature of emotion as against distorted conceptions of it as essentially non-rational and so irrational and disruptive of rational thinking and action. The usual case for this is based on the citation of examples only of violent emotional eruptions and other irrational ones which their victims do not control. For example, those who say that "love is blind" focus only on examples of infatuation, and even then omit to mention that the infatuated person often, probably always, knows but ignores the obvious defects of its object because he will not break himself from it, just as the drug addict lacks the strength of will to break his habit even though he knows it is destroying him.

Furthermore, philosophical and psychological reductions of emotions to mere feelings, i.e. sensations, which simply arise in us and non-rationally affect us, ignore the intentionality of all mental acts

² See below. As well as Strasser's comprehensive study (Strasser 1956/1977), other philosophers have shown that emotion has essential roles in cognition. Two programmatic essays are Max Scheler's *Liebe und Erkenntnis* (Scheler 1915/1963) and John Macmurray's *Reason and emotion* (in Macmurray 1935/1962). The former argues that knowledge depends on love and the latter that reason depends upon properly directed emotions. But it is notable that both authors devalue natural science: Scheler as intellectual control over nature and Macmurray as technological control over it.

and states, as revived by Brentano (1874)³. It will be sufficient here and now to summarise the principal features of emotional experiences:

1. emotions are *felt*, and to feel angry is to *be* angry, but to feel brave is not to be brave. But feeling, as opposed to mere sensations, if there are any, are with, towards, about, in response to, etc., someone or something⁴. I cannot simply hope or fear but must be hopeful or fearful with regard to *X* or *Y*. Emotions are intentional and so have objects.

2. The object of an emotion is not its “cause”: the death of a friend in accident miles away is the object and cannot be the cause of my sorrow, for I may never hear about it. It is my *encounter*, at first-hand or by being told or reading about it, which causes me to be sorrowful. Thus the object does not have to be real: it could be imagined as in a play or film, or an illusion or delusion. Hence the “cause” of the emotion is my imagining of the events on the stage or screen as real, or my being illuded or deluded into taken perception to be of something real when it isn’t.

3. But I can be sorrowful only if I (i) believe that something has happened; (ii) it is something bad or untoward; and (iii) it has happened to someone or something I value. Thus hearing that someone who has cheated me in business is now bankrupt because of schemes, may induce *Schadenfreude* in me.

4. It is therefore the intentional content of an emotion which determines the nature of the emotion. This has two ingredients: the factual and valuational with the evaluative stemming from it. Thus in (3) the factual is believing that *X* has died in an accident; the valuational

³ But Brentano’s use of “intention” is not the same as that of the Scholastics. Their equivalents to the modern sense was the “formal object” which defined the sort of emotion, e.g. hope is the belief that a valued object will be realised, and the “material object” which denoted the individual object of a particular experience, e.g. that I shall win the lottery.

⁴ Many, even all, sensations are not purely bodily feelings but also include an emotional response to them, usually of enjoyment or dislike, which can be temporarily inhibited or attenuated by concentrating on them, even with toothache. This shows that sensations are not simply “passive” nor emotions with them, for the emotional response is something we *do* and do not merely “suffer”. Also, “feeling” itself has an important cognitive meaning of tentative or exploratory apprehension or belief. We *feel* that something is wrong even without knowing what it is, such as when on entering a room full of people at a party, we find them to be silent and staring at each other. See further (reference withheld).

is the affection I have for him; and thence my evaluation of his death as something bad which has happened to him. Hence I am sorrowful. But in (4) the factual is the bankruptcy of Z; the valuational is the negative one of my loathing for him; and the consequent evaluation of his death as something which “serves him right”. Hence my emotional response is *Schadenfreude*. This also reveals a distinction between the evaluated *proximate* object, such as the accident in which X was killed or the schemes that bankrupted Z, and the valued *ultimate* object such as the death of X and the bankruptcy of Z.

5. Emotions naturally give rise to desires and vice-versa: positive emotions issue in desires to experience, be with, enjoy, cherish and enhance their objects; negative ones to avoid, ward off, defend what we value against them, disable or destroy them. Desires engender hope and fear about the chances of satisfying them, and satisfaction or disappointment in doing so. Consequently, *ceteris paribus*, emotions and desires issue in executive plans and actions to fulfil them. They also issue in expressions and expressive actions which manifest them and can be enhanced, elaborated and simulated to fulfil desires issuing from them.

In short, emotions are felt attitudes, that is, if there are any attitudes which are not felt. It is their intentional content and especially its valuational and evaluative factors which make life possible. A purely factual apprehension of the world would never move us to do anything about ourselves and it.

Max Scheler mentioned an actual example (Scheler 1924/1963), and George Santayana (1961) imagined one, of a person without any such capacity. Scheler’s example recognised that her baby was hers, but this had no effect upon her, and she had to be told what to do in respect of it. Likewise, she had to eat by the clock, the times set for eating, and not because she felt hungry. Even Kant, for whom the human person was an organ of pure reason sitting on top of a sensationist and hedonist psychology like that of the Utilitarians, and took love to be a “pathological” upsurge, had to acknowledge the need for reverence for the Moral Law (Kant 1785/1912).

Indeed, as Scheler (1915/1963) and Macmurray (1935/1962) argued, emotion and desire are logically prior to knowing in all its forms, starting with the infant’s efforts, spurred by what Scheler called “a general taking an interest in” making sense of the initially unordered, fleeting and meaningless sounds, shapes, colours and physical sensations which it experiences, an “interest in” that is an

embryonic love. In contrast, indifference and hatred would shut ourselves off from the world and ourselves.

The roles of emotion in all our activity, including knowing, are set out in detail in the [Table](#), which is the general schema for all human activity, practical or theoretical, habitual or explicitly deliberated, and with particular reference to the natural sciences as demonstrated by Michael Polanyi.

3. *Michael Polanyi and the roles of emotion in the life of science*

3.1. *The significance of Polanyi's account of emotion in the natural sciences*

Polanyi's target in his *magnum opus*, *Personal knowledge* (Polanyi 1962)⁵, is "Objectivism", the demand for an impersonal conception of knowledge as wholly a function of the objects of knowing and independent of the activity and contributions of the knower for that would make it "subjective". Furthermore, his knowledge of natural science from the inside enables him to refute the objectivist claim that impersonal knowledge can be obtained in physics and chemistry and only in them along with other sciences insofar as they are reduced to them or used their conceptions, categories and methods. Hence Objectivism leads to scientific reductionism.

Polanyi seeks to overcome this dichotomy of Objectivism and Subjectivism by stressing the responsibility of the person for his knowing as for all his activities: "*The freedom of the subjective person to do as he pleases is overruled by the freedom of the responsibility person to act as he must*" (Polanyi 1962: 309). And not only that, but he also stresses the need for the engagement of the powers of the whole person, including emotion. Thus towards the end of the *Preface to Personal knowledge* he states that he has shown that "into every act of knowing there enters a passionate contribution of the person knowing what is being known, and that this coefficient is no mere inflection but a vital component of his knowledge" (Polanyi 1962: VIII).

⁵ *Personal knowing* would perhaps have been a better title, because "knowledge" refers both to the activity of knowing (*noésis*, cognition) and that which is known (*noémata*), and so it encourages the modern focus upon the latter and thus to the neglect of the former, and hence to impersonalist and "objectivist" conceptions of knowledge as what is known but without anyone knowing it.

This theme is developed in detail in chapter 6, *Intellectual passions*, where he refutes Objectivism on its home ground by showing how the scientist's "passions are no mere psychological by-product, but have a logical function which contributes an indispensable element to science" (Polanyi 1962: 134. See also 173-4). He recognises three roles of emotion *in* the natural sciences: *selective*, *heuristic* and *persuasive*. Of these, the heuristic function is a form of the sustaining role which I have added to Strasser's schema. Also, Polanyi adds to the three functions and values *in* natural science the background support of society at large *for* natural science and the value *of* it. What applies to the natural sciences applies *a fortiori* to the technological and human ones and to our everyday and practical knowledge of each other and the world, out of which the specialised sciences have developed and in turn have refined, yet upon which they still depend. Impersonal, emotionless knowing is not and could not be found anywhere⁶.

Finally, it is important to note that by "passions" and "passionate" Polanyi means all desires and emotions, and particularly sustained ones, and not just violent ones.

I shall now summarise, develop and relate to the revised scheme of Stefan Strasser, Polanyi's three functions of emotions in scientific research and discovery, plus a fourth which he does not explicitly group with the other three.

3.2. *The selective function*

The selective function has two roles: (i) to signal that a discovery is intellectually precious, and (ii) that it is precious to science.

(i) The former role is, in effect, the primary experience in the Table, which gives rise to all intellectual enquiries: the felt conviction of their value which selects them as worthy of pursuit. It is this which is Polanyi's over-all concern. Science along with the other great articulate systems of civilisation, such as religion and law, evokes and imposes and claims to be right those emotions which sustain and appraise it and appraise its theories for their intellectual beauty as a token of contact with reality (Polanyi 1962: 134)⁷. Presented, we may

⁶ See § 4 below.

⁷ See also p. 27 on feeling the weight of personal responsibility by a juryman and a doctor in a difficult case. Robert Pirsig stresses the need for the same attitudes and feelings in technical work (Pirsig 1974: 30). But Strasser is somewhat mistaken in

say, as a mere body of objective fact, all that science can evoke is a “so what?” or a “what use is it?” in terms of its technological utility, which would crimp and stunt it:

The scientific method was devised precisely for the purpose of elucidating the nature of things under more carefully controlled conditions and by more rigorous criteria than are present in the situations created by practical problems. These conditions and criteria can be discovered only by taking a purely scientific interest in the matter, which again can exist only in minds educated in the appreciation of scientific value. Such sensibility cannot be switched on at will for purposes alien to its inherent passion. No important discovery can be made in science by anyone who does not believe that science is important – indeed supremely important – in itself. (Polanyi 1962: 183)⁸

(ii) The second role of the selective function corresponds to the notion of a motivating emotion in the Table, for it gives a specific direction to the underlying desire to discover the truth about nature. Out of all the facts which are known or knowable, only a few are of scientific interest. The appreciation of this interest, which relies on a sense of intellectual beauty, cannot be dispassionately defined, as neither can the beauty of works of art nor the excellence of noble actions. Without selection and guidance by emotional appraisal of the scientific value of what is known or appears likely to be discovered, enquiry would “spread out into a desert of trivialities”. What is needed is a general vision of reality which yields a scale of interest and plausibility, so that important conceptions can be upheld as intrinsically plausible even when there is evidence against them at the moment, and others can be rejected as specious even though there may be some evidence for them. A scientist, in selecting a problem to be pursued, requires a sense, a feeling, for problems which are likely to be soluble, soluble by him (or his student or colleague), with the resources and time available, and to be of some wider value and significance for science. There is no set of formulae or rules for this (Polanyi 1962: 135). Only what is routine and thus easily anticipatable and mostly of low interest, we may add, can be attained by the scientist

stating that technical and scientific work require a “quiet and sure being-in-a-mood” which has no sudden shifts of emotion and is mostly neutral yet not the “gray everyday disposition” (Strasser 1977: 183-4). Here Strasser somewhat conflates the necessary discipline and redirection of emotion with its elimination.

⁸ See § 3.5 below.

or scientific technician who has only a little emotional involvement in what he is doing.

As for what constitutes scientific value, Polanyi suggests three joint factors, unevenly distributed over the natural sciences: certainty or accuracy, systematic relevance or profundity, and intrinsic interest. The first two decrease in degree from physics and chemistry, through biology and to the human sciences, while the third conversely increases in that order. This is clearly manifest in the interest in the individual object which has interest only as a particular or specimen of its type in physics and chemistry; has an increasingly individuality in ethnology; and is paramount in history. Sensitivity to such values, and their presence, absence and degree in problems, theories and results, is necessary to their scientific evaluation as worth investigating further and to deciding if results are acceptable or unacceptable. It is required to terminate enquiry or to provoke to further enquiry, as again in the Table⁹, as well as to turn a general interest in scientific research into a specific intention to take up and prosecute a particular problem or line of enquiry.

3.3. *The heuristic function*

The *heuristic* function is primarily that of sustaining the effort to discover by intimating specific discoveries, yet to be made, and sustaining the pursuit of them over a long period, which, we may add, is required in all human activity, save actions which are spontaneous and short.

Major discoveries which change the interpretative framework of science cannot be made by the routine use of the existing framework. Those who make them have to cross a logical gap between present conceptions and new ones, the problem and its solution, which involves a change in their whole way of seeing things, and they can do this only by relying on the unspecifiable impulse of their heuristic passion. "Like all ventures in which we comprehensively dispose of ourselves, such intentional change of our personality requires a passionate motive to accomplish it. Originality must be passionate" (Polanyi 1962: 143). Citing the example of Kepler, who expressed such passion in respect of both genuine discoveries and mistaken ideas, Polanyi points out that it is not infallible. All the same, it is necessary,

⁹ See § 3.5 below.

and the role of sustaining emotion needs to be added to Strasser's schema.

This heuristic function, I suggest, corresponds also to the notion of the motivating emotion. It, too, intimates something specific to be done and sustains through difficulties the effort to do it. It therefore also acts, not as a terminating emotion in the specific sense, but as a provoking one which evokes further efforts after disappointing results have been encountered at particular stages on the way.

3.4. *The persuasive function*

Having satisfied himself that he has made a genuine and significant discovery, the scientist must communicate it to his colleagues, and so have it confirmed. It is not made true by consensus, but all serious utterances about the world are put forth with what Polanyi calls "universal intent" as true sayings and worthy of all men to be believed. Though it is possible to be *Athanasius contra mundum* and later to be confirmed to have been right all along, the agreement of one's colleagues gives added assurance that one is correct¹⁰. Thus the scientific community, or those specialising in one's own corner, have to be convinced. Again it is the major discovery, creating a wide logical gap, which demands persuasive passion, on the one side, and, on the other, sympathy with what one initially cannot comprehend¹¹. The other scientists have, as it were, to learn a new language, for the great discovery cannot be expressed in terms of existing conceptions and terminology. One cannot argue for a new framework of thought in terms of an old one. A process of conversion is required to bring the others to follow the pioneer in crossing the logical gap that he has bridged. Thus arises the phenomenon of unseemly scientific controversies, some of them long lasting such as those concerning the status of psychoanalysis, in which persuasive emotions get out of hand. At the limit these concern what it is for something to be science in

¹⁰ Polanyi himself experienced this in respect of his potential theory of adsorption, which did not fit the prevailing theories of that field at the time but was later accepted. As he acknowledged, "Discipline must be severe", and in his case it nearly ended his career in physical chemistry at the start: *The potential theory of adsorption*, in Polanyi 1969: 93.

¹¹ See also Polanyi 1962: 101, where Polanyi, drawing on his own experience as a medical student, shows that such sympathy is needed in the learning of anything radically unfamiliar, otherwise one will take it to be nonsense from the outset.

the first place: the one party claiming that its theory, practice or branch of study is science, the other denying it.

In terms of our scheme of governance by emotion, this persuasive passion is the motivating emotion of a second course of action – to secure the agreement of one’s colleagues – which follows upon the successful outcome of a previous one, the original line of research. It is not an essential role of all human activity but it is essential to any co-operative endeavour. Furthermore, the practice of any activity, practical or theoretical, cannot be improved if those participating in it keep any improvements and discoveries to themselves.

Polanyi has a wry comment to make at the end of his discussion of these three constitutive emotions of science:

Some people may listen to these illustrations of continuing and sometimes violently conducting controversies with impatience, for they believe that science provides a procedure for deciding any such issues by systematic and dispassionate empirical investigations. However, if that were clearly the case, there would be no reason to be annoyed with me. My argument would have no persuasive force, and could be ignored without anger. (Polanyi 1962: 159)

3.5. *The terminating function*

“The scientist seeks to discover a satisfying theory, and when he has found it, he can enjoy its excellence permanently” (Polanyi 1962: 173)¹². This is, in effect, a fourth function of emotion in scientific discovery. Without experiences of satisfaction and dissatisfaction with what we are doing and have done, we would not know when to stop, either because the results so far are more or less satisfactory or are disappointing, and, in the latter case, whether it is worth continuing, starting afresh or giving up altogether, because we would have no idea of whether we had succeeded or not. At every moment in any course of action, attitudes of indifference and mere judgments of success or failure, proceeding correctly or incorrectly and the like, would neither get us started nor be able to guide us if and when we did embark on any activity. What makes scientific theories satisfying is primarily their truth¹³. As mentioned in § 3.3. above, Polanyi sug-

¹² See also pp. 173-5, 301-2, on the satisfaction of “public” passions, such as intellectual ones which are aimed at universal standards and leave behind knowledge, and “private” ones, which we share with animals, such as feelings of hunger, and which are satisfied within the situation which evokes them.

¹³ See above. Polanyi decisively refutes evasions of truth by such terms as “simplicity”, “economy”, “fruitfulness” and “regulative principles” (Polanyi 1962:

gested that, secondarily, there are three further forms of scientific value which distinguish more important and valuable truths from the mass of trivial ones. One suspects that, in vain attempts to ape the mathematisation of physics and chemistry in subject-matters which do not permit of it, i.e. the human and social sciences, often produce precise trivialities, dangerous expectations of precision in measuring and forecasting as in the mathematisation of economics, or downright distortions of the truth as in behaviourist and stimulus-response psychologies (Polanyi 1962: 139-42). Whether that is so or not, one can see that there is a real question as to the satisfactions sought and the standards used. They do not come revealed on tablets of stone, but have to be themselves discovered, confirmed and established in a tradition. Intellectual enquiry is an intelligent and intentional activity: it aims at a goal and seeks an imagined satisfaction in attaining it. It seeks to satisfy the desire to know, and to know more thoroughly and more profoundly. It implicitly projects a conception of what will satisfy that desire. Such a conception may be vague, both in general and in specific terms. Generally, we may not yet know what sort of knowledge, understanding and insight we are seeking, only that we seek something which we feel ourselves not yet to have (Polanyi 1962: 62-5). Such is necessarily the case during the birth and infancy of any branch of disciplined enquiry, or during a profound revision of it, such as happened to historical studies at the end of the eighteenth century, when they turned from reliance only upon secondary sources to the use of primary ones such as records in archives, letters and diaries, and the material ones recovered by archaeology. The story of the rise of modern natural science from the later Middle Ages through the Renaissance and into the seventeenth century shows how it was mixed up with other interests, which we now recognise to be non-scientific, such as magic in the chemistry of Paracelsus and the Pythagorean number mysticism of Kepler, but which were not, and perhaps could not, be distinguished from it at the time. It required, on the part of the pioneers, intense effort and profound belief in a vision that could not be verified for some time in actual accomplishments. Newton's wider historical significance is his demonstra-

16, 42, 95n, 113, 145, 147-8, 166, 169, 307, 308, 315, 354). Despite this, and other publications by him such as *The study of man*, *The tacit dimension* and *Knowing and being*, those still subject to "Objectivism" continued to dismiss Polanyi as a "subjectivist".

tion to the educated world of what the new science could do, and so he raised hopes, often much too grandiose, for many more such achievements. None of this could have been done with an attitude of indifference and by the mechanical following of established rules.

A similar general ignorance of what it is that he seeks affects the new recruit to a developed discipline, for he has yet to become familiar with the ways in which it operates and what sorts of things it accepts as valid and what it rejects as invalid. Insofar as he intends to practise the discipline, rather than just to acquire knowledge of its discoveries, the student has to have a desire to know and to discover, and has to acquire a sensitivity to intellectual values generally and those of his discipline in particular, and thereby has to learn what sorts of thing in general will appropriately satisfy his desire. These are the emotions which, as Polanyi says, every branch of study teaches its recruits. Specifically, in any particular enquiry we do not yet know what we seek, otherwise we would have already found it. We seek an X, or a set of unknowns, that will account for, or fill gaps in, what we already know. We have some vague conception of what it is, based upon what we already know. It is a relatively indeterminate something that will satisfy our desire to explain these data, to link up these currently separate fields or theories, to fill in the blanks of this story, to account for this person's sudden change of course. It is like a blank space on a map, unknown in itself but known to some extent as being here and not there, beyond this and north of that. If it were wholly indeterminate, we would never know where to look nor how to recognise it if we found it, and if it were wholly determinate, we would already know and possess it. Seeking something more or less indeterminate at the outset, whose nature is progressively revealed as we go along, is a familiar occurrence in daily life with regard to other desires and satisfactions, as when we experience states of restlessness, seek something to satisfy our felt but vague unease, and yet do not know what it will be. We try this and then that, and as we feel disappointed, more uneasy, less uneasy, partially satisfied – “warm” and “cold” in the terms of children's guessing games – we know we are moving away, towards or past what we seek. Following it through our experience of what does not satisfy it, and without pretending to ourselves that it is satisfied when it isn't it, will lead to what will satisfy it. That, I suggest, is true of all desires, intellectual ones included. Lines of research are often suggested by a felt unease with an existing theory, sets of data, wide-ranging conceptions or the received account.

An accepted explanation may be felt to be superficial or to leave out facts which are felt to go beyond random variations in observations and experimental results. I stress the word “felt” here for two reasons: it suggests both the “niggle”, the worry or itch which will not go away, a working of intellectual conscience and sensitivity, and also the tentative groping for something not yet in focus, still largely indeterminate, and yet to be found and seen as what it really is. One has to feel this worry or perhaps intellectual cramp in order to realise that there is a problem at all in what is already known. The imagined but often as yet largely indeterminate satisfactions of intellectual desire thereby set the standards for intellectual work and success and failure at it: what we shall take to be a true representation of reality, a good explanation, a cogent argument, a valid proof, a proper way to conduct experiments or to carry out surveys. Standards, as in accountancy and medicine, have to be achieved or refined by pioneers and then established through a growing consensus. They are obviously historical phenomena: they come gradually into existence, become established through teaching and thus in traditions, become more exactly defined and more exacting, and perhaps also decline. Professional and academic bodies emerge to endorse, codify, further refine, monitor and perhaps enforce such standards. For example, it is now almost impossible to get any article accepted by a scholarly journal or book by a scholarly publisher unless it has complete set of footnotes, but such was not the case forty or so years ago.

4. *Society at large and the value of science*

Before Polanyi considers the necessary roles of emotion *in* scientific discovery and the values in science, he mentions the necessity of them in the wider society and *towards* society and the value *of* science. He does this in the context of our delight in all achievements and of those of natural science in particular: “The affirmation of a great scientific theory is in part an expression of delight. The theory has an inarticulate component acclaiming its beauty, and this is essential to the belief that the theory is true” (Polanyi 1962: 133). In this way of calling “attention to its own beauty” and partly relying on it “for claiming to represent empirical reality”, a scientific theory is “akin to a work of art which calls attention to its own beauty as a token of artistic reality”, and thus joins the other “great systems of ut-

terances” which try to evoke and impose correct modes of feeling. In teaching its own kinds of formal excellence, science functions like art, religion, morality, law and other constituents of culture. Therefore the justification of science entails the justification of these and all other domains of culture:

Science can then no longer hope to survive on an island of positive facts, around which the rest of man’s intellectual heritage sinks to the status of subjective emotionalism. It must claim that certain emotions are right; and if it can make good such a claim, it will not only save itself but sustain by its example the whole system of cultural like of which it forms a part. (Polanyi 1962: 133-4)

Polanyi therefore continues in chapter 6, *Intellectual passions*, also to consider the roles of emotion, among other themes, in technology as overlapping with natural science but distinct from it, mathematics, abstract arts and religion. The distinction between natural science and technology was especially important for Polanyi, because Marxist demands for the central planning of natural science, and the Soviet attempts to implement them, for its technological applications and their economic ones in turn, and thus the threat to the freedom of science and scientists, spurred Polanyi to return to his former interests in economics and politics, and thence to philosophy, in order to defend the freedom of science and freedom generally. Today, when scientific research requires equipment that is much more sophisticated and expensive than in his day, those threats again arise but in a different form: the demands of governments for technological applications in order to reimburse at least some of the large amounts which they give to universities and other research institutes, demands which also apply to other disciplines. The value of pure enquiry and knowledge for its own sake and its diffusion among a wider public tends to be ignored, and higher education becomes valued and evaluated only in terms of its economic benefits to society at large and to graduates in particular. Only a widespread realignment of attitudes, desires and emotions, and thus of values, can safeguard all the sciences, natural and human, and also the technological sciences and applications of natural science which largely arise as unsought by-products of pure enquiry.

In conclusion: thus what is thought to be the wholly “objective”, detached and factual practice and results of the natural sciences, the only alternative to which is said to be the “subjectivism” of the emo-

tional and value-ridden distortion of allegedly pure facts, turns out to be logically impossible and itself a distortion of how true science, like all the other intellectual disciplines and human life generally, does and must proceed by the engagement of properly ordered emotions.

Bibliography

Brentano, F., *Psychologie von empirischen Standpunkt*, 1874 (trans. by A. Rancurello, D.B. Terrell, L.L. McAlister, *Psychology from an empirical standpoint*, London, Routledge and Kegan Paul, 1973).

Kant, I., *Grundlegung der Metaphysik der Sitten*, 1785, in *Gesammelte Schriften "Akademie-Ausgabe"*, ed. by the Königlich Preußische Akademie der Wissenschaften, vol. IV, 1912 (trans. by H.J. Paton, *The moral law*, London, Hutchinson, 1948).

Macmurray, J.M., *Reason and emotion*, London, Faber, 1935¹, 1962².

Polanyi, M., *Personal knowledge*, London, Routledge, 1962², 1958¹.

Polanyi, M., *The study of man*, Chicago and London, Chicago University Press, 1959.

Polanyi, M., *The tacit dimension*, Garden City, Doubleday, 1966.

Polanyi, M., *Knowing and being*, ed. by M. Grene, London, Routledge, and Chicago, Chicago University Press, 1969.

Santayana, G., *The sense of beauty*, New York, Collier Books, 1961.

Scheler, M., *Liebe und Erkenntnis* (1915/1963), in *Gesammelte Werke*, vol. 6, Bern, Franke Verlag, 1963 (trans. by H.J. Bershady with P. Haley, *Love and knowledge*, in H.J. Bershady, ed., *Max Scheler on feeling, knowing and valuing. Selected writings*, Chicago, University of Chicago Press, 1992).

Scheler, M., *Von Sinn des Leidens* (1924/1963), in *Gesammelte Werke*, Band 6, Bern, Franke Verlag, 1963 (trans. by M. Frings, *On the meaning of suffering*, in M. Frings, ed., *Max Scheler. Centennial essays*, The Hague, Nijhoff, 1974).

Strasser, S., *Das Gemüt*, Utrecht and Freiburg, Uitgeverij Het Spectrum, 1956 (trans. by R.E. Wood, *The phenomenology of feeling*, Pittsburgh, Duquesne University Press, 1977).

I Primary emotion	II Motivating emotion	III Deciding emotion to act or abstain	IV Sustaining emotion	V Terminating emotion (1) if successful	VI Terminating emotion (2) if success impossible or too costly	VII Emotion provoking to new effort at partial success
1. If the primary emotion is positive						
Felt <i>Attraction</i> to or <i>Approval</i> of a possible good.	Hope that it will be enjoyable or will enhance what one values	<i>Confidence</i> in one's powers and resources leading to <i>hope</i> of success and formation of an intention to act	<i>Determination</i> to continue one's efforts despite any setbacks	<i>Satisfaction</i> leading to <i>delight, triumph or joy</i>	<i>Disappointment, frustration and dissatisfaction</i> leading to <i>resignation</i>	<i>Disappointment, frustration and dissatisfaction</i> but leading to <i>confidence and hope</i> of further success

2. If the primary emotion is negative, as a response to something disvaluable (e.g. as a threat) or disappointment or indifference at its lack of value and hence no further action.

Felt <i>Aversion</i> to or <i>Disapproval</i> for an experienced evil of some type or degree	(a) Felt lack: <i>discomfort, dissatisfaction or yearning</i> (b) present evil - <i>ditto</i> - plus: <i>dislike, disgust or loathing</i> (c) impending evil: - <i>ditto</i> - plus: <i>anxiety, fear, fright, terror or horror</i> ; that it will be unpleasant or harmful (d) impending loss or diminution of good: - <i>ditto</i> - plus <i>anxiety</i> , etc.	(i) <i>Confidence</i> in one's powers and resources leading to <i>hope</i> of success and formation of an intention to supply what is lacked or (ii) to prevent, remove or alleviate the evil or (iii) <i>lack of confidence</i> in one's powers and resources leading to <i>no hope</i> of success in respect of (i) and (ii) and leading to <i>resignation</i> and formation of an intention not to act	In respect of (i) and (ii), <i>Determination</i> to continue one's efforts despite any setbacks. Not applicable in respect of (iii)	In respect of (i) and (ii) <i>relief</i> Not applicable in respect of (iii)	<i>Dismay, hopelessness, despair</i> leading to <i>resignation</i> or to <i>juttle rolling and refusal</i> to accept defeat	<i>Disappointment, frustration and dissatisfaction</i> but leading to <i>confidence and hope</i> of further success
--	--	---	--	--	---	---