

Individual psychology of risk-taking behaviours in non-adherence

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Abstract

This paper presents some theoretical considerations based on the theories of risk about non-adherence in the field of health care. Traditional models as the Health Belief Model and the Theory of Reasoned Action are presented and criticized. In order to enable the use of other theoretical frameworks, it is argued that non-adherence can be studied within the general frame of risk-taking. The behavioural decision theory is presented and it is argued that cognitive biases like unrealistic optimism play a major role in non-adherence as in risk-taking. It is also argued that these cognitive biases depend on self-related motivation factors. Results of a pilot study involving 16 patients are presented. These results only partly support the theoretical analysis and underline that it would be necessary to take mood factors into consideration in further research.

KEY WORDS: adherence; cognitive bias; behavioral decision theory; self

1. Traditional models of non-adherence

The stakes of the non-adherence phenomenon in health care are widely reported in the literature (Stockwell-Morris and Schultz, 1992; Wright, 1993) and can be examined at different levels. The deleterious effect of non-adherence on patients' health and treatment cost is clear (the latter is doubled for hypertension). This phenomenon has a great importance for public health, since it is very frequent and often underestimated (Wright, 1993). It is remarkable that the non-adherence concept is only defined through its opposite: adherence. This reflects major difficulties for clinicians and researchers to understand and explain this phenomenon within the framework of a traditional therapeutic relation. Adherence can be defined as the tendency of patients to follow clinicians' advice in terms of treatment and overall regimen. Adherence can be good or poor and a poor adherence is usually referred to as non-adherence. It has often been claimed that non-adherent patients take risks. However, this is more obvious from the observer's than the patient's point of view, which probably shows the main paradox in the understanding of this phenomenon in health care. Non-adherence is questioning for clinicians who consider it as pathological and/or resulting from irrational processes

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since subjects are aware of the risk. Surprisingly, theories of risk have hardly ever been applied to this area.

This may be due to traditional conceptions about the therapeutic relation, this relation being considered efficient only if some kind of authority and psychological influence is used. The risk-taking perspective may help to abandon this normative point of view and closely examine the individual functioning. This could lead to development of better means of interventions. Far from the only therapeutic relation, patients may have their own motives as far as treatment and regimen are considered.

Until today, non-adherence has been most often understood through different models from social psychology. The most widely used model is certainly the Health Belief Model (HBM; Janz and Becker, 1984). The HBM states that health behaviours depend on the following factors: (1) motivation of subjects to act, determined by the perception of disease severity or by the perception that subjects have of threats; (2) appraisal of benefits and costs yielded by another behaviour; (3) a stimulus allowing to start the behavior. So this model suggests that subjects likely to be adherent perceive themselves as more vulnerable to the disease, or perceive the disease as more serious. Benefits are appraised in terms of prevention, care, disease control or symptoms improvement. This appraisal of benefits and costs is related to the perceived threat of the disease. This leads subjects to produce a subjective judgment, consciously or not, on the opportunity to adopt a health behaviour. Finally, the stimuli favouring the action can be internal (symptoms) or external (social pressure for example). The HBM has first been developed to explain preventive health behaviours, and then has been applied to treatment or diet and self-care adherence. Some studies have shown the validity of this model in various situations (Tong Nagy and Wolfe, 1984), but the model has not been entirely validated: a literature analysis shows that only some components have been identified as very probable predictors of non-adherence (Ried and Christensen, 1988). The goal of the HBM is to explain the highest level of variability in the behaviour. From a scientific point of view, this could be questioned. In fact, this means developing comprehensive bio-psycho-sociological models, involving a great number of variables. From a psychological standpoint, this heterogeneity may be considered as a theoretical weakness and does not always favor efficient psychological intervention.

The Theory of Reasoned Action (TRA; Fishbein and Ajzen, 1975; Ajzen and Fishbein, 1980) sets up a link between intentions and behaviours, and specifies relationships and causal processes between variables. This model involves the strength of belief or conviction and the result appraisal. According to the TRA, patients evaluate benefits and drawbacks of complying behaviours depending on probability to occur. This model gives an important role to social influences on individuals, namely the perception that subjects have of other reference individuals, subjective norms, and motivation of individuals to comply with these norms and references.

Some researches show the interest of the TRA in the statistical explanation of adherence : the variables of this model have allowed to significantly increase the explained variance of non-adherence in regression analyses (Ried and Christensen, 1988). However being 'statistically attractive' does not mean having good heuristic qualities. In fact, it is not because TRA variables take part in the explanation that the structure of the model is validated. It is however the structure of these models which is of high interest for clinicians.

The HBM and TRA theories have been criticized largely because they do not include the individual differences and in particular the personality of subjects (Booth-Kewley and Vickers, 1994). In fact, recent studies have shown the importance of personality to predict health behaviours (Friedman *et al.*, 1993; Marshall *et al.*, 1994). In these studies personality is considered as consistent dimensions, which can explain by definition only some part of situational factors.

The cognitive model of coping and emotions proposed by Lazarus and Folkman (1987), widely used in Health Psychology (e.g. Nicassio and Smith, 1995) could help explain some characteristics of the non-adherence phenomenon since non-adherence can be considered as a coping behaviour. However, due to the relative lack of research in this area, this model does not allow to be precise concerning the status of the non-adherence variable. This variable could reveal the failure of coping with the illness process (a negative outcome), or could belong to the coping process itself. Moreover, the bio-psychological framework of Health Psychology largely derived from Lazarus and Folkman's assumptions involve numerous biological and social variables which do not make them easy to apply to clinical practice.

Thus, there is a crucial need in this field for more specific and clinically relevant variables. Therefore, the call for a risk-taking perspective in the explanation of non-adherence can be justified, since risk-taking has given rise to various theoretical hypotheses whose main trends are presented below.

2. Risk-taking theories and non-adherence

2.1. A RESULT OF PERSONALITY TRAITS

Some authors have addressed the question of whether risk-taking is due to an internal disposition (or vulnerability) of the subject to risk. There would be a 'risk-taking trait', stable across various situations. This personality trait could be favoured by psychobiological particularities, inducing more generally stimulation or 'sensation seeking' (Zuckerman, 1979; Zuckerman *et al.*, 1980; Zaleski, 1984). This is also assumed by Wilde (1988) in the field of the general psychology of risk. Wilde assumes that there is a level of risk sought by subjects. This may be linked to psychoanalytic theories of risk in which risk-taking is the result of a tendency to seek stimulation, as a defensive reaction against internal disorders or internal gaps (Fenichel, 1939; Balint, 1968). The relevance of these questions (risk disposition) was criticized by many authors in cognitive psychology (i.e. Huteau, 1985). According to them, risk-taking is a complex variable resulting from a combination of more elementary variables, which do not necessarily appear together (e.g. estimation of probability of success or failure, representation of benefits and losses and their personal meaning for the subject). In the present authors' view, it seems quite simplistic to sum up all kinds of non-adherent behaviours to a unique personal characteristic since risk-taking appears to be caused by various factors.

2.2. A RESULT OF DECISION MAKING

In the perspective of the general psychology of risk, taking a risk has been considered as taking the decision of a risky alternative. In this view, decision taking is a choice between different alternatives (Von Winterfeld, 1986). The normative models of the

decision theory describe the steps subjects are supposed to follow in order to maximize their chances to improve their well-being according to their own values and beliefs (Fischhoff *et al.*, 1987).

This has been applied in the field of non-adherence. In fact, non-adherence can be rational, namely an outcome of a deliberate choice resulting from a decision, in which costs are compared to expected benefits (Tong-Nagy and Wolfe, 1984; Donovan and Blake, 1992; Dugdale, 1993). So, a non-adherent behaviour (apparently irrational) could be the result of a totally rational decision taking, from the patient's point of view. Each patient would analyse costs and benefits for every treatment proposed by the clinician. He would evaluate expected benefits (symptomatic amelioration) versus symptoms severity and perceived risks of treatment (dependence, adverse events, ...) according to his beliefs and the information he has (Donovan and Blake, 1992). This perspective can appear adapted when applied to specific circumstances, but studies using it as their theoretical background often generate a confusion between psychological mechanisms and adaptational quality of the chosen option. Since decision is rational, its good quality would be guaranteed.

Beside this classical normative approach, the behavioural decision theory developed the concept of 'cognitive bias'. This helps understanding of real behaviours (Slovic *et al.*, 1977; Kahneman *et al.*, 1982). Researchers have identified a limited number of inferential rules used by subjects in this type of situation, and on which they rely (Fischhoff *et al.*, 1987). These judgment rules called 'cognitive biases' are used to simplify difficult mental tasks. However, they are useful in specific circumstances, but induce important and persistent biases, with serious consequences on decision making in various areas (Slovic *et al.*, 1982). These biases may concern the availability of information and the feeling to be protected from various negative events (in comparison with peers). The behavioural decision theory has also demonstrated the importance of situational frames in which risks are referred to (Tversky and Kahneman, 1981; Kahneman and Tversky, 1984). Is non-adherence understandable through normative models? This depends on what is understood by the 'maximization of chances to improve the well-being according to the personal values and beliefs of the subjects'. Obviously, if the clinician and the patient have the same representation of well-being (and share a substantial part of their personal values and beliefs), non-adherence appears irrational and thus it is necessary to adapt the normative model of decision making to explain non-adherence.

Adopting non-adherent behaviours, as taking a risk could be the result of specific biases like an unrealistic optimism (Weinstein, 1987), the illusion of control or the feeling to be protected (Langer, 1975). Therefore, it would be interesting to test empirically the hypothesis that non-adherence is somewhat related to cognitive biases such as unrealistic optimism or the feeling of invulnerability.

Hence, two research trends appear in explaining health behaviours. On the one hand, traditional integrative models try to account for a maximum of behaviour variance in including variables other than psychological. On the other hand, personality and cognitive models of psychology may be directly applied to non-adherence, although it is difficult to integrate all these factors into any coherent framework. However, trying to explain why some cognitive processes appear in decision making leads to the problem of motivation being raised. For most authors working in this field, the reasons why a subject shows cognitive biases are related to the self, or 'self-serving' (see Perloff and Fetzer, 1986, for instance).

2.3. COGNITIVE BIAS AS 'SELF-SERVING' MECHANISMS

In fact, according to Greenwald (1980) the self appears to constitute cognitive biases (e.g. the illusion of control). The biases considered by this author contribute to the self-esteem. Greenwald's discussion induces an interesting link between some cognitive biases and the investment of (or the reference to) the self, that is narcissism. In fact, the thought 'it will not happen to me' concerning the non-adherence consequences could be the result of an excess of narcissistic investment, appearing as unrealistic optimism, or simply a justified self confidence, appearing as a realistic optimism. Here cognitive biases can be understood in a self-enhancement perspective.

In the same way, the feeling of invulnerability has been shown to be involved in risk-taking (Jacobs-Quadrel *et al.*, 1993). The development of the concept of Egocentrism, a particular conception of the self in relation with the others during adolescence, Elkind (1967) showed that invulnerability refers to the responsibility of the self and the self-image in risk-taking processes. According to Jacobs-Quadrel *et al.* (1993), there is no reason why this concept of Egocentrism should only be applied to adolescence. In fact, the tendency to consider oneself less likely than others to live negative events (and more likely to live positive events) has been evidenced in various populations and situations including susceptibility to health problems (Weinstein, 1987; McKenna, 1993). Here the cognitive bias of invulnerability (unrealistic optimism) may be related to a personal tendency to protect the self-concept. So it is not unreasonable to hypothesize a link between self-esteem and non-adherence because of the self-esteem maintenance or protection influencing cognitive biases.

The role of self-related variables may also be discussed via the direct role of self-esteem. To the authors' knowledge, empirical studies including measures of self-esteem are rare in the field of risk-taking. Nevertheless, self-esteem can appear as a major variable for different reasons. Studies on the development of self-esteem (Kohut, 1977; Kernberg, 1975) and the remarks of Robson (1988) advocating the existence of an increased risk-taking in individuals with high self-esteem could refer to a feeling of omnipotence in risk-takers. However this is without taking into consideration the individual learning capacities in the long term. In fact, it is possible for individuals who regularly encounter risky situations to learn to cope with it better than others. This must have effects on their subjective appraisal of risk. However, low self-esteem individuals could also be assumed to ignore the existence of risk and take risks because they have nothing to risk. It could be hypothesized that low self-esteem individuals would have a higher tendency for non-adherence since efforts are simply not worth it. But it has been demonstrated that the motivation to protect self-esteem influences decision making (Tennen and Herzberger, 1987). So it could be hypothesized that some decisions involved in risk-taking are related to high self-esteem, although this direct link remains unclear.

Thus it would be very interesting to show evidence: first, a relation between a cognitive bias and non-adherence; second, that non-adherence is related to self-esteem.

3. Pilot study

In order to explore these hypotheses the authors have organized a pilot study involving 16 men who have suffered from a severe heart failure for more than one year (see

Table 1 for age information). Subjects were recruited from two settings in the private practice by random selection. A clinical assessment was performed including a structured interview to measure three dimensions of adherence with the clinician's advice on smoking, dieting and physical activity. Non-adherence was defined as an unchanged behaviour on two of the three dimensions despite repeated physician's advice (the patients were followed for more than one year). Therefore, the amount of smoking, the type of food taken and physical activity before the heart failure (retrospectively) and at the time of the interview was measured by a questionnaire. These measures yielded two groups of eight patients, one defined as the poor adherence group, the other as the high adherence group.

Patients also took a questionnaire on their perceived susceptibility to various health problems (e.g. 'sunstroke', 'influenza', . . .). This was taken from the measure of unrealistic optimism in Weinstein (1987) and states different kinds of health problems on which the subject is asked to appraise his/her chances to experience them in the future, in comparison with subjects of his/her age (from 'much lower chances' to 'much higher chances'). All subjects also took the Rorschach inkblot test (scored and interpreted in the comprehensive system, Exner, 1990, 1991) which gives a measure of self-esteem (EGO index computed on the basis of reflection and pair responses) and some indicators of the mood of the subject (e.g. depressive mood and cognition by the Depression index and the Coping deficit index; definition of indices and validation/reliability studies are available in Exner, 1991). This instrument was chosen because of the large scope it offers on personality and cognitive functioning. It also has fair psychometric properties (as for indices used).

Clinical variables are shown in Table 1. It was not possible to show any optimistic bias (Weinstein's procedure) in the non-adherent sample, whereas these subjects were likely to be pessimistic which reflects an acute perception of vulnerability in comparison to people of the same age ($p < 0.05$; Mann-Whitney test). Moreover this pessimism was significantly higher than in adherent subjects: including for health problems independent from any heart trouble, poor adherence patients felt more concerned ($p < 0.01$ for skin cancer and ulcer, for example). This contradicts the first assumption that a cognitive bias like unrealistic optimism would play a role in the decision making of poor adherence patients. In fact, if this was to play a role, it should be observed that pessimistic cognitions would go along with a *better* self-protection.

As for self-esteem (as measured by the EGO index in the Rorschach), no difference could be evidenced between the two groups. However, it was observed that there was a tendency for poor adherence subjects to express reflection responses ($p < 0.041$; Fisher exact test). The results go along with the second assumption since some aspects of the self-esteem may be related to non-adherent behaviours. However, it must be kept in mind that reflection responses have been related to self-focus (Exner, 1991, 1973). Moreover, when compared to other Rorschach factors, reflections may be interpreted in terms of conflict in the self-concept (Exner, 1991) which could influence the understanding of depression characteristics in some patients. Confirming this would need further investigations.

Non-adherent also showed signs of depression (more Depression or Coping deficit indices were positive at the Rorschach). This mood factor is likely to influence scores in optimism (seen as a feeling of invulnerability).

In fact, pessimism has long been related to depression and optimism is negatively related to Neuroticism. In fact, if depressed patients were not included in the analyses,

Table 1. Description of demographic and clinical variables in the pilot study.

	<i>Good adherence</i> <i>n = 8</i>	<i>Poor adherence</i> <i>n = 8</i>	<i>p</i>
Age	65.1 ± 5.0	59.4 ± 8.2	ns
<i>Rorschach variables</i>			
EGO index	0.39 ± 0.09	0.45 ± 0.13	ns#
Depression Index			
positive	2	7	
negative	6	1	0.0410*
Coping deficit index			
positive	2	6	
negative	6	2	0.1320
Reflections			
yes	6	1	
no	2	7	0.0410*
<i>Unrealistic optimism</i>			
Heart attack	0.714 ± 1.380	2.250 ± 0.707	0.0130*
Gastric ulcer	-1.000 ± 1.633	0.250 ± 1.753	0.0045**
Pneumonia	-1.429 ± 1.397	0.500 ± 0.756	0.0182*

Note. * $p < 0.05$; ** $p < 0.01$. # not significant event when EGO index is considered as categorical variable. Depression Index consists in the computation of several factors measuring depression; Coping deficit index measuring depression and social anxiety.

For Rorschach variables, Fisher exact tests were computed. For unrealistic optimism, Mann-Whitney tests were computed.

the difference between non-adherents and adherents decreased and the pessimism difference was not statistically significant anymore. It also seems that the measurement of a more specific optimism (covering not only health problems in general but heart disease) could assess specific cognitive activities directed to biasing risk perception. Developing more specific measures in this field could be done by precisising the situations within Weinstein's framework or making people compare themselves with people suffering from the same health problem.

However this analysis has avoided some variables which are usually the core of the psychological explanation of non-adherence, like the personal meaning of the handicap or the subject's representations. This would be another way to study non-adherence, referring to different conceptual backgrounds and methods.

In conclusion, it seems that risk-taking theories like the behavioural decision theory can shed a new light on the non-adherence phenomenon. Some authors advocate that these theories are linked to self-enhancement or protection. The clinical data presented here are not straightforward though. The results show that people with poor adherence may feel more vulnerable, which surprisingly do not make them change their non-adherent behaviour. This can be interpreted within the behavioural decision making theory as a fundamental difference between the clinicians' and patients' values and beliefs which is reflected by depression characteristics, as seen in several patients.

The data reveal that mood variables have been over-neglected which are likely to influence both cognitive variables like self-esteem and the feeling of invulnerability

(optimism). In addition it must be observed that it is very difficult to interpret such correlational data as personal psychological characteristics are likely to be influenced by the illness or the behaviour as well as self-care behaviours and adherence are likely to be influenced by psychological variables. Yet there must be awareness of the medical specificity of the health problem chosen for study. In fact, the relationship with death is very specific for these patients, who face direct experience of a major body function failure, reinforced by the social image of the heart considered as the centre of life and the source of any individual activity. This probably has various consequences on the elaboration of disease representations in the patient's as in the clinician's mind. Non-adherence could reveal the difficulties of both sides to acquire the same disease representation.

References

- Ajzen, I. and Fishbein, M. (1980) *Understanding Attitudes and Predicting Social Behavior*, Englewood Cliffs, NJ: Prentice Hall.
- Balint, M. (1968) *The Basic Fault: Therapeutic Aspects of Regression*, London: Tavistock Publications.
- Booth-Kewley, S. and Vickers, R.R., Jr. (1994) Associations between major domains of personality and health behavior, *Journal of Personality* **62**, 281–98.
- Donovan, J.L. and Blake, D.R. (1992) Patient non-compliance: deviance or reasoned decision-making?, *Social Sciences and Medicine* **34**, 507–13.
- Dugdale, A. (1993) Non-compliance or rational decision?, *The Lancet* **342**, 1426–27.
- Elkind, D. (1967) Egocentrism in adolescence, *Child Development*, **38**, 1025–1034.
- Exner, J.E. Jr. (1973) The self focus sentence completion: a study of egocentricity, *Journal of Personality Assessment* **37**, 437–55.
- Exner, J.E. Jr (1990) *A Rorschach Workbook for the Comprehensive System* (3rd edn), Ashville NC: Rorschach Workshops.
- Exner, J.E. Jr. (1991) *The Rorschach: A Comprehensive System. Volume 2: Interpretation* (2nd edn), New-York: Wiley.
- Fenichel, O. (1939) The counter-phobic attitude, *The International Journal of Psycho-analysis* **20**, 263–74.
- Fishbein, M. and Ajzen, I. (1975), *Belief, Attitude, Intention and Behavior: An Introduction to Theory and Research*, Reading, MA: Addison-Wesley.
- Fishhoff, B., Svenson, O. and Slovic, P. (1987) Active responses to environmental hazards: perceptions and decision making, in D. Stokols and J. Altman (eds) *Handbook of Environmental Psychology*, pp. 1089–133, NY: Wiley.
- Friedman, H.S., Tucker, J.S., Tomlinson-Keasey, C., Schwartz, J.E., Wingard, D.L. and Criqui, M.H. (1993), Does childhood personality predict longevity?, *Journal of Personality and Social Psychology* **65**, 176–85.
- Greenwald, A.G. (1980) The totalitarian ego: fabrication and revision of personal history, *American Psychologist* **35**, 603–18.
- Huteau, M. (1985), *Les Conceptions Cognitives de la Personnalité (Cognitive Conceptions in Personality)*, Paris, Presses Universitaires de France.
- Jacobs Quadrel, M., Fishhoff, B., and Davis, W. (1993), Adolescent (in)vulnerability, *American Psychologist* **48**, 102–16.
- Janz, N.K. and Becker, M.H. (1984) The Health Belief Model, a decade later, *Health Education Quarterly* **11**, 1–47.
- Kahneman, D., Slovic, P., Tversky and A. (Eds) (1982) *Judgment Under Uncertainty: Heuristics and Biases*, New York: Cambridge University Press.

- Kahneman, D. and Tversky, A. (1984) Choices, values, and frames, *American Psychologist* **39**, 341–50.
- Kernberg, O. (1975) *Borderline Conditions and Pathological Narcissism*, New-York: Jason Aronson.
- Kohut, H. (1977) *The Restoration of the Self*, New York: International Universities Press.
- Langer, E.J. (1975) The illusion of control, *Journal of Personality and Social Psychology* **32**, 311–29.
- Lazarus, R.S. and Folkman, S. (1987) Transactional theory and research on emotions and coping, *European Journal of Personality* **1**, 141–69.
- Marshall, G.N., Wortman, C.B., Vickers, R.R., Jr, Kusulas, J.W. and Hervig, L.K. (1994) The Five-Factor Model of personality as a framework for personality-health research, *Journal of Personality and Social Psychology* **67**, 278–86.
- McKenna, F.P. (1993), It won't happen to me: unrealistic optimism or illusion of control ?, *British Journal of Psychology* **84**, 39–50.
- Nicassio, P.M. and Smith, T.W. (Eds) (1995) *Managing Chronic Illness: A Biopsychosocial Perspective*, Washington DC: American Psychological Association.
- Perloff, L.S. and Fetzer B.K. (1986) Self-other judgments and perceived vulnerability to victimization, *Journal of Personality and Social Psychology* **50**, 502–10.
- Ried, L.D., and Christensen, D.B. (1988) A psychosocial perspective in the explanation of patients' drug-taking behavior, *Social Sciences and Medicine* **27**, 277–85.
- Robson, P.J. (1988) Self-esteem, a psychiatric review, *British Journal of Psychiatry* **153**, 6–15.
- Slovic, P., Fishhoff, B., and Lichtenstein, S. (1977) Behavioral decision theory, *Annual Review of Psychology* **28**, 1–39.
- Slovic, P., Fishhoff, B. and Lichtenstein, S. (1982) Facts versus fears: understanding perceived risk, in D. Kahneman, P. Slovic and A. Tversky (eds) *Judgment Under Uncertainty: Heuristics and Biases*, pp. 52–71. New-York: Cambridge University Press.
- Stockwell Morris, L. and Schultz, R.M. (1992), Patient compliance – an overview, *Journal of Clinical Pharmacy and Therapeutics* **17**, 283–95.
- Tennen, H. and Herzberger, S. (1987) Depression, self-esteem and the absence of self-protective attributional biases, *Journal of Personality and Social Psychology* **52**, 72–80.
- Tong Nagy, V. and Wolfe, G.R. (1984) Cognitive predictors of compliance in chronic disease patients, *Medical Care* **22**, 912–21.
- Tversky, A. and Kahneman, D. (1981) The framing of decisions and the psychology of choice, *Science* **211**, 453–58.
- Von Winterfeld, D. (1986) *Decision Analysis and Behavioral Research*, New-York: Cambridge University Press.
- Weinstein, N.D. (1987) Unrealistic optimism about susceptibility to health problems, *Journal of Behavioral Medicine* **10**, 481–500.
- Wilde, G.J.S. (1988), Risk homeostasis theory and traffic accidents: propositions, deductions and discussion of dissension in recent reactions, *Ergonomics* **31**, 441–68.
- Wright, E.C. (1993) Non-compliance – or how many aunts has Matilda?, *The Lancet* **342**, 909–13.
- Zaleski, Z. (1984) Sensation seeking and risk-taking behaviour, *Personality and Individual Differences* **5**, 607–8.
- Zuckerman, M. (1979) *Sensation Seeking: Beyond the Optimal Level of Arousal*, Hillsdale, NJ: Lawrence Erlbaum.
- Zuckerman, M., Buchsbaum, M.S. and Murphy, D.L. (1980) Sensation seeking and its biological correlates, *Psychological Bulletin* **88**, 187–210.