

STRATEGIES IN BEHAVIOUR MODIFICATION: THEORETICAL BACKGROUND

An introductory literature study for the OECD-Expert Group on
"Enforcement and Rewarding: Strategies and effects"

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1. INTRODUCTION

In the domain of traffic safety, attempts in the past to modify the behaviour of individuals through punishment and rewards have been carried out in a largely ad hoc and unsystematic manner, despite the fact that behaviour modification has been a central topic in psychology for nearly a century. In recent times, however, the application of psychological theories in traffic safety has markedly improved the progress made in strategies for changing the behaviour of individuals and governing bodies. Although there are still many problems in the understanding and modification of human behaviour, these psychological theories are based on a large body of experimental research and evaluations of real life field trials. Applications of these findings in the everyday work of the police and of governing bodies in the field of traffic safety are becoming more frequent, and with promising results.

In order to grasp the background to these new approaches, we first discuss three main streams of relevant theorizing in the study of human behaviour, and then give a short review of the major existing theories of risk taking in traffic. The theoretical streams are:

1. learning theory of behavioural change.
2. cognitive and social theory on the influence of attitudes, beliefs, values and norms.
3. utility and choice theory of preference and risk behaviour.

These three theoretical streams are the most relevant, but by no means the only ones; for example theories in motivational psychology are also relevant. Linkages between motivational theory and the above mentioned theoretical streams are given in the discussion of traffic risk theories of this study.

2. LEARNING THEORY

In the experimental study of learning the concept of "reinforcement" is predominant. It can be traced back to Thorndike's research on trial-and-error learning around the beginning of this century. Thorndike's first formulation (Thorndike, 1903) of his "law of effect" is most succinct: "Any act which in a given situation produces satisfaction becomes associated with that situation, so that, when the situation recurs, the act is more likely than before to recur also." The term is also used in Pavlovian classical conditioning where reinforcement applies to stimuli that promote the learning of responses on which they are consequent. These reinforcers that strengthen the occurrence of certain need satisfying responses in the presence of certain stimuli are called positive reinforcers or rewards. Thus stimuli and subsequent responses become associated by the action of contiguous rewarding.

Given aroused conditions of certain physiological drives or social needs, this principle of contiguity (Guthrie, 1935) has turned out to be a necessary component in learning, discrimination and generalization. Reward strategies aimed at selected types of responses in specified ranges of stimulation have shown to be very effective in restricting and in broadening behaviour patterns by discrimination and generalization learning. Time and frequency schedules of reinforcement are also of great importance in learning (Ferster & Skinner, 1957). The longer the time elapsing between the reward and the responses given in a specific field of stimuli the less the probability that such a field of stimuli elicits the responses that were intended to be rewarded. Once a particular response is learned as a reaction to a stimulus condition, it becomes a somewhat durable change in behaviour if that reaction is never punished in that stimulus condition. It remains a very stable change in behaviour if it is learned by intermittent positive reinforcement and an increasing non-reward frequency, following a low initial non-reward level in order to establish the learned behaviour.

Withholding a reward that has been delivered permanently and contiguously to a response on certain stimuli has been shown to have effects similar to punishment. Punishment is a so-called negative reinforcer in that it acts

in many respects in the opposite way as rewards. The basic difference is that rewards specify which links between features of responses and stimuli are strengthened, while punishment only specifies which links are weakened. Rewards elicit the correct behaviour and thereby reduce irrelevant and other incorrect behaviours, whereas punishment only blocks the specific incorrect behaviour and thereby leaves room for other incorrect behaviours such as punishment escape behaviour as well as correct behaviour.

There are clear implications here for traffic safety, where unsystematic schedules of punishment are employed far more widely than systematic schedules and reward, despite the fact that, to be effective, the modification of road user behaviour requires systematic schedules of reinforcement for not only stopping undesirable behaviour, but also eliciting desired behaviour in its place. There is recent research evidence in the field of traffic safety [several articles in: Rothengatter & De Bruin (Eds.), 1988; Benjamin (Ed.), 1990; Koornstra & Christensen (Eds.), 1991] that randomly scheduled (in time and place) intermittent punishment (enforcement) to incorrect behaviour and the joint delivery of persuasive information with some reward value on correct behaviour will not only effectively reduce the occurrence of incorrect punishment escape behaviour, but also establishes lasting correct behaviour.

Habituation to reward and punishment is a well known phenomenon; more fundamentally, however, behavioural research has shown that all judgmental behaviour is relative, i.e. based on the difference of stimulation to the prevailing adapted level of stimulation. The general validity of this "Adaptation-level theory" (Helson, 1964), also for learning, explains why less reward or less punishment than obtained before elicits characteristics of their opposites. Hilgard and Bower (1966) in their classical book "Theories of learning" state: "<Adaptation-level theory> implies a relativistic view of reinforcement... The effect on behaviour of a given outcome is seen as dependent upon its relation to an internal norm derived via a pooling process from series of prior outcomes encountered in a given situation. ... <It> is a conception that makes contact also with the economists' notion of utility and even more obviously with the cognitive theorists' notion of expectancy" (p. 418). In modern neo-behaviouristic learning theory whether or not a person carries out a certain act depends

on what consequences one has learned to "expect" and on how one has learned to "evaluate" those consequences. The term "incentive value" is the most common designation for this "evaluation" (Logan, 1960) in learning theory.

In many real life situations actions are accompanied with conflicting expectancies and much experimental learning research is devoted to so called avoidance-avoidance conflicts (punishments to mutual exclusive behaviours), approach-approach conflicts (rewards for mutual exclusive behaviours) and approach-avoidance conflicts (behaviour that avoids punishment excludes alternatives of rewarded behaviours). The general observation in these studies is that behaviour in such conflict situations is governed by the difference in gradients of nearness for rewards and/or punishments (Miller, 1959). For example, in an approach-avoidance conflict of remote punishment and direct reward one observes delayed responses to remote punishments in order to obtain direct rewards from alternative responses.

For less cognitivistic oriented psychologist these expectations and evaluations of need satisfaction are just internal mediating response sequences for the resulting overt psycho-motoric reactions (Mowrer, 1960). In modern theories of learning cybernetic concepts of positive and negative feedback are linked with positive and negative reinforcement as accompaniments of responses that promotes its continuation or its interruption. Moreover, response-produced external and internal stimuli, like verbal and imaginative stimuli, form self-produced loops acting as intervening chains in the production of manifest overt psycho-motoric behaviour. Human information processing and learning theories are combined in theories for the formation of complex behaviours (Staats, 1968).

The relevance to road safety of conflicting expectancies and of intervening loops of internally self-produced responses in learning theory is great. For example, risk taking behaviour in speeding and overtaking can be understood as approach-avoidance learning by delayed safer behaviour to remote threats of fines or crashes in order to obtain the direct benefits of speeding and overtaking. Also some effects of enforcement can be explained by such theoretical deduction as that, in the presence of discriminative stimuli for an anticipation of punishment, additionally discovered escape behaviour is more likely to be learned to these discriminative stimuli than the correct behaviour.

Not only the principle of contiguity, but also the satisfaction or deprivation of innate or acquired drives is an important component in learning, since it has been shown a determining factor of the response strength (Hull, 1943). Basic to learning theory remains the notion that pleasantness and unpleasantness have to become associated with responses for certain stimuli in order to modify behavioural processes; pleasure tending to sustain reactions and unpleasantness to inhibit them. More recent learning theories, such as Gray's "Two process theory of learning" (Gray, 1975), and neurophysiological research have shown evidence for two separate mechanisms. One signal facilitating mechanism associated with pleasantness sensations and one signal inhibitory mechanism associated with sensations of unpleasantness, originating from different sources of stimulation. Both signal intensities are relative and are dependent on the adapted level of stimulation in a given situation. The reward mechanism provides a "go" or "go-to-it" signal and the punishment mechanism provides a "no-go" or "stop" signal; depending on the relative intensity of both stimulations the response tendency and intensity are determined. As a simple example one may think of the drinking response to water supply depending on the anticipatory reward stimulation from the thirst-senses of the mouth and on the anticipatory punishment stimulation from the saturation-senses of the stomach.

Applied to more complex behaviours, modern learning theory states that behaviour will only change if less reward or more punishment than anticipated is obtained contiguous on that behaviour, and/or if modifications of behaviour are contiguously more rewarded or less punished than anticipated. These modifications may be learned by reinforcing self-generated random trial and error deviations of existing behaviours (Skinner, 1953), but are more effectively obtained by rewards in instructional schemes (Skinner, 1954; Hilgard (Ed.), 1964; Engelmann & Carnine, 1982) or are otherwise more likely acquired by observational learning (Bandura, 1976) from acts of others who are more rewarded or less punished for modifications of behaviour compared to one's own behaviour.

3. COGNITIVE AND SOCIAL THEORY

In the cognitive and social approach, behaviour is viewed as guided by personal attitudes, beliefs on how significant others think one should behave and values shared in the culture one belongs to. The dominating views of how one should interpret circumstances and behave in these circumstances in a society can become official norms or laws which as enforced standards also directs behaviour.

The traditional usage of the concept views an attitude as some internal affective orientation that would explain the actions of a person. The concept of attitude, however, is rather troublesome in that it entails several components, namely:

- a. cognitive (consciously held opinion);
- b. affective (emotional feeling);
- c. evaluative (positive or negative);
- d. conative (disposition for action) and
- e. socially appreciative (expected approval or blame).

Moreover, there is considerable dispute in psychology as to which of these components should be regarded as more (or less) important. The operational problem is that personal attitudes are mainly to be inferred from the observed behaviours which they are supposed to explain. A working definition for the measurement of attitudes (McGurie, 1985) is that attitudes are responses that locate objects of thought on dimensions of affective judgement. In more process orientated terms, attitudes are described as a mediating process grouping a set of objects of thought in a category that evokes a socially significant pattern of responses.

Positive attitudes to laws is assumed to generate behaviour according these laws, but the positiveness of such attitudes is also derived from judgments on the appreciation of these laws. Although attitude theorists agree that attitudes are acquired from experience rather than determined a priori, the main cognitive position is that behaviour is also directed by attitudes through selection of perceptions and responses that are not in dissonance with personal attitudes. In this "Cognitive dissonance theory", originally formulated by Festinger (1957), attitudes are frames formed by perceptions and behaviours which, ones they are formed, influence by

selective facilitation those perceptions and responses that fit into the acquired frame of reference.

The view that attitudes can act as a mediating process to influence behaviour can be accommodated within learning theory, but for a learning theorist changes in attitude can only come from responses to stimuli that are rewarded or punished. By contrast most cognitive theorists stress changes in attitudes by persuasive communications. Referring to intensive indoctrination, like psychoanalytic treatments or brainwashing methods, even reversals in attitudes are obtained by such methods of indoctrinating information.

The relation between attitudes and actual behaviour is troublesome. The causal relation can be from behaviour to attitude or the reverse. All together there have been seldom found high positive correlations between personal attitudes and actions of individuals. Differences between group attitudes, however, are firmly correlated with differences in group actions. This may indicate the influence of social groups or indicates that such groups are formed on the basis of conformity of behaviour and attitudes and that this induces social compliance. The values shared by the social group to which one belongs, therefore, are an important reference frame for the interpretation of persuasive information and for the meaning given to alternative behaviours.

Despite the lack of evidence in the literature for a strong relation between attitudes and behaviour, there has been for many years a widespread belief among practitioners in traffic safety that the 'improvement' of personal attitudes could bring about significant accident savings. The lack of success from this approach stemmed largely from its simplistic view of attitudes as easy changeable dispositions. A major advance in this area was provided by Fishbein and Ajzen (Fishbein & Azjen, 1975; Azjen & Fishbein, 1980) with their "Theory of reasoned action". This theory maintains that the intention of performing a specific behaviour is determined by two factors: one's personal attitude and one's beliefs on how significant others think one should behave. This line of theorizing has been seen as having particular relevance for traffic safety research, as may have also its more recent development, the "Theory of planned behaviour" (Ajzen, 1988).

The addition of measurements on beliefs about how people important to one (significant others) think one should behave to the measurement of one's personal attitude toward the behaviour in question, has been able to demonstrate higher correlations between behaviour and attitudes than the earlier theories. In this more recent formulation of attitude theory, there is the added factor of the degree of control one has over particular behaviours by the influence on the reinforced social-belief component. This is also recognized in the more recent application to traffic safety [see several articles in: Rothengatter & De Bruin (Eds.), 1988; Benjamin (Ed.), 1990; Koornstra & Christensen (Eds.), 1991], where the advantage lies in the ability to identify the most appropriate targets (reference group, type of behaviour, kind and content of information) for effective intervention strategies.

Relevant to effects of information on attitude change is also Anderson's "Information integration theory" (Anderson, 1981). This theory, based on extensive research results, describes how new information is assimilated in a changed attitude. Attitude changes are formed by a weighted average of the prior existing attitude information and the attitude content in the new information, where the weights are determined by the salience, relevance and reliability of, respectively, the old stored and the new information. This weighting in the theory explains why information from significant others and Socratic questioning of the salience of information already possessed by a person are more influential than just information from an outside source. The frequency of exposure to new, but salient information often has been shown to be important, which is what Anderson's theory of information integration predicts.

The joint recognition of the social-belief component ("Reasoned action theory") and the initial-belief component ("Information integration theory") in attitudes are particularly relevant for the effectiveness of public communications campaigns (Rice & Paisley, 1981), probably also in the field of traffic safety. According to these theoretical notions, one should not expect any marked influence from information campaigns that contain material that contradicts the information one is regularly exposed to, nor from campaigns without salient information, without information from significant (credible, attractive, powerful) sources and without social relevance for a particular concrete behaviour.

4. UTILITY AND CHOICE THEORY

The cost/benefit utility of behavioural alternatives as well as acquired, less rational preferences for certain behaviours may explain the usual risk behaviour of the road user. Utility and choice theory, therefore, may be important for the understanding of safety strategies and effects.

Utility theory, first advanced by Bernoulli (1738; translation by Sommer, 1954), discussed by Ramsey (1931) and fully formalized by Von Neumann & Morgenstern (1944) and Savage (1954) is a mathematical theory for the maximization of expected utility for individual decisions on choices with uncertain outcomes. This classical prescriptive theory for rational decisions has been modified to a more descriptive theory of choice and preference in psychology by subjective probability judgement, stochastic aspects of behaviour and subjective estimation of utility differences between objects of choice. An overview of this descriptive theory is given by Luce & Suppes (1965). According to this line of theorizing the individual seeks by his choices to maximize the sum of the product of

- a. the probability of outcomes from the alternative actions available (subjectively estimated for most decision theorists) and
- b. the utility value for these outcomes (subjectively perceived differences between outcomes for most psychologists).

Rational decision theory for governing bodies and econometric theory of individual behaviour have embraced classical utility theory by defining utility as the money value of alternatives, since from an economist's point of view every obtainable good can be exchanged against money on the market. So under equal probability of attainment of outcomes the alternative with the highest monetary value must be chosen on rational grounds. More of the same obtainable good represent more monetary value and therefore, if the choices concern equally probable attainment of different amounts of the same good with positive money value the highest amount should be chosen. Only if more of some good is less probable to obtain a choice for less could be rational, since only than the expected utility difference for less (the comparison of outcome value times probability of outcome), can become positive.

Although satiation for money may decrease of the gain in subjective utility for more money, more money has always more utility (a strict monotonic utility function for objectively measured money). In the economist world, individual saturation of some aspect (that means less pleasantness for more) is excluded from theory. In econometric theory individual excess of such aspects are excesses of goods which always can be sold on the market and with that money other individually desired goods could be bought. Partly due to the fact that in many areas of life objects of choice are not exchangeable against money, this view is in contradiction with the psychological research findings on the single peaked curve for subjective appreciation for more of the same feature.

This notion of a single peaked curve for hedonic tone of scales for stimulus intensity goes even back to Epicurus (3th century B.C.) and is first explicitly pictured as a preference curve by Wundt (1876). In psychological theory aspirations of individuals in achieving things are not only reduced by satiation, but also bounded by saturation or even by oversaturation. The concept of level of aspiration for which individuals settle was a popular concept in psychology around and after the last world war and was a topic of extensive research in that period (Frank, 1941). A most important theoretical article on the concept of level of aspiration (Lewin et al., 1944) asserts that the level of aspiration set by a person is a function of a) the seeking of success, b) the avoiding of failure, and c) the cognitive factor of a probability judgement. Siegel (1957) has tried to unify the more qualitative theory on aspiration level and the formal theory of decision and utility theory.

The merit of Siegel's analysis is twofold. First, there is the notion of zero subjective utility as the present position of obtained utility by a person. Second, there is the notion of level of aspiration as some optimal point at some distance from zero on the expected utility scale. Together these notions bring the dynamics of behaviour into the picture. Simon (1955) has formulated a 'satisfying' principle by which an individual does not choose out of the evaluation of all future alternatives, but chooses the first satisfactory alternative offered. Siegel and Simon both suggest that the discovery of satisfactory alternatives, may give a rise in level of aspiration and that such will lead to next higher choices in sequence.

They argue that -" such changes would tend to guarantee the existence of satisfactory solutions to the choice situation, for failure to discover initially satisfying alternatives would depress the level of aspiration and thereby bring satisfactory solutions into existence"-.

The missing issue in utility theory and in Siegel's interpretation of level of aspiration is the fact that subjective appreciation for more of a single aspect is often shown to be single peaked (Pfaffman, 1960; Berlyne, 1960; Berlyne & Madsen, 1973). Modern measurement and analysis of preference behaviour in psychology is founded on Coombs' "Theory of data" (Coombs, 1964), which theory is based on single peakedness of the value function and in which, more naturally, level of aspiration is equated with the maximum subjective value or ideal point on choice relevant feature dimensions. Coombs (1975) has even shown that preference for risk it self can be single peaked (by scaling the preference of gambling probabilities for alternatives with equal expected value and different outcome probabilities). Multidimensional scaling methods (Shepard et al., 1972), based on single peaked value functions for the relevant underlying feature dimensions of complex objects of choice, has shown an overwhelming evidence for single peakedness in studies of preference and risk.

The relevance of utility theory as well as choice theory based on single peaked preference function recently has become particular apparent for strategies in reducing the risk in traffic and the understanding of effectiveness of safety measures [see below and also several articles in: Rothengatter & De Bruin (Eds.), 1988; Benjamin (Ed.), 1990; Koornstra & Christensen (Eds.), 1991].

5. THEORIES OF RISK IN ROAD TRAFFIC

Based on the above mentioned theoretical streams several specific theories for risk taking in road traffic have been developed: an overview.

Atkinson (1957) presented a "Motivational theory of risk taking" based on the line of thinking in this last stream and on some links with the two earlier described approaches. The main points could be formulated as:

- a. probability of actually obtaining something together with an associated incentive value (expectancy aspect);
- b. strengths of association between that something and the incentive values (strength of motive aspect);
- c. maximum of incentive value obtainable (strength of incentive aspect);
- d. direction and distance of level of aspiration with respect to the adapted level (goal-setting aspects).

Näätänen and Summala (1976) presented in their "Zero-risk theory" a motivation based model for risk in traffic in which only high risk levels can be perceived. Below a certain threshold, depending on the framing of the perception, situations are experienced as zero risks. Only risks above that perceived level are compensated for by safer behaviour. Learning and trip related motivations and experiences during the trip may change the framing of perception for that perceivable risk level (Summala, 1988).

"Utility theory of risk" in traffic have been proposed by O'Neill (1977) and Bloomquist (1986). In this theory the basic assumption is that driver maximizes his expected utility by an implicit probabilistic cost/benefit analysis of positive and negative outcomes of his behavioural alternatives. Most model efforts, here, are concentrated on speed behaviour with sure benefits from time saving and cost as crashes occurring with a speed related probability. The maximized utility for the opposing aspects of speed assumes an ideal speed for which expected costs and benefits are equal. Safety improvements, therefore, are compensated by the 'rational driver' in driving some what faster.

A single peaked preference curve for risk in traffic, mainly based on the single peakedness of preference for arousal and utility for risk, has been

proposed by Wilde (1982) in his "Risk homeostasis theory". In this theory a target level of risk is maintained by compensatory behaviour, notable more risky behaviour for lower levels of risk offered by safer traffic environments. According to risk homeostasis theory the target level of risk can only be changed (Wilde, 1988) by cognitive and social changes discussed before. Bower (1991) has presented an analysis for risk in traffic, similar to Wilde's theory, but bases changes in risk taking on learning theoretical notions. Bower's analysis is similar to Coombs and Avrunin's (1977) foundation of single peakedness in that both assume that the value for opportunities of reward satiate and of punishment escalate with increasing risk. Risk behaviour, therefore, tends to obtain the resulting optimal value of anticipated rewards minus anticipated punishments. In Bower's view, changing rewards and/or punishments will change that optimal level in risk taking behaviour.

In his "Threat-avoidance theory of risk", Fuller (1984) developed a theory of risk behaviour in road traffic based on threat avoidance and learning theoretical principles. In this theory the risk taking of the road user becomes partially delayed threat-avoidance behaviour in order to obtain the rewards for which the driving was undertaken.

Mainly on principles from behaviour theory Koornstra (1990) formulated a frame of reference theory of risk, later on reformulated (Koornstra, 1991) in mathematical terms as "Risk-adaptation theory". This theory, in which risk judgement is relative to mean experienced risk, views risk behaviour as a conflict between two underlying dimensions: fear for danger and satisfaction of arousal and utility. These conflicting dimensions also underlie Zuckerman's "Sensation-seeking and anxiety based theory of risk" (Zuckerman, 1979), but in risk-adaptation theory not only for the dimension of arousal or sensation seeking, but for each dimension a single peaked preference function is assumed. In risk-adaptation theory, the optimal level at low risk for the dimension of danger and the optimal level at high risk for the dimension of arousal and utility poses a cognitive and behavioural dilemma. The minimization of the cognitive dissonance for that dilemma leads to a zero-valued indifference range between these optimal levels. Risks that are higher or lower than that indifference range will be compensated respectively by less or more risky

behaviour. Since subjective risks are judged as deviations from the mean objective risk offered by the traffic system, a safer road traffic environment will increase the subjective riskiness of risks in traffic. Moreover, apart from such mean changes, also changes in reward or punishment as well as new salient information can cause shifts of the indifference range with its lower and upper risk control levels .

Given these different theories the need for some comparison and evaluation is evident. One comparison for risk in overtaking behaviour is given in Rothengatter and De Bruin (Eds.), 1988; Chapter 2), partially by the original theorists themselves. Evans (1985; 1991) formulated a model for the analysis of effects of human behaviour feedback to traffic safety measures. He argues on the basis of the evidence from analysis by that model that safety improvements which are highly visible are compensated by more risky behaviour, whereas invisible improvements are not. His results as well as the evaluation by the OECD-RTR Expert Group on behavioural adaptations to changes in the road transport system (OECD, 1990) would invalidate the risk-homeostasis theory. On the basis of the evidence in modern learning theory on the symmetry of reward and punishment processes the assumed difference of a satiating process for rewards and an escalating process for punishments, a difference that underlies risk-homeostasis theory, has also been questioned (Koornstra, 1991). The value-of-time concept of the road user in the utility theory of risk, has been questioned by Evans (1991, p.297) on empirical grounds.

Atkinson's motivational risk theory is in line with risk-adaptation theory and in fact risk-adaptation theory forms an integration of the earlier theories. If the optimal level of low risk for the danger dimension is located at zero risk the risk-adaptation theory reduces to the zero-risk theory, if on the other hand the weight for the danger dimension becomes zero it reduces to the risk homeostasis theory or utility theory of risk, and otherwise if the weight for the arousal dimension becomes zero it reduces to the threat-avoidance theory. Although risk-adaptation theory can explain some observed phenomena and predicts the results of Evans' model analyses, both less plausible or impossible in other theoretical conceptions, it may be judged a rather too flexible and complex theory.

6. THEORIES AND ROAD SAFETY STRATEGIES

Despite some correspondence between the theoretical streams of Chapters 2 to 4 and the topics of individual behaviour modification, the modification group behaviour and norms and values, and strategies to influence corporate and governmental behaviour, there must not be seen in a simple one to one relation to each of these three topics and Chapter 2 to 4. The topic of values and norms borrows much from social psychology and attitude theory, but is also related to choice or utility theory. The topic of individual behaviour is more related to learning theory and utility or choice theory, while the topic of corporate and governmental policies stresses more aspects of utility theory and social theory. Although, there are such links present, every topic is better viewed against the background of all three theoretical streams. Not only because each topic implies references to each stream, but also because these streams are not so much separated as they may seem.

In fact the different theoretical streams are complementary rather than antagonistic, because they differ in complexity level of study area and field of interest. Neurophysiology and learning are as basic for cognition and preference, as cognition and value of preferences are for rational utility analysis, while cognition and preference are basic for social behaviour. More specific it may be noted that information integration theory and learning theory are in fact partially based on the same adaptation-level theory and comparable association principles. Likewise, the influence on one's behaviour by what significant others may think how one should behave can very well be explained by learning theory, if social anticipatory rewards are taken into account. Also expected utility maximization and learning theory for behavioural alternatives associated with different frequencies and amounts of rewards and/or punishments can be in line with each other. Something similar holds for choice theory as Berlyne (1973) and Coombs and Avrunin (1977) showed by their respective theoretical foundations of the single peaked preference curve as the general result from learned approach and avoidance behaviour for stimuli with increasing intensity. So learning, attitude and choice theories need not to be too contradictory at all, although some predictions may differ due to incompleteness of one theory on aspects covered by the other.

In recent proceedings of symposia on traffic safety research and policies (Rothengatter & De Bruin (Eds.), 1988; Benjamin (Ed.), 1990; Koornstra & Christensen (Eds.), 1991) and in the chapters that will follow, the interaction between psychological theory and traffic safety strategies is apparent. This is a quite different state of affairs than in the report of the OECD-RTR Expert Group on Police enforcement from 1972-1974 (OECD, 1974). It is envisaged that the contribution of research and theory to the practices and strategies in traffic safety will be even more fruitful in the future.

The applicability of theories is often hampered by the fact the theories split what in real life is always connected. The interdependence of the individual, the social and institutional context in facts of real life must be realized. The best advice for theory-guided strategies, therefore, is to look for new strategic opportunities and their possible effects from the angles of the different theoretical approaches. The art of theory-guided strategies is to go ahead in directions where different theories converge and to take additional fine-tuning precautions for the counteraction of theoretically possible adverse effects. The effort put into the design of theory-guided strategies in traffic safety has been shown to pay off by the benefits of their better results. Behaviour modification in road safety no longer need to be a matter of trial and error, because nowadays theory surely can help to foresee possible errors in given strategies, and probably can help in designing satisfactory strategies and sometimes even can provide optimal strategies.

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