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Nudging Safer Road Behaviours

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1. Introduction

This report presents evidence and some further thoughts on the application of insights from the emerging field of behavioural economics, and in specific the design of contextual effects to 'nudge' safer road behaviours

Changing the behaviour of road users towards safer behaviours has been a subject of much interest to researchers, practitioners and policy-makers. It can be argued that the main thinking in this area has been much influenced (although sometimes in an implicit way) by behavioural assumptions of rational behaviour. Road users are largely assumed to apply behavioural and cognitive mechanisms; as in other contexts of decision making, it is largely assumed that the behaviour of individuals is triggered by two assumptions: people know what's in their best interest; and they act on that knowledge. Policy makers and 'classical' economists have often emphasized that incentives and education are very effective in changing behaviour. However, studies in cognitive psychology provide wide evidence that the rationality of individual decision makers is bounded, that there are affected by contextual effects, and the effectiveness of incentives and education do not always lead to better decisions.

In many road safety behaviour contexts, bounded rationality is clearly evident. However one might argue that the 'homo economicus' approach has been too dominant in changing road behaviours, through the design of the built environment and the vehicle environment, regulation and enforcement, education and marketing, and there is a room to incorporate more insights from the emerging field of behaviour economics in the design of interventions and measures to change road users behaviours.

Behavioural Economics is an increasingly recognised field of research that draws on behavioural sciences and in specific cognitive psychology. It is increasingly used by policy-makers to design effective policy interventions. This report provides a brief review of relevant finding from behavioural economics that are of relevance to the context of changing road user behaviours, and brings some examples on applying such insights in such a context. The report also provides some thoughts on applying the 'nudge' approach to enable and encourage road safety behaviours, and in specific in the Israeli context.

2. Behavioural Economics, Nudges and Road Safety – An Introduction

Behavioural change initiatives in a road safety behaviour context have been shaped by a wide range of theories and concepts that have emerged from economics, psychology, sociology, and criminology. Different approaches have been applied to encourage, enforce, educate and 'nudge' road users to behave in ways that are better for them and society.

In the last decade there has been a growing interest in behavioural economics; several books on behavioural economics, or fields related to it, and their applications in explaining human behaviour in a range of contexts introduced the general principles of behavioural theories to explain economic behaviours, as well as applications to a range of contexts, to the broad public, among them are Thaler and Sunstein's '*Nudge*' (2008); Ariely's '*Predictably Irrational*' (2008); Shiller's '*Irrational Exuberance*' (2000); Akerlof and Shiller's '*Animal Spirits*' (2009); Kahneman's '*Thinking, Fast and Slow*' (2011); Chabris and Simmons' '*The Invisible Gorilla*' (2010); and Cialdini's '*Influence*' (2007). Perhaps some of the catalysts to public's interest in bounded rationality in decision making are the behaviour of financial markets (such as the 1987 stock market crash) and the ongoing economic crisis, where it can be claimed that not only the 'general public', but also experts, financial organisations and governments suffer from bounded rationality in making economic decisions (Avineri, 2012).

Behavioural economics can be described as an emerging body of work seeking to understand behaviour that deviates from the predictions of rational choice models by incorporating insights from behavioural sciences into economics, giving more weight to what are sometimes called 'irrational' motives and behaviours (Avineri and Goodwin, 2010). Research in behavioural sciences, especially cognitive psychology, indicates that individuals' choices in a wide range of contexts deviate from the predictions of rational behaviour. Some of these deviations are systematic, consistent, robust and largely predictable (Tversky and Kahneman, 1974; Kahneman and Tversky, 1979). Herbert Simon stressed the importance of emotion as a determinant of behaviour and choice making, taking into account intuition and heuristics in decision making processes, and coined the term 'bounded rationality'. Simon (1956) created doubt on the use of economic theories of rational behaviour as a basis for explaining the characteristics of human rationality. He argued that the behaviour of an individual should be understood relative to their environment. Recent research in behavioural sciences indicates that individuals' choices in a wide range of contexts deviate from the predictions of the rational man paradigm – inspiring research on the bounded rationality of travellers (see, for example, special issue by Avineri and Chorus, 2010), with less evidence of direct application to road user behaviour. Laibson and Zeckhauser (1998) see behavioural economics as a field which is "*skeptical of perfect rationality, emphasises validation of modelling assumptions, integration of micro-level data on decisions (including experimental evidence), and adoption of lessons from psychology*". As one of the aims of social sciences is to provide explanations and predictions of human behaviour, behavioural economics aims to "*increase the exploratory and predictive power of economic theory by providing it with more psychologically plausible foundations*" (Angner and Loewenstein, 2010).

Studies on the cognitive architecture of the mind (Fodor, 1983) suggest that is composed of an array of interacting, specialised subsystems with somewhat limited flows of intercommunication. Many perceptual and cognitive processes work independently of each other, specialise in processing specific inputs from the environment. Brain scientists and cognitive psychologists have discovered that the brain functions as if it had two systems of decision making; one is very fast and automatic, while the other one is reflective (Epstein, 1994). It appears that while the reflective system processes the information *content*, and applies rather systematic and rational 'algorithms', a parallel process takes place in our brain by the automatic system which processes the *context* of information – such as the visual environment of the main message, applies heuristic 'short-cuts', and attaches emotions and feelings. People are influenced by images, symbols and context, i.e. the manner in which information is being presented to them. For example, a textual message coloured in red would carry an additional connotation besides the text or numeric content.

Nobel Laureate Daniel Kahneman argues that "*it turns out that the environmental effects on behavior are a lot stronger than most people expect*". In his recent book, Kahneman (2011) describes the two different ways the brain forms thoughts as *system 1* and *system 2*:

> *System 1*: Fast, automatic, frequent, emotional, stereotypic, subconscious
>
> *System 2*: Slow, effortful, infrequent, logical, calculating, conscious

Through evidence emerged from a range of experiments, Kahneman (2011) demonstrates the differences between these two thought processes, and how, given the same inputs, they produce different outcomes.

But its applications go beyond providing explanations and predictions of choice behaviours. The '*predicted irrationality*' (a term coined by Dan Ariely, 2008) of individuals could (and some argue - should) play a role in the design of behavioural change interventions. Of much relevance to the application of behavioural economics to behaviour change is the recent emergence of '*libertarian paternalism*' (Thaler and Sunstein, 2003) and modern concepts (and practices) of government associated with it. According to this political philosophy, governments could seek to influence the behaviour of individual citizens in directions that will improve their lives, but at the same time aim are commonly perceived by public and government as interventions that do not limit or enforce the choice; instead, they aim to influence individuals' choices by altering their perceptions of the objective environment, for example by altering their judgements of the consequences associated with the alternative road user behaviours, and by motivating and empowering them to behave safer while using the road environment. Responding, in part, to disappointing results from attempts to change behaviour via information (in a range of domains) behavioural economists have proposed a new approach that operates not via economic pricing and information, but by 'nudging' individual behaviour toward self-interest. Termed *libertarian paternalism*" (Thaler and Sunstein, 2003), this approach is intended to shift behaviour in self-interested directions, without limiting individuals' ultimate freedom to choose. Also known as '*asymmetric paternalism*' (Camerer *et al*., 2003) this approach is intended to encourage desired behaviours among those behaving

against individual or social well-being, without distorting the decisions of those performing desired behaviours that are in line with individual and social well-being. A specific approach to asymmetric paternalism is to use decision errors and biases that ordinarily hurt people to instead help them (as illustrated, later on by 'priming' and 'defaults' effects).

One of the terms most associated with behavioural economics, and its application to influence behaviour, is the concept of *Nudge*, coined by Thaler and Sunstein (2008, p.6):

> "*A nudge, as we will use the term, is any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives. To count as a mere nudge, the intervention must be easy and cheap to avoid*."

Another definition is given by Hausman and Welch (2010, p. 126):

> *"Nudges are ways of influencing choice without limiting the choice set or making alternatives appreciably more costly in terms of time, trouble, social sanctions, and so forth. They are called for because of flaws in individual decision-making, and they work by making use of those flaws."*

Thaler and Sunstein (2008) and Thaler *et al*. (2010) advocate the use of '*choice architecture*' to influence behavioural change; they illustrate how 'nudges', small features designed in the environment of choice making, could help individuals to overcome cognitive biases, and to highlight the better choices for them (by helping the automatic system to make better decisions) and increase the effect of behavioural change – without restricting their freedom of choice, and without making big changes to the physical environment, the set of choices, or the economic attributes of the choices. Choice architecture may be perceived by policy makers as less controversial and cheaper than larger scale interventions, which might have contributed to its recent popularity (Avineri and Goodwin, 2010).

In the public policy arena, behavioural economics is starting to become a foundation for policy-making in the UK (Dolan *et al*., 2010). The Behavioural Insights Team, often called the '*Nudge Unit*' is a team in the Cabinet Office of the UK government that "*applies insights from academic research in behavioural economics and psychology to public policy and services*."[1] Their claim was that "*new insights from science and behaviour change could lead to significantly improved outcomes, and at a lower cost, than the way many conventional policy tools are used*.' (Dolan *et al*., 2010). Their MINDSPACE report (Dolan *et al*., 2012) drew heavily on applied behavioural economic work popularised by Thaler and Sunstein's (2008) '*Nudge*', and Richard Thaler is advisor for Prime Minister David Cameron's Behavioural Insight Team. In the US, the political machinery of President Barack Obama has sought to employ Nudge Theory to advance their respective domestic policy goals. Cass Sunstein, co-author of '*Nudge*', was appointed (between 2009 and 2012) as the Administrator of the White House Office of Information and Regulatory Affairs (OIRA) in the Obama administration. Other governments, such as the Netherlands, France, Denmark and New South Wales (Australia) have growing interests in using nudge techniques.

[1] https://www.gov.uk/government/organisations/behavioural-insights-team

3. Revisiting the Paradigm of 'Planned Behaviour' in a Road Safety Context

For a long time, road users' attitudes towards safe behaviours were seen as key predictor of their behaviour. As reported in Musselwhite *et al*. (2010), much research on the safety behaviour of road users have been focused on attitudes. In these studies it is generally assumed that attitude, as a function of beliefs about the perceived consequences of the behaviour under consideration, is a determinant of intended behaviour; the individual's intention to be engaged in the behaviour is believed to have a direct effect on behaviour. For example, if one strongly believes that speed driving is dangerous, wrong, or has negative consequences, he or she will be less intended to speed, leading him or her to do less speed-driving. While some of the studies reviewed in Musselwhite *et al*. (2010) illustrate the links between road users' attitudes and their revealed behaviour, many assume the correlation between the two without providing empirical evidence to support it. Moreover, in some of the empirical studies that tested the hypothesis about attitudes as a main determinant of behaviour, it was found out that attitudes provide only a partial and limited explanation of intentions or behaviour. For example, Whissell and Bigelow (2003) found no link between attitudes toward speed driving and actual reported crashes. Studying drivers' compliance with speed limits, Elliott *et al*. (2003) found very little relationship between attitude and intention. Studying the intention to commit driving violations, Parker *et al.* (1992) found that the relation between attitudes towards behaviour and behavioural intentions was consistently weaker than other determinants of behavioural intentions. Tolmie (2006), who studied pedestrian decision-making of young adolescents, found that attitudes have influence on behaviour, but not as strong as other determinants of behaviour.

Examining the empirical evidence from the literature, Musslewhite *et al*. (2010) argued that while road users' attitudes towards safe behaviour is an important determinant of (intended) behaviour, it does not provide by itself a full explanation of that behaviour. Together with attitudes, Subjective norms and Perceived Behavioural Control form the three main determinants of behavioural intentions, according to Ajzen's Theory of Planned Behaviour (TPB) (1988, 1991) (for a review, see Musselwhite *et al*., 2010). According to TPB, the relative strengths of individual's intentions to perform alternative behaviours guide the choice between them, where the determinants of intended behaviour are a set of individual's beliefs: attitudes toward behaviour, subjective norms and perceived behavioural control.

The TPB model, presented in figure 1, with its determinants of behaviour is a powerful model for explaining and predicting human behaviour. Thousands of studies have tested the TPB in various behaviour domains. There is compelling evidence that the TPB (applied in general non-transport contexts) accounts for about 40%-50% of the variance in intentions and about 25%-30% of the variance in behaviour (see, for example, Armitage and Conner, 2001). TPB implies that changes in attitude, subjective norm, perceived behavioural control can lead to changes in intentions and behaviour. However the effect of this type of interventions is a matter of debate in both a general context and a traffic safety context. Some (e.g. Conner and Armitage, 1998) argue that more research is needed to test whether changes in beliefs lead to behaviour change, and that the TPB could be more widely used to develop and evaluate interventions.

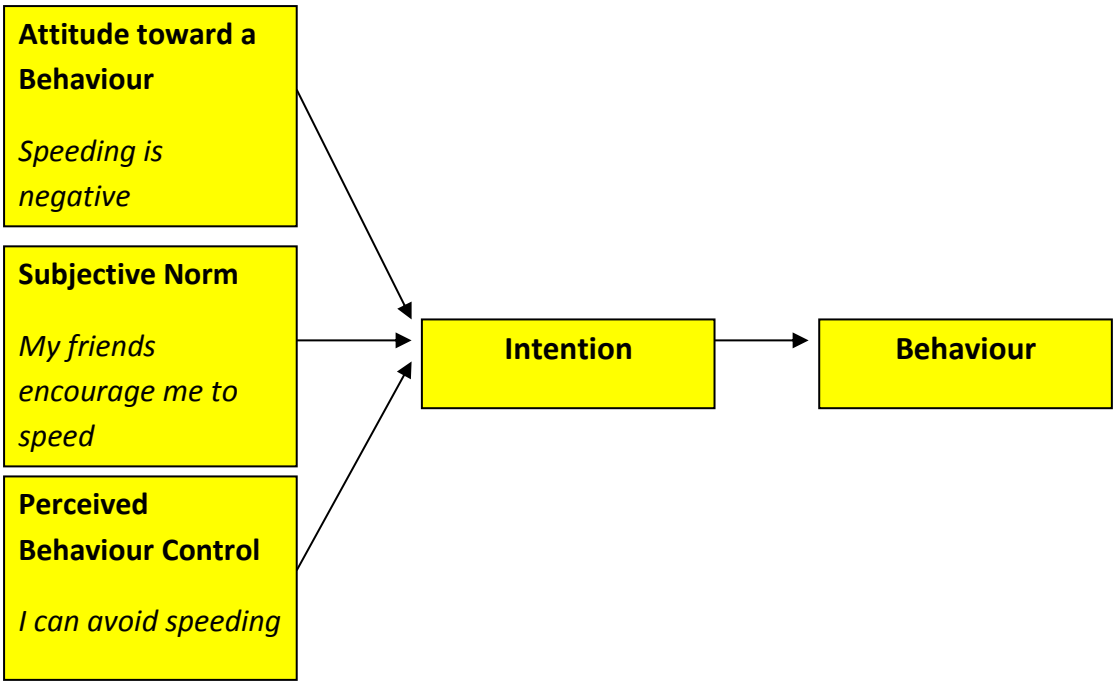


Figure 1: Illustrating the Theory of Planned Behaviour (Musselwhite *et al.*, 2010)

According to a range of theories in social psychology, behaviour is determined by beliefs and attitudes rather than utilities. Much of the psychological research on road safety behaviour has been guided by TPB. Although attitudes and believes, and their role in decision making, are explored in the field of behaviour economics, most behavioural economists would not consider social psychology theories (such as TPB) appealing for it postulates a quite strong of rationality (Avineri, 2012). Although neoclassical economics and social psychology have different views of choice making, it is argued by Avineri (2012) that rational behaviour, in its broad meaning, is still largely assumed by theories such as TPB: individuals faced with choices are assumed to perform a high-level cognitive process, a process that can be largely described as a reasoned, controlled, planned and consistent. Whilst TPB, which assumes behaviour is a product of intention, provides powerful explanation of behaviour in a wide range of contexts, it can be also argued that some behaviour occurs with little or no pre-planned intent. In that aspect behaviour (and in specific road user behaviour) can be seen in many contexts as either impulsive, habitual (Elliott *et al*., 2003; RAC, 2007) or emotional rather than planned.

One criticism of TPB had been that it was only really applicable to volitional control, i.e. the patient's wilful control over their behaviour. Reason *et al.* (1990) showed that driver violations, errors and lapses are empirically distinct classes of behaviour. '*Violations*' are defined as "*deliberate deviations from those practices believed necessary to maintain the safe operation of a potentially hazardous system*" (for example disregarding speed limit or more 'aggressive' violations). '*Errors*' are defined as "*the failure of planned actions to achieve their intended consequences*" (for example, braking too quickly on a slippery road). '*Slips and lapses*' can be defined as attention and memory failures, which can cause embarrassment but are unlikely to have an impact driving safety (Parker *et al*., 1995) – for example, get into the wrong lane approaching a roundabout.

Unlike errors and lapses, violations were seen as deliberate behaviours, although both errors and violations are potentially dangerous and could lead to a crash. Since violations, errors and lapses result from different psychological processes, they should be treated differently (Reason *et al*., 1990). The study of violations, errors and lapses, applying the *Driver Behaviour Questionnaire* (DBQ) has been used in dozens of studies (such as Lajunen *et al*., 2004; Reason *et al.*, 2001; Crundall *et al*., 2003). Reason *et al.* (2001) found that violations, not errors or lapses, are statistically linked to greater crash involvement. Not like errors, driving experience is not related to the number of lapses (Crundall *et al*., 2003). Women had more lapses than men, but fewer reported violations than men (Crundall *et al*., 2003).

Many studies in road safety behaviour research already integrate insights from psychology and other behavioural sciences without specific references to behavioural economics, choice architecture and nudges. Obvious parallels between the aims of and processes applied in behavioural economics and recent advances in road safety behaviour can be observed, although road safety behaviour research make few direct references to behavioural economics. For example, there is an emerging body of work seeking to understand behaviour by incorporating insights from behavioural sciences into road safety behaviour research, giving more weight to what are sometimes called 'irrational' motives and behaviours, leading to the development of new, and sometimes alternative, modelling approaches. Studies in road safety behaviour research suggest incorporating behavioural notions in modelling and analysis of road safety behaviour in order to improve understanding and predicting of behaviour, and to improve the effectiveness of design, planning and policy making processes. Behavioural notions that have been incorporated in road safety behaviour models and analysis might include attitudes and believes, social and cultural norms, habits, and emotions, determining human behaviour.

Although they share some similar insights with research studies in behavioural economics, the incorporation of behavioural notions into the design of road user environment, and the development of new frameworks that apply conceptual models from behavioural sciences have not directly evolved from behavioural economics; recent thinking in road safety behaviour mainly linked to works in ergonomics, psychology and sociology that some of them has also inspired behavioural economists. However, as there are so many similarities and parallels between the behavioural factors emphasised in behavioural economics and the research interests in road safety behaviour, behavioural economics might provide a useful conceptual framework to the study of travel behaviours that are not purely rational.

4. Applying the MINDSPACE Framework to Road Safety

We need to bear in mind that applications of the nudge approach to encourage safer road behaviours have not been tested in a large scale or systematically analysed in this specific context. Therefore their effectiveness remains an open question. However, the intuitive thinking associated with the nudge concept has been around for years (and some would argue – for centuries) in different guises – including in the context of encouraging road safety behaviour.

Over the last few decades the field of behavioural economics has generated a large body of conceptual and empirical models that would be relevant to the context of road safety behaviour, and it is not possible to cover all (or even most) of them. However, to provide a brief overview of some of the key findings of behavioural economics, and to highlight the main shortfalls in the neoclassical model of human behaviour, it might be useful to refer to the following key principles identified by the MINDSPACE framework.

Being a multidisciplinary field of research, with very little systematic framework applied to it, the sheer volume of theoretical concepts and empirical results emerging from the behavioural economics literature can make it difficult to apply behavioural economics in practical settings (road safety behaviour being one of them). Against this background, Dolan *et al*. (2010, 2012) presented 'MINDSPACE' as a helpful mnemonic for thinking about the effects on our behaviour that result from contextual influences (see table 1).

Messenger	We are heavily influenced by who communicates information
Incentives	Our responses to incentives are shaped by mental shortcuts
Norms	We are strongly influenced by what others do
Defaults	We 'go with the flow' of pre-set options
Salience	Our attention is drawn to what is novel and seems relevant to us
Priming	Our acts are often influenced by unconscious cues
Affect	Our emotional associations can powerfully shape our actions
Commitments	We seek to be consistent with our public promises, and reciprocate acts
Ego	We act in ways that make us feel better about ourselves

Table 1 - MINDSPACE – the role of context on behaviour.

Source: Dolan *et al*. (2010) and Dolan *et al*. (2012).

The MINDSPACE approach (Dolan *et al*., 2010, 2012), emerged from a report published in 2010 by the UK Cabinet Office, draws together evidence from behavioural economics and presents nine key effects. Although the MINDSPACE theoretical concepts have been applied to a specific toolkit developed by the UK Department for Transport (DfT, 2011), they were mainly used to illustrate their potential application in influencing travel behaviours (making them more sustainable) rather than focusing on safety issues; however there are some specific references to road safety behaviour and some relevant parallels between travel behaviour and road safety behaviour.

The next sections of this report make use of MINDSPACE as a framework to illustrate how these nine key effects have been explored in road safety or relevant contexts, provide discussion and examples of the relevance of these concepts to design which encourages (and sustain) desired road safety behaviours.

5. Messenger

We are heavily influenced by who communicates information.

We respond to who and where the message comes from – the 'messenger' - as well as to the message itself. For example, Dolan *et al*. (2010) review some of the evidence that information has more weight if experts deliver it. The weight we give to information depends greatly on the automatic reactions we have to the perceived authority of the messenger (whether formal or informal) (Dolan *et al*., 2010, 2012).

Uniforms have been found to influence honesty, helping behaviour, political behaviour, aggression, and compliance (for a review see Bushman, 1984). Bickman (1974) found that when requests were made from an individual who was perceived as an authority, compliance was higher. It was observed by Brase and Richmond (2004) that different factors, such as authority and friendliness, are affected by doctors' style of dress: casual dress decreases perceptions of authority, and also decreases perceptions of friendliness (compared to formal attire), trust (for male patients), and attractiveness. The presence of a uniformed authority figure standing at the corner of an intersection decreased overall rates of violation (rates of prohibited right turns on red lights) (Sigelman and Sigelman, 1976). Some of these effects can be associated with priming effects (see section 10 of this report).

There is also evidence that people are more likely to act on information when the messenger has similar characteristics to themselves (Durantini *et al*., 2006). We are also affected by the feelings we have for the messenger: for example, we may discard advice given by someone we dislike (Cialdini, 2007). So the individuals or organisations that provide us information about the risks associated with road user behaviours might be important for understanding and changing such behaviours. Those from lower socio-economic groups are more sensitive to demographic and behavioural characteristics of the messenger being similar to them e.g. age, gender, ethnicity, social class/status, culture and profession (Durantini *et al*., 2006).

Whilst expertise matters, so do peer effects. For example, the *'Health Buddy'* scheme involved older students receiving healthy living lessons from their schoolteachers. The older students then acted as peer teachers to deliver that lesson to younger 'buddies'. Both older and younger 'buddies' enrolled in this scheme showed an increase in healthy living knowledge and behaviour and beneficial effects on weight (Stock *et al*., 2007, cited in Dolan *et al*., 2010). Peer-to-peer education and youth-initiated monitoring of safety belt use among teens have a positive effect on teen belt use (NHTSA, 2005 and Eyler *et al*., 2010, cited in Goldzweig *et al*., 2013).

Antanas Mockus, the former mayor of Bogota, Colombia hired professional mimes to tame the city's unruly traffic. The mimes ridiculed bad behaviour and handed out thumbs-up/thumbs-down cards to help people shame bad drivers (see figure 2) and pedestrians who didn't follow crossing rules; a pedestrian running across the road would be tracked by a mime who mocked his every move. Mimes also poked fun at reckless drivers. The mimes made fun of traffic violators, because Mockus

believed Colombians were more afraid of being ridiculed than fined. The scheme has achieved dramatic success in terms of visibilization. "*It was a pacifist counterweight*," Mockus said. "*With neither words nor weapons, the mimes were doubly unarmed. My goal was to show the importance of cultural regulations*" (Caballero, 2004).

Figure 2 – A mime ridiculing bad behaviour at Bogota, Columbia.
Image source: Guillot (2013)

6. Incentives

Our responses to incentives are shaped by mental shortcuts.

"Classical" economists often emphasize that (monetary as well as other) incentives work. Generally it has been assumed that higher incentives would motivate individuals to change their behaviour and improve their performance. Financial incentives work on two dimensions. They could make a change to the market conditions and thus operate in the same way as prices to influence supply and demand; at the same time they may have a psychological effect on the individual; a rewardcan be associated with a positive meaning to the desired (incentivised) behaviour, and can be seen as a reward or positive reinforcement to encourage and maintain desirable behaviour (Avineri and Goodwin, 2010).

Direct financial incentive paid to a driver as a result of driving in a safe manner is a popular concept amongst the public (Musselwhite *et al*., 2010). UK Drivers who took the *PassPlus* course were offered a financial incentive by some insurance companies. A survey carried out for the Driving Standards Agency showed that 93% of people who had taken the course felt more confident on the road, and 80% considered that the course had improved their driving skills (RAC, 2009). Evaluation of the Pass Plus initiative in Fife (Greer, 2002) in a simple before and after study found a reduction in blameworthy accidents from 69% prior to the Fife Pass Plus Initiative to 42% after its introduction. Campaigns that use tangible incentives (such as money, prizes and vouchers) lead to substantial short-term increases in safety belt use, but have more modest longer term effects (Hagenzieker *et al*., 1997, cited in *Morrison* et al., 2003); a similar pattern of behavioural change has emerged from studies on the effect of incentives in healthy behaviours contexts (Marteau *et al*., 2009). Campaigns were most effective in elementary schools, where incentives were given immediately rather than delayed, and where the initial baseline use of seatbelts was low.

Economics has been criticized for using self-interest as a mono-motivational theory. Such theories have been criticized for being too reductive or too abstract.

Studies in behavioural sciences suggest that in addition to extrinsic (external) motivation, associated with rewards and incentives, human beings have unconscious motivations that cause them to make important decisions because of these unconscious forces (a concept associated with the work of Sigmund Freud). In psychology, motivation can be divided into two types: intrinsic (internal) motivation and extrinsic (external) motivation. In recent years the use of monetary incentives in behavioural interventions has become more common. Much evidence (mainly in the field of social psychology) suggests that using incentives could backfire, because extrinsic incentives could crowd out intrinsic motivations that are important to producing the desired behaviour (Gneezy *et al*., 2011). Research has indicated that extrinsic rewards can lead to overjustification and a subsequent reduction in intrinsic motivation. In one study demonstrating this effect, children who expected to be (and were) rewarded with a ribbon and a gold star for drawing pictures spent less time playing with the drawing materials in subsequent observations than children who were assigned to an unexpected reward condition.[6] However, another study showed that third graders who were rewarded with a book showed more reading behavior in the future, implying that some rewards do not undermine intrinsic motivation.[7] While the provision of extrinsic rewards might reduce the desirability of an activity, the use of extrinsic constraints, such as the threat of punishment, against performing an activity has actually been found to increase one's intrinsic interest in that activity. In one study, when children were given mild threats against playing with an attractive toy, it was found that the threat actually served to increase the child's interest in the toy, which was previously undesirable to the child in the absence of threat.[8]

In some situations, *Financial (dis)incentives might send the wrong message*. Although the use of financial incentives to motivate behavioural change is advocated by economists, for its economic rationale, Avineri (2012) shows how recent findings from behavioural economics suggest otherwise. For example, increased incentives can cause people to consciously think about the task, shift control of behaviour from 'automatic' to less effective 'controlled' mental processes, and narrow individuals' focus of attention on a variety of dimensions, including the breadth of the solution set been considered by individuals (Easterbrook, 1959, Langer and Imber, 1979; and Camerer *et al*., 2005, cited in Ariely *et al*., 2009b). Moreover, studies in behavioural economics show that when prices are not mentioned people apply social norms to determine their choices and effort (Heymen and Ariely, 2004). People natural motivation 'to do the right thing' and perform pro-social behaviours might be cancelled by other motivations where financial (dis)incentives are introduced. For example, introducing a penalty for parents who are late picking up their children from nursery increased the frequency of late arrivals (Gneezy and Rustichini, 2000). Generally, when people receive a financial incentive for performing a behaviour they would have done anyway, they do it less well if they perceive the payment as inadequate (Ariely *et al*., 2009a). By the same token, making 'good' road safety behaviour a matter for financial reward can discourage it. For example, penalties on illegal parking might be seen by some as a probabilistic price as a signal of market price that might substitute a social norm. Providing financial (dis)incentives to promote safe road user behaviours might be particularly problematic in light of the fact that many are motivated to drive in a safe manner by pro-social attitudes, values and norms.

It is important to remember that often incentives do motivate individuals towards the desired behaviour, and they do not usually 'backfire'. According to a

review by Gneezy *et al*. (2011), the effects of incentives depend on "*how they are designed, the form in which they are given, how they interact with intrinsic motivations and social motivations, and what happens when they are withdrawn*". Unfortunately, the literature in behavioural sciences does not provide a clear framework or model to explain and predict how incentives work.

One of the key observations of behavioural economics, called loss aversion (or gain–loss asymmetry) refers to the fact that people tend to be more sensitive to negative impacts, or losses, than to positive impacts, or gains. This effect is captured by the cognitive modelling approach developed by Kahneman and Tversky (prospect theory, Kahneman and Tversky, 1979; and its further extension, known as cumulative prospect theory, Tversky and Kahneman, 1992). Studies of so-called '*framing effects*' in a range of contexts have explored how individuals respond differentially to equivalent descriptions of the same critical information, presented in different formats. Information can be putted in a positive or negative light, emphasising choice outcomes that can be perceived as either 'gains' or 'losses', in order to focus attention either on the positive or the negative aspects of it. Across many contexts, the impact of negatively framed information has consistently been found to be stronger than the impact of the same information framed in positive terms of the same magnitude. It can be therefore hypothesized that loss framing can be incorporated in the design of a variety of information-based measures to promote safer road behaviours.

7. Norms

We are strongly influenced by what others do.

Subjective norm is an individual's perception of social normative expectations and pressures. Relevant others' beliefs that he or she should (or should not) perform a behaviour have an effect on the intended behaviour (see figure 1). For example an individual might speed if he or she believes that others (friends, family members, colleagues) might support this behaviour – even if his or her attitudes towards speed driving are negative. In their review, Musselwhite *et al*. (2010) describe much evidence from the reviewed literature that social norms do play an important role in explaining intensions and behaviours in the context of road safety. Subjective norms are one of the factors that predicted intentions to speed (Conner *et al*., 2007). The relation between subjective norms and behavioural intentions to commit driving violations was consistently stronger than between attitudes towards behaviour and behavioural intentions (Parker *et al*., 1992). Social pressure and more normative pressure for young males to speed is reported in a study by Connor *et al.* (2003), cited by Reason *et al*. (2001); this was even stronger when male passenger is present. Based on reviewed literature, Reason *et al*. (2001) suggested changing the perceived normative pressure from younger men with regard to speeding behaviour. On their study on drivers' compliance with speed limits, Elliott *et al*. (2003) found that older drivers and female drivers perceived more pressure from significant others, than younger drivers and male drivers.

In a study by WHO (2007) it was found that as young children become adolescents, peer influence becomes increasingly important, compared to the earlier strong influence of parents. For many young people, their peers are the most important people in their lives and are often also their primary source of behavioural

norms. Teenagers can be led by what is considered 'cool', not necessarily what is safe. Peer pressure can mean that young people are more likely to behave in a risky manner on the road, both as novice drivers or riders, and as pedestrians.

Large corporations and industries can influence both individual behaviour and social norms in a manner that may increase risk on the roads (WHO, 2007). For this reason, one needs to consider not only individual behaviours, but also the environmental factors – including media messages, community norms, and public and institutional policies – that may support high-risk behaviours.

Tolmie (2006) found that perceived approval/disapproval of young adolescents' different pedestrian behaviours by their parents and peers has an effect on their behaviour. Peers were seen as substantially more likely to engage in risky behaviour. Participants' self-identity and risk-taking profiles lay between parent and peer norms, being less cautious than the former, but more so than the latter. There was a gradual drift towards greater espousal of risk-taking amongst older participants, reflecting the shift in peer norms. Adolescents seem more likely to behave in risky fashion as pedestrians where parental influence is weakened.

One of the key principles of behaviour economics is that other people's behaviour matters: "*people do many things by observing others and copying; people are encouraged to continue to do things when they feel other people approve of their behaviour*" (Dawnay and Shah, 2005). Social norms, social learning, social proof, social identity, pro-social behaviour and altruism are some of the concepts applied in social psychology to explain and predict how individual's decision making is influenced by others (or more accurately, by one's believes regarding others).

Social and cultural norms are the behavioural expectations, or rules, within a society or group, or alternatively a standard, customary, or ideal form of behaviour to which individuals in a social group try to conform (Axelrod, 1986). Social norms can influence behaviour because individuals take their cues from what others do and use their perceptions of norms as a standard against which to compare their own behaviours (Clapp and McDonnell, 2000). The operation of social norms is at least partly conscious: conformity may be a deliberate strategy, since we may obtain pleasure from choosing to behave like everyone else – even though this choice may not be maximising overall utility. Dolan *et al*. (2012) bring two arguments that the effect of social norms has a powerful automatic component. There is evidence that those engaging in conformist behaviour demonstrate no awareness of having been influenced by the behaviour of others (Chartrand and Bargh, 1999). Moreover, social norms can lead to behaviour that is difficult to explain in terms of 'rationality' (Dolan *et al*., 2012).

Descriptive Norm (*What I think is common behaviour*) and past behaviour (habits) have significant effect on intention to speed above and beyond other factors measured under the Theory of planned behaviour (Forward, 2009).

Examples – how norms can work in practice to make road behaviours safer?

Providing people or organisations with information about their peers can exert a strong influence on them to modify their behaviour accordingly. In seatbelt use, the

'Most of Us Wear Seatbelts Campaign'[2] (sponsored by the Montana Department of Transportation, 2002-2003) used a social norms approach to increase the number of people using seatbelts (see figure 3). Initial data collection showed that individuals underestimated the extent to which their fellow citizens used seatbelts either as drivers or passengers: although 85% of respondents to a survey used a seatbelt, their perception was only 60% of other citizens adults did. An intensive social norms media campaign was launched to inform residents of the proportion of people who used seatbelts, and the self-reported use of seatbelt significantly increased (Linkenbach and Perkins, 2003, cited in Dolan *et al*., 2012). The MOST campaign illustrates how the primary message is a norm supported by normative data: an attitude or behaviour that is shared by more than 50% of the target population.

Similar approach of using social norms is demonstrated by the *'MOST of Us Prevent Drinking and Driving Campaign*' (2000-2003)[3] (see figure 4). The campaign successfully reduced the target population's misperceptions of the frequency of impaired driving among their peers. Linkenbach and Perkins (2005) report that follow-up surveys found a decrease in the percentage who believed the average Montanan their age drove after drinking during the previous month and an increase in the percentage who accurately perceived that the majority of their peers use a non-drinking designated driver. The change in perceptions was associated with a change in reported behaviour. In the target area there was a decrease in the percentage that reported personally driving after drinking and an increase in the percentage that reported always using non-drinking designated drivers. The campaign also affected attitudes towards impaired driving enforcement policy. Target county residents reported an increase in the percentage who would support passing a law to decrease the blood alcohol concentration (BAC) legal limit for driving to 0.08% from 0.10%. Findings were supported in an evaluation of the MOST Campaign: perceived and reported behaviour measures were collected at the U.S western "intervention" countries and was compared to eastern "control" states, using before (Nov 2001) and after (June 2003) surveys (Perkins *et al*., 2010).

Figure 3 – Use of Social Norms, *'MOST of Us Wear Seatbelts Campaign*' (Montana)
Image source: http://www.mostofus.org/project-gallery/traffic-safety/2010/most-of-us%C2%AE-wear-seatbelts-campaign-2002-2003/

[2] http://www.mostofus.org/project-gallery/traffic-safety/2010/most-of-us%C2%AE-wear-seatbelts-campaign-2002-2003/
[3] http://www.mostofus.org/project-gallery/substance-abuse/alcohol/2010/most-of-us-prevent-drinking-and-driving-campaign-2000-2003/

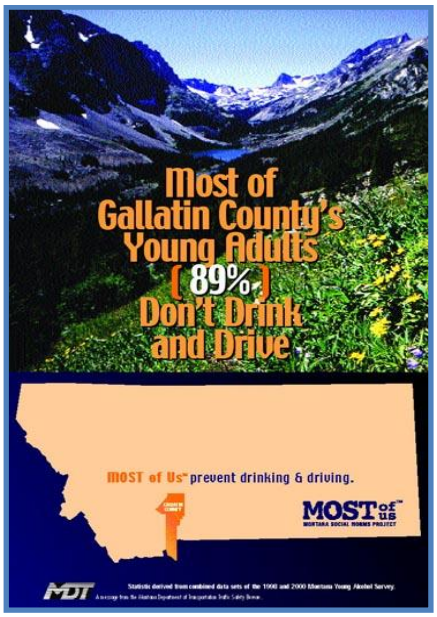


Figure 4 – Use of Social Norms, *'MOST of Us Prevent Drinking and Driving Campaign*' (Montana)
Image source: http://www.mostofus.org/project-gallery/substance-abuse/alcohol/2010/most-of-us-prevent-drinking-and-driving-campaign-2000-2003/

8. Defaults

We 'go with the flow' of pre-set options.

Loewenstein and colleagues have been advocating a specific approach to asymmetric paternalism (Loewenstein *et al*., 2007, 2013); the essence of the approach is to use decision errors that ordinarily hurt people to instead help them. For example, the status quo bias, a decision maker's tendency to stick with his/her current or default option even when superior options are available (Samuelson and Zeckhauser, 1988) can be used to help people if desired options are made the default. Many individual decisions have a default option, whether individuals recognise it or not. Defaults are the options that are pre-selected if an individual does not make an active choice (Dolan *et al*., 2012).

It is often impossible for private and public institutions to avoid picking some option as the default. Well-chosen default rules are examples of helpful choice architecture. Much of the evidence on the effect of defaults comes from financial behaviour. Defaults-based nudges were successfully applied in the US to increase savings. For example, the *'Save More Tomorrow'* plan (Thaler and Benartzi, 2000), which allows employees to commit themselves now to increasing their savings rates later, when they get raises, has been remarkably successful. Enrolling people automatically into savings plans, while allowing them to opt out, is an example of a successful nudge reported in Madrian and Shea (2001). There is also evidence that the use of opt-out defaults can be effective for organ donation rates (Johnson and Goldstein, 2003), and choice of car insurance plan (Johnson *et al*., 1993). Picking 'smart' defaults is a way to nudge towards healthy eating behaviours (Volpp *et al*. 2008; Downs *et al*., 2009). Pichert and Katsikopoulos (2008) argue that offering an

environmentally friendly source of energy as a default, more people will choose to use and buy green electricities.

Defaulting road users into desired behaviours seems like a relevant approach for road safety research and policy. However, there is not be an obvious parallel between opt-out defaults in financial, energy consumption or healthy eating contexts and road safety behaviour, perhaps indicating a gap in both research and policy. While there is no systematic research on the design of defaults into the road user environment to influence his/her behaviour, some examples of intuitive choice architecture might illustrate how road users may be defaulted into desired behaviours..

Example of defaults: setting default pedestrian routes

Environmental graphic design of elements incorporated in directional and wayfinding systems may 'nudge' road users towards specific directions or modes, reducing crowding, congestion, and conflicts between road users in the built environments, reduce navigation errors, encourage sustainable travel, and improve the user experience. For example, at rather crowded Paddington station, London, directions towards the underground lines, car parking, and other popular destinations (see figures 5-7). Such choice architecture applications aim to set specific routes to be more attractive to pedestrians. This choice architecture could be seen as an implementation of *default* and *priming* concepts.

Figures 5-7: Setting default pedestrian routes, Paddington, London
Images source: pictures taken by Erel Avineri

Example of defaults: locating near-side crossing signals

In many countries, Israel among them, the walk signal at pedestrian crossings is located at the far side of the crossing. A pedestrian facing a walk signal may cross the road in the direction of the signal. While crossing, although pedestrians have the right-of-way over vehicles, they are exposed to cross-traffic and other road hazards, and therefore should pay attention to it. However, it is argued that some segments at the pedestrian population tend less than others to pay attention to cross-traffic while crossing. Of specific importance is the beginning of the crosswalk, where pedestrians step down the sidewalk.

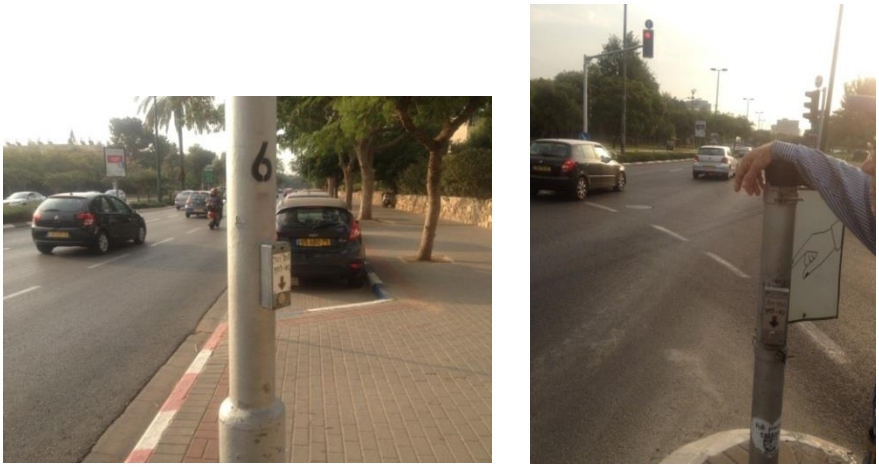
A British development, a Pedestrian User Friendly Intelligent, or 'PUFFIN' (and a similar version of it, 'TOUCAN') crossings are now commonplace in the UK (with other countries following, such as Australia and New Zealand). Like

'PELICAN', the older type of pedestrian crossing with far-side signals, they are signal controlled crossing points where a pedestrian is able, through use of a button, to call a red light and halt the traffic. The main operational difference between a standard crossing and a PUFFIN crossing is the configuration of the information display for the pedestrian (see Austroads, 1995). The information for a standard crossing is presented on the opposite side of the street. In contrast, the pedestrian information for the PUFFIN and TOUCAN are located above the push button on the same side as the pedestrian, and is oriented to focus the pedestrian's attention in the direction of approaching traffic. These are known as near-side signals (see figures 8-9). These signals are gradually replacing the Pelican which is the older type of pedestrian crossing at the UK with far-side signals.

This design of crossing can be seen as an intuitive application of choice architecture, setting pedestrian's visual attention towards coming traffic as a default, which is of specific importance for those pedestrians who do not have a natural tendency to pay attention to traffic. Also, evidence show that such design has increased rate of compliance with red single compared with far-side crossing. A UK-based comparative study (Walker *et al.*, 2005) between PUFFIN crossings and Pelican crossings found that compliance was higher at the PUFFIN crossing. A New Zealand study into compliance with the pedestrian signals reported that the PUFFIN crossing was found to result in a higher rate of compliance than the standard crossing.

A different design, of a combination of far-side signal and a near-side push button can be found at several crossing in Israel, might be seen as a 'nudge in the wrong direction'. At some locations, the near-side push button is oriented against the direction of approaching traffic (see figures 10-11). This design is against the intuitive thinking of choice architecture – as defaulting pedestrians to focus their attention against the direction of oncoming traffic while pushing the button does not seem to carry any advantage for pedestrians or other road users.

Figures 8-9: Near-side crossing, Bristol, UK
Images source: pictures taken by Erel Avineri



Figures 10-11: Signal crossing with near-end push buttons,
Roul Wallenberg Street, Tel Aviv (left), Bney-Efrayim Street, Tel Aviv (right)
Images source: pictures taken by Erel Avineri

Example of Defaults: Default Activation of Intelligent Speed Adaptation

An ISA (Intelligent Speed Adaptation) system studied in Lai and Carsten (2012) was by default enabled upon engine ignition but drivers could override the ISA control by pressing a button located on the steering wheel (i.e. the right button in figure 12). Once the system was overridden, the driver was able to go over the speed limit. The ISA control would be resumed when the vehicle's speed dropped below the current speed limit, or the vehicle reached a new speed zone, or the driver voluntarily opted back in (by pressing the left button in figure 12). Once the ISA system was re-engaged, the driver would have to override it again in order to go over the speed limit. The occurrence of user overriding was logged. Lai and Carstern (2012) observed that the ISA system has a distinctive effect in terms of transforming the speed distribution. Speeds over the speed limit were curtailed. When ISA was switched on, a large proportion of the speed distribution previously spread over the speed limit was shifted to around or below the speed limit. ISA not only diminished excessive speeding, but also led to a reduction in speed variation, which has been argued to be significantly correlated with accident occurrence.

Figure 12 – The ISA HMI developed in the UK ISA project.
Image source: Lai and Carsten (2012)

9. Salience

Our attention is drawn to what is novel and seems relevant to us.

Our behaviour is greatly influenced by what our attention is drawn to (Kahneman and Thaler, 2006). People are more likely to register stimuli that are novel, accessible and simple (Dolan *et al*., 2012). Simplicity is important here because our attention is much more likely to be drawn to things that we can understand.

Without feedback, a behavioural change is less likely. For example, direct feedback on energy consumption (e.g. smart metre reading) was found to have an impact ranged from 5% to a 15% reduction in energy use (Darby, 2006). A specific challenge travel planners are faced with is how to visualise and contextualize feedback on the environmental costs of journeys (Waygood and Avineri, 2013).

Many drivers have already experienced such nudges; the high-pitch sound alert when driving over the speed limit or when leaving a lane serves as a nudge to provide the driver feedback (Avineri and Goodwin, 2010).

Habit might act as a major obstacle to pedestrians accustomed to road environments being free of cars or of low traffic volumes. Some of them might be used to crossing without looking. Even with well-designed nudges, this behaviour may be difficult to change. An example brought by Thaler *et al*. (2010) is of visitors to London who come from other countries and have spent their entire lives expecting cars to come at them from the left, and their '*system 1'* (the 'automatic system') knows to look that way. However, in the UK car traffic is on the left-hand side of the road - and so the danger often comes from the right. The city of London tries to help with choice architecture: on many corners (especially in neighbourhoods frequented by tourists) the pavement has signs that say 'look right', with an arrow directed towards coming traffic (Thaler *et al*., 2010) (see figure 13). Thaler and Susnstein have advocated this example of choice architecture demonstrating how expecting human errors could be taken in a good design of the choice making environment to make people make better choices (as judged by themselves). A similar approach can be found in the design of signs reminding pedestrians and bicyclists to look both ways before attempting to cross train tracks or bus lanes, where traffic might come from both directions (see figures 14-18).

Figure 13 – "Look right" road sign, London.
Image source: http://zmilkygoeslondon.blogspot.co.il/2006/09/look-right-look-left_26.html

Figure 14 - One of the signs reminding pedestrians and bicyclists to look both ways before attempting to cross train tracks (Sound Transit's new Central Link light rail system)
Image source: http://www.nwprogressive.org/weblog/2009/07/live-from-link-testing-testing.html

Figures 15-18 - Signs reminding pedestrians to look both ways before attempting to cross bus lane at Jabotinsky Road, Petach Tikva, Israel.
Images source: Pictures taken by Erel Avineri

10. Priming

Our acts are often influenced by unconscious cues.

Priming of knowledge in memory makes it more accessible and therefore more influential in processing new stimuli (Richardson-Klavehn and Bjork, 1988, cited in Dolan *et al.*, 2012). Priming shows that people's later behaviour may be altered if they are first exposed to certain sights, words or sensations. In other words, people

behave differently if they have been ‘primed’ by certain cues beforehand. Priming seems to act outside of conscious awareness (Dolan *et al*., 2012).

Many of the examples brought in this section can be considered as a specific type of priming, *associative priming*. In associative priming, the target is a word/image that has a high probability of appearing with the prime, and is "associated" with it but not necessarily related in a direct way. An example of associative priming was done by Bargh *et al.* (1996). Subjects were implicitly primed with words related to the stereotype of elderly people. While the words did not explicitly mention speed or slowness, those who were primed with these words walked more slowly down the hallway when leaving the experiment than did those who were primed with neutral stimuli, consistent with the content of that stereotype.

Avineri and Goodwin (2010) note that some of the instruments used as a matter of course in road design, to influence driving behaviour, have been standard practice for many years, and include the use of gateways, sightlines, coloured or textured road surfaces. These can be interpreted as a form of nudge in traffic calming applications, affecting perceived speed and safety rather than actual conditions.

Example: Speed Reduction Markings

Optical speed bars are one of many tools in a traffic engineer’s toolbox that may be applicable at a site given its specific conditions. They are not to be confused with rumble lines.

Rumble lines are a mean to reducing speed before roundabouts, curves, intersections or other places where speed reduction is a need. The rumbling effect of the rumble lines make the driver aware of the potential dangerous situation, and hopefully make him or her reduce the speed (see figures 19-20). There are other examples of road marking indicating the driver he or she should slow down.

Figures 19-20: Yellow rumble lines applied in Haifa, Israel before a right curve.
Image source: http://www.geveko-markings.com/road-marking/news-from-geveko-materials/item/article/rumble-lines-reducing-speed-in-7-years-in-israel.html

A different approach to calm traffic, and reduce driver's speed is the use of *optical speed bars* (also known as *speed reduction markings*, *SRMs*); transverse lines configured such that the spacing between the lines decreases as the hazard is approached, thus creating an optical illusion of acceleration to the driver and the

impression of traveling faster than intended, thereby causing driver's to slow down. This would be especially useful in school zone applications.

The curve at Lake Shore Drive and Oak Street in Chicago is a one of Thaler and Sunstein's favourite nudges (see figure 21)[4]. The tight turn makes it one of the city's most dangerous curves. To try and limit wrecks, in September 2006 the city painted a series of white lines perpendicular to traveling cars. The lines get progressively narrower as drivers approach the sharpest point of the curve, giving them the illusion of speeding up, and nudging them to tap their brakes. According to an analysis conducted by city traffic engineers, there were 36% fewer crashes in the six months after the lines were painted compared to the same 6-month period the year before (September 2006 – March 2007 and September 2005 – March 2006)[5].

Figure 21: The curve at Lake Shore Drive and Oak Street in Chicago.
Image source: http://nudges.org/?s=lake+shore+drive

VDOT (Virginia, US) crews installed optical speed bars at two sites: Lee Chapel Road and Route 460 through Town of Zuni (Arnold and Lantz, 2007) (see figures 22-23). A pattern used at a site in New York was used for installing the bars. It consisted of 31 bars over a length of 530 feet. The spacing between the bars varied from 24 to 12 feet.

At the Lee Chapel Road, although a large number of statistically significant decreases in speed occurred after installation of the optical speed bars, with the higher decreases ranging from 8% to 12% at specific stations, most of the decreases were much smaller and it is questionable whether the decreases in actual speeds are practically significant. At the Route 460 Zuni site, a thermoplastic tape used for the

[4] A video simulating the Lake Shore Drive effect can be found on the original amazon page for the hardcover edition of Nudge. The Lake Shore Drive effect is in the video titled "*Richard Thaler Explains the Nature of Nudges*" The key footage is about halfway through: http://www.amazon.ca/gp/mpd/permalink/m2011H7OK5GKM0

[5] http://nudges.org/?s=lake+shore+drive

markings produced a slight bumping when motorists rode over the bars, similar to what occurs with cross-lane rumble strips. The effect was not as pronounced as only one layer was placed for the bars versus the typical two layers of tape for the rumble strips. The noise impact of traveling over the bars was also less because of the single layer versus the double layer. Speed decreases were generally higher in Zuni, where the speed bars were 8.5 feet wide and placed in the center of the travel lanes, than on Lee Chapel Road, where the bars were 18 inches wide and placed on the edges of the travel lanes. Based on their analysis, Arnold and Lantz (2007) have concluded that:

- Optical speed bars are effective in reducing the speeds of vehicles approaching a hazardous roadway section, a reduced speed zone, or other roadway/travel change area. The reductions in speeds may be small.
- Optical speed bars that extend across the travel lane are more effective in reducing speeds than those that just extend a short distance from the centerline or edge line.
- If thermoplastic tape is used for installation of the optical speed bars, motorists traversing the bars experience a slight bumping effect, similar to that with rumble strips but less pronounced and not as noisy. This experience likely enhances the effectiveness of the bars in reducing speeds.

The study has recommended that VDOT's Traffic Engineering Division and regional traffic engineers should consider the use of optical speed bars as a safety countermeasure to be placed just in advance of a hazardous area, a reduced speed zone, or another roadway/travel change area where the number of crashes is higher than expected or where excessive speeding occurs.

The detailed design, application, placement, guidance, options and support provisions for SRMs can be found in the U.S. 2009 Manual on Uniform Traffic Control Devices (the 2009 MUTCD)[6]. According to the 2009 MUTCD, SRMs are transverse markings that are placed on the roadway within a lane (along both edges of the lane) in a pattern of progressively reduced spacing to create the illusion that drivers are driving faster than they really are, thus persuading them to slow down (Federal Highway Administration, 2009).

[6] http://mutcd.fhwa.dot.gov/pdfs/2009r1r2/pdf_index.htm

Figure 22. Optical Speed Bars on South End of Lee Chapel Road Installation (Virginia, US).
Top: View Looking North. Bottom: View Looking South.
Source: Arnold and Lantz (2007).

Figure 23. Optical Speed Bars on Route 460, West Side of Zuni (Virginia, US).
Top, View Looking East. Bottom, View Looking West.
Source: Arnold and Lantz (2007).

According to the Chinese national standard Road Traffic Signs and Markings, SRMs are used to warn drivers of the need to reduce their speed (Standardization Administration of the People's Republic of China, 2009). SRMs are placed on or in advance of horizontal or vertical curves, tunnels, or other featured roads where drivers need to slow down in advance. The pattern of SRMs (which are classified as transverse markings) in the 2009 MUTCD is similar only in being transverse, otherwise not to LSRMs in China (Ding *et al*., 2013) (see figure 24). Unlike speed reduction markings in the 2009 MUTCD, TSRMs in China traverse the lanes, so that drivers may feel slight vibration due to the elevated transversal bars created by the thermoplastic paint (such as applied in the Zuni case study, Arnlod and Lantz, 2007). Chinese SRMs include longitudinal speed reduction markings (LSRMs) and transverse speed reduction markings (TSRMs); both can be audible and vibratory (Ding *et al*., 2013). The patterns of SRMs were shown in figures 24(a) and 24(b). The national standard describes detailed design requirements, including the size, length, width, spacing, as well as the placement location.

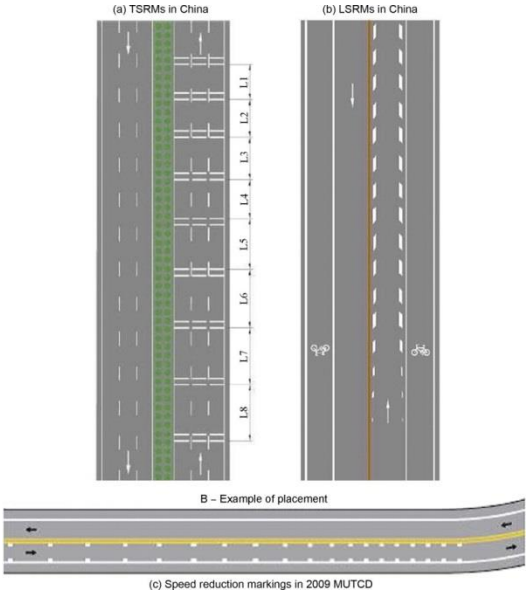


Figure 24 – Speed reduction markings in China and the U.S
Image source: Ding *et al*. (2013)

Analyzing data collected in a driving simulator to test the effect of SRMs, Ding *et al*. (2013) concluded that almost all subjects were influenced by SRMs, and the majority of subjects agreed that SRMs made them slow down. SRMs had an effect on subjects' speed choice, and TSRMs made more subjects decelerate than LSRMs; the magnitude of speed reduction due to TSRMs was significantly greater than that due to LSRMs. Under this experimental environment, TSRMs were found to reduce vehicles' speed; the speed drop reached 10 km/h at the location of 300m from the beginning of the 521m downhill section. SRMs, particularly TSRMs, had a significant effect on the number of subjects decelerating, the deceleration rate, and accelerator/brake pedal response.

Example: The effect of trees on driving speed

An innovative approach which applied similar conceptual design has been applied in four Norfolk (UK) villages[7] [8]. The planting of trees and hedges was designed to reduce speed "by playing with the driver's peripheral vision". One technique involved placing trees – at decreasing distances apart – on the approach to a village, tricking drivers into thinking they were speeding. "If you are staying at a constant speed, your peripheral vision [which takes in the trees] is giving you the impression you are going faster," explained Mr Hallett. Another method was to plant trees "*so that it looks like the environment is closing in on the driver*", he added. The road remains the same width but trees are planted on a 'lazy diagonal' that gets narrower towards the entrance to the village[9] (see figure 25). According to scheme evaluation by King and Chapman (2010), three of the four villages planting schemes reduced combined traffic speed as measured in both directions. In quantitative terms, the mean speed tended to reduce by about 1.5%, or just less than 1mph, whilst the proportion of vehicles driving between 40 and 50mph or between 50 and 60mph tended to fall by about 20%. This is considered a considerable success as it manages to reduce traffic speed and presumably improve safety whilst at the same time using interventions that are in keeping with and enhance the rural setting.

Figure 25 – Trees planted in Norfolk speed cut scheme.
Image Source: King and Chapman (2010).

[7] BBC, 17 August 2010. "*Trees planted in Norfolk speed cut scheme*". http://www.bbc.co.uk/news/uk-england-norfolk-11000299

[8] The Independent, 15 August 2010. "*Tree scheme slows down fast drivers*". http://www.independent.co.uk/life-style/motoring/motoring-news/tree-scheme-slows-down-fast-drivers-2053057.html

[9] A BBC video of the scheme can be found at: http://www.bbc.co.uk/news/uk-england-norfolk-11000299

Example: A speedometer designed to capture a change in the impact force

The following example applies similar design concepts demonstrated by SRMs (discussed above) to the vehicle environment.

Rumar (1999) argues that speeds are increasing because speed is less noticeable in modern cars; he suggested that speedometers are inaccurate and should instead show kinetic energy. Research has shown that twelve factors influence speed levels; most of them are driver perceptions and attitudes that increase speed; only one of them reduces speed. An alternative design of a speedometer, illustrated in figure 26, demonstrate how a change in the impact force can be better captured (for example, the impact force change associated with a speed reduction from 30 to 40 km/hr is 1600-900=700, while the impact force change associated with a speed reduction from 100 to 110 km/hr is 12100–10000=2100). Similar to the conceptual design of SRMs, this alternative design of a speedometer might give the driver the sensation that driving speed is over-increasing, signalling him or her to slow down.

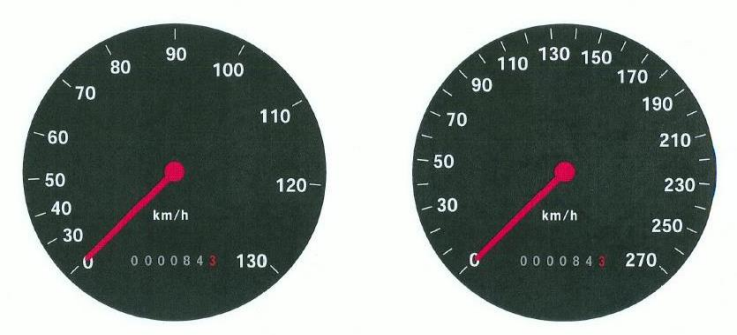


Figure 26 – an alternative design of a speedometer to capture change in the impact force.
Image Source: Rumar (1999)

Example: The effect of subtle eye-like cues on behaviour

Recent literature has shown that people are sensitive to subtle cues of being watched. In particular, it was demonstrated that the mere presence of pictures of a pair of eyes, or an eye-like stimulus, led to significant increases in donations to strangers in dictator games (Haley and Fessler, 2005, Oda *et al.*, 2011, Rigdon *et al*., 2009 and Nettle *et al*., 2013, cited in Baillon *et al*., 2013), increased donations to a public good (Burnham and Hare, 2007), and induced greater disapproval of moral transgressions - violations were more strongly condemned in a condition where participants were exposed to surveillance cues using an image of eyes (Bourrat *et al*., 2011). Bateson *et al*. (2006) found that participants will contribute more money to an 'honesty box' in the presence of an image of a pair of eyes. Similarly, Powell *et al*. (2012) found that displaying pictures of eyes on charity collection buckets in a supermarket increased donations. Ernest-Jones *et al.* (2011) showed that placing pictures of eyes in a university cafeteria that required diners to clear their own trays halved the odds of littering. Baillon *et al*. (2003) found that pictures of eyes led to more pro-social behaviour in interaction tasks; subjects gave more money to strangers and were less likely to destroy the endowment of others in response to eyes cues. The common interpretation of the eye effect is that pictures of eyes trigger feelings of being watched, which in turn activate reputation concerns and subsequent behavioural

changes. The effect of pictures of eyes on behaviour may be caused by a social exchange heuristic that works to enhance mutual cooperative behaviour (Baillon *et al*., 2013).

The UK *THINK!* marketing programme has drawn heavily on behavioural research. It was found that for drug drivers there is a strong view that there was no way they could be caught '*Can see it in eyes*' campaign was designed to redress this (O'Sullivan, 2011) (see figures 27-29). Applying images of eyeballs, this campaign aims to make drivers more sensitive to subtle cues of being watched. Eyeballs have been featured in the campaign for another reason. When a person is under the influence of drugs his/her eyes show it, opiates like heroin and methadone create tiny pin prick pupils. At the other end of the scale, stimulants like coke and speed cause massive saucer pupils, easy to spot in any light. The most obvious effect of cannabis is that it causes the blood vessels in the eyes to become larger (see figure 27). Taking ecstasy significantly enlarges the size of pupils (*mydriasis*) (see figure 28). The short-term physiological effects of cocaine include constricted blood vessels and enlarged pupils (see figure 29).

Figures 27-29 – Eye-like stimulus - THINK! Drug Driving Campaign

Images Source: http://drugdrive.direct.gov.uk/

11. Affect

Our emotional associations can powerfully shape our actions.

Emotional responses to words, images and events can be rapid and automatic, so that people can experience a behavioural reaction before they realise what they are reacting to (Dolan *et al*., 2010). Moods (rather than deliberate and international decisions) can influence judgments, meaning they end up contrary to rational thinking or self-interest.

Fear and threat appeals have been used widely in road safety advertising to provoke fear, anxiety or apprehension in the target audience. While there is much interest in the use of threat appeals, after many years of scientific research its effects are far from clear and unequivocal. Reviewing the literature on fear appeals Elliott

(2003) concluded that road safety media campaigns should use fear with caution as fear arousal can have both facilitating and inhibiting effects and can lead to defective coping mechanisms. A number of studies have found that, perhaps against intuition, exposure to fear appeals (e.g. mortality salience) can elicit maladaptive responses (e.g. Schoenbachler and Whittler, 1996; Witte *et al*., 1998; Taubman Ben-Ari *et al*., 1999), that is, responses that do not try to control or remove the threat implied by the fear message but attempt to cope with unpleasant feelings that result from the advertisement.

Perception studies demonstrate how little people actually see when they are not paying attention (Mack and Rock, 1998; Simons and Chabris, 1999; Chabris and Simons, 2010). The explanation lies in a relatively recent discovery in the field of psychology called *inattentional blindness*, a situation in which a stimulus that is not attended is not perceived, even though a person is looking directly at it. *Cognitive conspicuity* (or '*mental visibility*') provides some explanation to inattentional blindness, which is greatly increases if a stimulus is relevant or meaningful to the observer.

Example – The Think! Named Riders Campaign

Research suggests that attitudes of drivers towards motorcyclists may be important in how such interactions are treated on the road and hence has implications for road user safety. Crundall *et al*. (2008) suggest the most negative attitudes towards motorcyclists on the road tend to come from the least experienced drivers and this group in turn also has poorer skills in dealing with motorcyclists on the road. They suggest greatest empathy towards motorcyclists comes from drivers who are motorcyclists themselves. Empathy tends to be brought about by a perception of attachment (kinship, friendship, familiarity, similarity) to others and is displayed by a deliberate attempt to take the other's perspective (Batson and Shaw, 1991).

Research suggests empathy is important in a motorcycle safety context. Car drivers who are also motorcyclists have fewer accidents with motorcyclists when driving than drivers with little or no motorcycling experience (Magazzu *et al*., 2006). Drivers who have family members or close friends who ride motorcycles are less likely to collide with motorcycles, and showed better observation of motorcycles than drivers who did not (Brooks and Guppy, 1990). Fylan *et al*. (2006) suggested that they are mentally prepared for motorcyclists and this is as a result of empathy rather than just experience alone. Musselwhite *et al*. (2012) reports on more empathy from those that had previously ridden, and empathy from those with family or friends who rode. Least empathy came especially from females, especially those who had never ridden a motorcycle.

Following studies that associated empathy towards motorcyclists, awareness, and road safety behaviour of drivers, the UK Department for Transport (DfT) launched at 2010 a motorcyclists campaign, "*Named Riders*" which was part of the overall UK Road Safety campaign programme under the *Think!* banner and aims to reduce deaths and serious injuries amongst motorcyclists by 'humanising' them in the eyes of car drivers. The campaign's message was that motorcyclists are a wide range of people, with names, personalities and families just like car drivers (see figures 30-32). The creative work itself encourages drivers to think about the person on the bike by introducing some of them, with all their foibles. TV introduced a number of bikers,

accompanied by a soundtrack that quite literally suggested that drivers might like the bikers that they got to know. The resulting campaign idea sought to 'reveal' motorcyclists to drivers in order to encourage them to think of bikers as humans, just like them. Using a variety of media, the creative work itself encourages drivers to think about the person on the bike by introducing some of them, with all their foibles. The campaign effectively helped to change perceptions and shift attitudes by encouraging drivers to think about the person riding the bike, but there hasn't been a direct evaluation of behaviour change following the campaign.

Figures 30-32 – media items of the *THINK!* "Named Riders" Campaign
Images source:
http://www.125ccsportsbikes.com/forums/index.php?app=nexus&module=payments&section=store&do=item&id=2

12. Commitments

We seek to be consistent with our public promises, and reciprocate acts.

Individuals tend to procrastinate and delay taking decisions that are likely to be in their long term interests (O'Donoghue and Rabin, 1999). Even the very act of writing a commitment can increase the likelihood of it being fulfilled, and commitment contacts have already been used in some public policy areas (Cialdini, 2007). There have been a range of instances where individuals are willing to self-impose costly deadlines to help them overcome procrastination (Ariely and Wertenbroch, 2002). Commitment devices have been used for a range of behaviours, such as improving physical behaviours and charitable behaviours with very large effect sizes (Metcalfe and Dolan, 2012).

Signing safety pledge cards has been one of the road safety measures reviewed in Banks *et al*. (2010). Applications are illustrated in figures 33 and 34.

At March 2012 the Israeli Association for Safer Driving ('Or Yarok') has launched a drink driving campaign[10]. One of its elements was a pledge, distributed among youth clubs (such as the scouts). Youth club members have signed a pledge committing not to drive under the influence of alcohol, and look after their friends, ensuring they won't drive if they have had too much to drink.

An initiative by the Israeli city of Ashdod, the Ministry of Education in Israel, and the 'Children Parliament' (a children leadership body, comprised of pupil representatives from the city schools) a road safety campaign was launched in February 2012; primary school pupils were encouraged to sign (by members of the 'Children Parliament') a pledge, in which they commit the follow ten safety rules.

Figure 33 – A '*Teen Task Force*' pledge card; an item of an educational awareness program for teen drivers and their parents, *'The ART of Driving*' (US)
Image source: http://www.theartofdriving.org/takeaction/pledge.html

[10] http://www.nrg.co.il/online/1/ART2/348/197.html (in Hebrew)

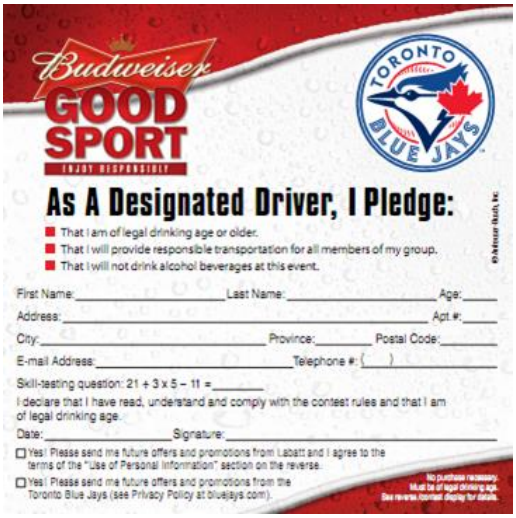


Figure 34 – A designated driver pledge card, *'Budweiser Designated Driver Programs'* (Canada)
Image source: http://gsri.worldwidebrewingalliance.org/img/Pledge_Card.png

Figure 35 – A pledge card – Ashdod Municipality (Israel) (in Hebrew)
Image source: http://www.ashdod.muni.il/Edu/volanteer/Pages/Amana.aspx

13. Ego

We act in ways that make us feel better about ourselves.

We attempt to behave in ways that support the impression of a positive and consistent self-image. People's road safety behaviour may be linked to their ego and identity, so changing this through using saliency could change people's behaviour.

This concept can be demonstrated by the effect of competitions on people's motivation to change behaviour. For example, an educational program aimed at increasing seat belt use among teens, providing resources and incentives were provided to generate peer-to-peer motivation. Schools competed against one another to see which could achieve the highest seat belt usage rate leading to an increase in seat belt usage at the participating high schools (Houston *et al*., 2010).

Figure 36 illustrates a competition on traffic safety knowledge among adolescents.

Figure 36 –Road Safety Competition, Somerset County, England.
Image source: http://www.somersetroadsafety.org/userfiles/downloads/27/0535ScoolsCompetitionR6-page-001.jpg

Thackery *et al.* (2009) describe the advantage of involving the target audience in the creative process. The increased engagement and loyalty to the programs by those who are invested in programs are more likely to generate intentions to engage in desired behaviours. They may be also more likely to talk to their friends and associates about what's being communicated. These communication strategies are more cost-effective to produce, and when developed by the audience for the audience, have enhanced potential to resonate with the target audience. Consumer generated promotion may be more successful because it is in essence; created for the people by the people. Dougherty *et al.* (2008) discovered that online creators of content are motivated to create, publish and share content for their own self-interest or personal incentives and creators often feel gratified, with an increased in their sense of self-esteem. These findings suggest that users who create content for social causes may want to change the society they care about for the better. Faulks (2011) describes how peer influence (also associated with the '*messenger*' and '*norms*' effects, see sections 5

and 7) has been harnessed by bodies such as the Australian Road Traffic Authority (RTA), Transport Accident Commission (TAC) and Victoria Department of Transport (VicRoads) which have involved young road users in the creative process by assisting in the generation and production of advertising. Road safety advertisers are engaging users online. For example, in the Australian *'Make a Film, Make a Difference'* (MAFMAD)[11] campaign young people create their own road safety advertisements and submit them to Traffic Accident Commission. Winners get production support to enhance their advertisement, which are then shown in cinemas. The TAC developed this competition as part of its marketing strategy that targets risk taking behaviours amongst 16-25 year olds. Advertisements were placed on the MAFMAD YouTube channel and are shared by their creators on social networking site such as Facebook (Banks *et al*., 2012).

14. Concluding Comments

This paper has sought to offer an insight into some of the challenges and opportunities associated with theory and evidence emerge from behavioural economics, choice architecture and 'nudge' thinking and their applications to a context of road user safety. What is evident is the considerable diversity of factors that are likely to explain systematic deviations of human behaviour from the predictions of rational models, and the potential application of contextual design and other insights emerge from behavioural economics to the design of behaviour change measures and policies in transport through choice architecture and 'nudges.' Although not an exclusive framework of behavioural economics applications to the design behavioural change initiatives, the MINDSPACE framework was found useful to map a range of such applications. For the convenience of the reader, table 2 provides a summary the nine key concepts of it together with some examples made in a road user behaviour context.

What is the Theory?	**How can it work in practice in a road safety context?**
Messenger - We are heavily influenced by who communicates information	Information about risks associated with certain types of behaviours is more likely to be acted on if communicated by a person or organisation seen to have authority and to be 'independent'; by an individual who has similar characteristics to us; or by someone for whom we have positive feelings. Example: Peer-to-peer education and youth-initiated monitoring of safety belt use among teens.
Incentives - Our responses to incentives are shaped by mental shortcuts	Making 'good' road safety behaviour a matter for financial reward might discourage it. For example, penalties on illegal parking might be seen by some as a probabilistic price as a signal of market price that might substitute a social norm.
Norms - We are strongly influenced by what others do	Providing people or organisations with information about their peers can exert a strong influence on them to modify their behaviour accordingly. Examples - inform residents of

[11] http://www.mafmad.com.au/

	the proportion of people who perform desirable behaviours (e.g. use seatbelts, do not drink and drive).
Defaults - We 'go with the flow' of pre-set options	Locating pedestrians' near-side signals or push buttons on the same side as the pedestrian, oriented to focus the pedestrian's attention in the direction of approaching traffic, making it a default direction for observing traffic.
Salience - Our attention is drawn to what is novel and seems relevant to us	high-pitch sound alert when driving over the speed limit; 'look right/left/both ways' signs reminding passengers to look at the direction of coming traffic.
Priming - Our acts are often influenced by unconscious cues	Physical features of the road infrastructure may subconsciously trigger certain behaviours, e.g. more responsible driving (example – speed reduction marking).
Affect - Our emotional associations can powerfully shape our actions	For example, road safety campaigns have sought to reinforce the emotional consequences of traffic accidents for those affected. Example - campaigns to increase awareness and empathy towards other road users (such as motorcyclists).
Commitments - We seek to be consistent with our public promises, and reciprocate acts	Individuals and organisations who make a public commitment to change their road safety behaviour in some way (e.g. signing safety pledge cards) are more likely to sustain their change in behaviour, particularly if they have the support of others trying to do the same.
Ego - We act in ways that make us feel better about ourselves	An educational program aimed at increasing road safety behaviour, providing incentives to generate motivation through competition.

Table 2: Nine Key Effects of MINDPACSE Applied to Road Safety Behaviour Context.

However, Avineri and Goodwin (2010) argue that one of the limitations of the 'nudge' strategy is that being designed to influence individuals' behaviour through intuitive and impulsive processes of the automatic system they do not address the fundamental problem of behavioural change. Nudges work best on unintentional/automatic behaviours ('*System 1*') within a controlled context, however they are not designed to change the decision making process of the reflective system (*'System 2*'). They do not make an objective improvement to the choice set or to the choices' attributes and utilities. Moreover, not like some of the traditional measures (such as education), they do not lead directly to a real change to the individual's knowledge, attitudes or values towards sustainable travel choices. It might thus be difficult to maintain and achieve long-term and sustainable behavioural change just by designing measures that are based on the nudge approach, as without promoting and maintaining sustainable road safety behaviour through values and attitudes, their effects are likely to be cancelled. Moreover, it is not possible to control the overall context in which nudge initiatives are introduced – and behavioural change achieved by choice architecture might be easily offset by unintended effects.

The incorporation of principles and behavioural notions used in behavioural economics in a road safety context, and the use of choice architecture in the design of planning, design and policy measures, have already become subjects of professional and academic debate and undoubtedly will remain such in the future. There is a need to outline a research agenda regarding behaviour change in a road user safety context. The following is a first attempt to identify several priorities for such an agenda.

- There is a need for critical evaluation of the robustness of evidence and findings that have emerged from the study of human behaviour in decision making environments associated with economic and financial or other contexts to road safety contexts .
- Awareness of road safety experts, engineers, planners, urban designers, vehicle designers, educators and policy makers to behavioural economics theory and evidence among might be limited. Dissemination of research findings to these communities, and the incorporation of relevant contents in the curriculum of academic and professional studies in road safety might help in raising the awareness to the potential use of behavioural economics in applied road safety contexts .
- Further investigation of contextual effects on individual perceptions and behaviours; generally, there is a need to develop tools that might inform the design and evaluation of effective choice architecture in the road environment.
- Above all, it should be emphasised that the nature of road users' behaviour and the success of behaviour change measures are ultimately empirical issues. Further progress in understanding, analysing and changing road safety behaviours will require formal and systematic study of road safety interventions designed based on behavioural economics insights. In this respect, in order to study and evaluate the effectiveness of 'nudge' interventions and measures, and in order to make sound assessments and refinements to practice and policy in a road safety context, there is a need in a systematic evidence-based research to. This calls for the design and conduction of empirical, controlled studies (including large-scale, panel and field studies in more natural environments), and for a systematic process of evaluation.

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