Livable streets and perceived accident risk: quality-of-life issues for residents and vulnerable road-users

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Introduction. This paper stems from a research proposal into the effects of traffic levels on the environmental quality of urban streets. It has drawn much of its inspiration from the work of Donald Appleyard who, together with Mark Lintell, pioneered efforts to gauge the effects of differing levels of traffic on environmental quality.

In this paper the author begins by focusing on recently-published research which demonstrates the relationship between traffic levels and livable streets, as described by Appleyard and Lintell in 1972[1]. That is, the increasingly hostile street environment as traffic levels rise, the consequent perceived road accident risk, and general erosion of the livability of urban streets, reflected in the withdrawal of community activities such as children's play and decline in social support networks. The example given is the restrictions placed on children's independent mobility. Moreover, by calling on epidemiological research, the author seeks to draw a causal link between perceived accident risk, community severance and mortality rates as compounding evidence of the degree to which quality-of-life is diminished by unacceptably high levels of traffic.

The hypothesis suggests that not only are restrictions being placed on health-invigorating activities, but also that health-damaging lifestyles have been and are being formed in response to perceptibly obtrusive levels of traffic on residential streets. Road accidents are at the tip of a morbidity 'iceberg' which extends far beyond both reported and unreported road accidents. A severance index drawing on Appleyard and Lintell's fieldwork (amongst others) would provide the basis by which environmental capacity ceilings could be established. With road traffic predicted to rise by between 72 and 121 per cent by 2025 there will be increasing pressures on residential streets. Establishing environmental capacity limits is therefore an imperative in order to protect environmental quality and counter the health disbenefits accruing from traffic.

Road safety *versus* accident casualty reduction?

A brief look around at the road safety literature gives a strong indication that the main thrust of road safety research and practice is not concerned with road safety, but rather with accident reduction. While the latter is an understandable aim it does not necessarily improve safety for large sections of the population such as children, women and the elderly, whose ability to pursue particular activities, such as travel, may be limited or curtailed all together. Such effects are particularly disturbing if the activities are generally life-enhancing, such as cycling and walking. The viability of these modes is particularly susceptible to perceived risk posed by other road-users, as are children's outdoor activities.

So what, then, is road safety if not accident reduction? Turning to the dictionary, 'safety' is defined as: 'The state of being safe from injury or hurt; freedom from danger'. Danger, the converse of safety, is defined as: 'Liability to exposure to harm or injury; the condition of being exposed to the chance of evil; risk; peril'. Presuming that one can accept a definition of road as a geographical area with precise boundaries it can be concluded that road safety means 'the freedom from the liability of exposure to harm or injury on the road'. Therefore, the promotion of road safety can be said to be the promotion of this freedom from liability to harm or injury[2]. In contrast, the term 'road safety' as commonly used refers to the lack of safety (danger) and is expressed in terms of accidents. As Silcock, Barrell and Ghee have noted, 'road safety usually means the unsafety of the road transport system'[3].

The relationship between safety, danger and accidents is simple. Road-users make assessments, correctly or otherwise. A length of road may, for example, be dangerous and result in a high number of accidents. Another length of road with a similar traffic flow and environment may also be dangerous yet have few accidents. An example, albeit extreme, of how dangerous a road is would be to consider children crossing the M1 motorway. Of 10 children attempting the crossing the number arriving intact on the other side would provide a very stark indication of how dangerous ('unsafe') such a road is for pedestrians. Compare such a situation against a quiet residential street. The likelihood of 10 children successfully crossing would be much higher. In a real-life situation the M1 has far fewer pedestrian accidents than a residential street due to the virtually non-existent exposure level.

The importance of perceived accident risk

Perceived risk, as opposed to actual risk, is subjectively assessed and may under- or over-assess the true level of risk in any given situation. Boyle and Wright have concluded that 'it is often the failure to perceive the true nature of a risk which ultimately leads to an accident'[4]. When the risk is accurately assessed, however, and then prudently dealt with the potential danger is not realised. Risk-taking, it should be noted, is an accepted element of our culture. Accidents are an inevitable outcome of this.

The curtailment of some activities is one way of prudently dealing with perceived risk. Adams has often cited the case of Muswell Hill Road, in north London, where his family lives. As it is a busy road he forbids his children to cross it unless accompanied by an adult, as he considers it dangerous. Yet the local traffic engineers proclaim that Muswell Hill Road is reasonably safe[5], there is not a significantly high level of accidents. Examples such as this illustrate how children's 'range behaviour' has been negatively affected. In this instance parental action may have helped to reduce road accidents, but clearly no road safety improvements have taken place. However, for those who walk or

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cycle because there is no practical alternative and for those who use these modes out of choice the perceived and actual level of risk has substantially increased with the rapid motorisation of society.

Effects on children's independent mobility

Analysis by West-Oram, among others, has highlighted this increased exposure to risk for 10-14 year olds[6]. They can be said to be given a far greater degree of independence when compared with younger children. The school journey has been a focal point for such analysis, showing how exposure levels for this age group have remained similar to those for children of, say, 30 years ago while the risk per unit of exposure has increased substantially. West-Oram's research is supported by the recent findings of Hillman, Adams and Whitelegg[7]. In a 19-year follow-up survey of five schools, they found that parental perception of road accident risk from traffic had led them substantially to restrict their junior school-aged children's independent mobility.

Parents had been perceiving, correctly, that the danger from traffic demanded a level of skill and attention which their children had not yet developed. In consequence the amount of escort journeys had risen dramatically. In 1971 14 per cent of junior schoolchildren were escorted to school, in 1990 this had risen to 64 per cent. The study also found that, on average, the 'licences' adults give to their children — such as to cross roads, to cycle on roads, as well as to come home from school on their own — were being granted, on average, over two years later in the 1990 survey than in 1971.

The research has highlighted the threat to children's development. The importance of independent mobility in the development of children should not be understated. Child psychologists stress the importance of facilitating the development of independence by allowing children new freedoms when they are ready to cope with them. Numerous studies have shown the importance of play and range behaviour for the development of children's cognitive abilities (Hart[8], Playboard Ltd[9]). The restrictions reduce the opportunities for children to explore the environment outside the home, including their ability to learn the skills necessary to take and overcome risks. Hillman *et al*[7] also point to studies which have concluded that children's physical fitness may be undermined as a result of increasing reliance on escort journeys by car.

More journeys are being made by car for road safety reasons, as was illustrated by the example of junior schoolchildren's travel. Yet the knock-on effects of the perceived accident risks to vulnerable road-users are largely ignored, even though there are strong arguments for road safety improvements which reduce the need for car travel. Ten per cent of London's morning peak traffic is accounted for by escort journeys. Clearly the benefits of providing safe alternatives to private car travel could reduce congestion? It has been suggested that 'if the morning escort car-driver trip could be eliminated by an improvement in the alternative ways of getting to school, the evening work-to-home car-driver trip would be eliminated as well'[10].

Environmental impact

In 1963 the pioneering Buchanan Report introduced the concept of the environmental capacity of streets to cope with traffic[11]. As Ferrary has noted, 'Buchanan took pedestrian delay as a proxy for this capacity in residential streets, and traffic noise in the case of non-residential streets. This was perhaps too simplistic a relationship'[12]. One of the first studies which attempted to broaden the criteria in order to evaluate the negative impact of traffic on urban street life was Appleyard and Lintell's research in San Francisco in the 1970s[1]. In the late 1960s and early 1970s urban traffic levels were rising rapidly and impacting heavily on communities across the United States.

They examined community reactions to differing levels of traffic using a range of environmental indicators in order to interpret the livability of streets. These included 'pedestrian delay times, counts of street activity, closed windows, drawn blinds, parked cars, trash, flower boxes and other signs of personal care'. From such indicators Appleyard and Lintell proposed environmental performance standards to which residential streets should be subjected. They also argued for what is now termed 'traffic calming' and the provision of more recreational street-space.

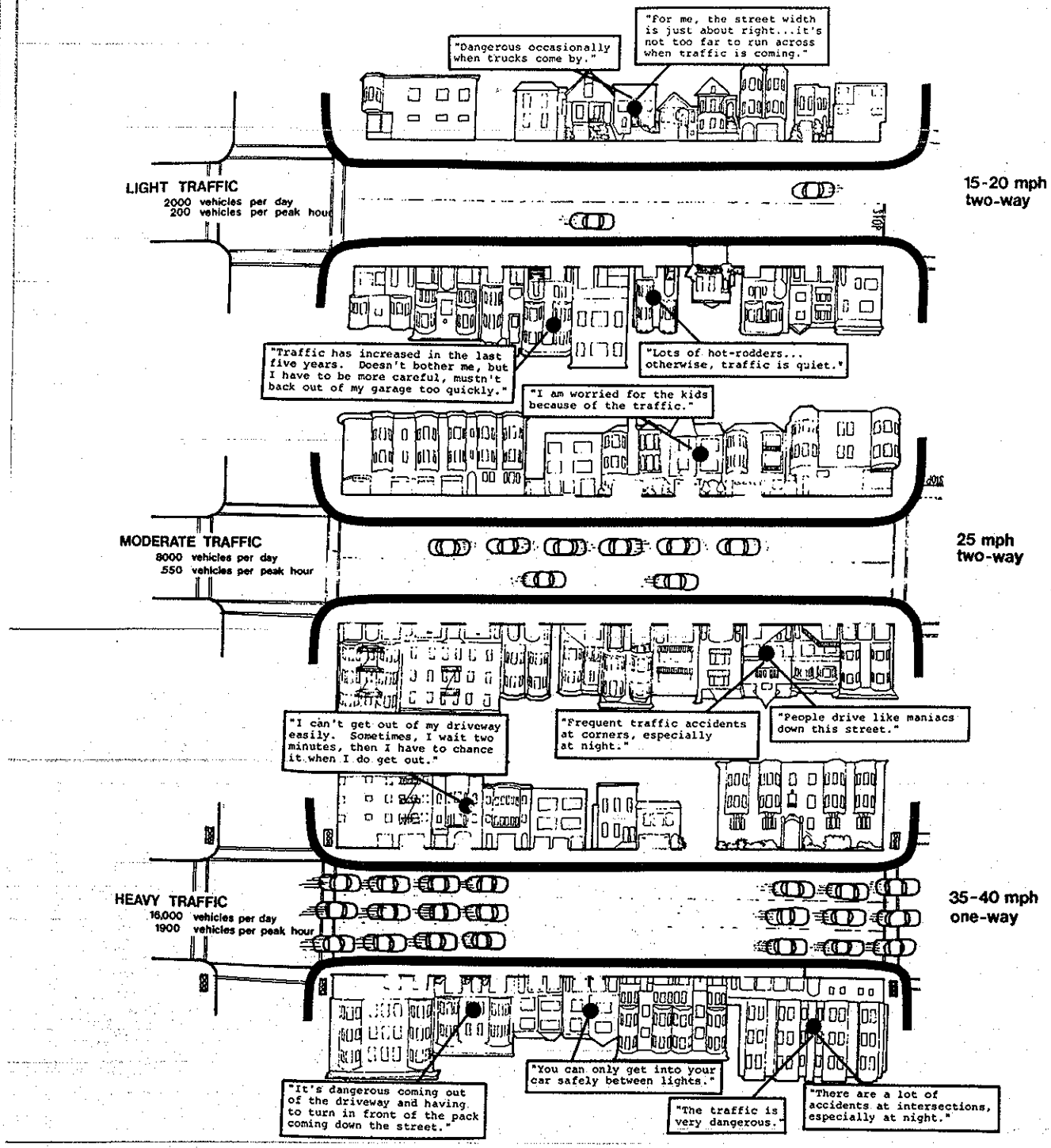

Fig 1. The three San Francisco streets, including residents' comments about traffic hazards.

The study comprised three adjacent north-south residential streets, similar in most respects except that one carried 15 750 vehicles per 24 hours, the second 8 700 and the third just 2 000 (Fig 1). They were thus labelled Heavy, Moderate and Light streets. Heavy street was one-way with synchronised stop lights. All aspects of perceived livability — such as absence of noise, stress, pollution, levels of social inter-action, territorial extent and environmental awareness, and safety — were examined. These were all found to correlate inversely with traffic intensity. Unsurprisingly safety was perceived to be less of a problem on Light street than on the others.

One of the most revealing aspects of the study was the degree of social interaction which took place on the different streets. Residents were asked how many friends and acquaintances they had on their street. On Light street the number of friends was three times as many and with twice as many acquaintances as for those living on Heavy street (Fig 2). The friendliness of Light street was undoubtedly related to the level of traffic. Families with children felt relatively free from traffic dangers. In contrast to the others, Heavy street had little or no pavement activities and 'was used solely as a corridor between the sanctuary of individual homes and the outside world'. Severance of the community by the traffic had eroded community ties. Appleyard and Lintell found through observations of environmental quality that conditions on Heavy street were particularly severe. By a process of environmental selection and adaption the street's residential make-up had changed significantly over the years as a result of the hostile traffic environment. For example, most families with children had departed from Heavy street. Some of the elderly people on Heavy street, finding it too costly or too

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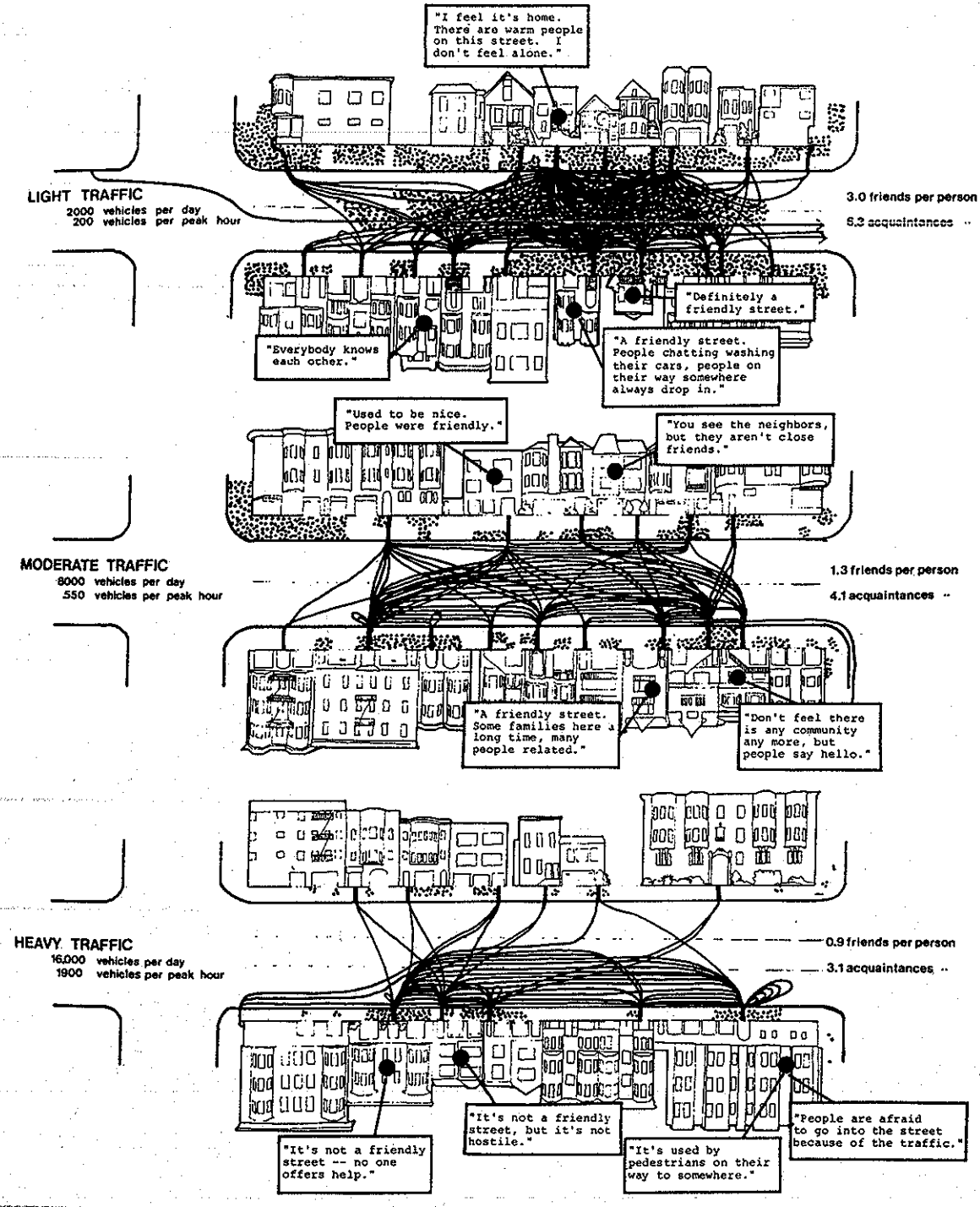


Fig 2. Social interaction: the lines show where people said they had friends or acquaintances, dots show where people are said to gather.

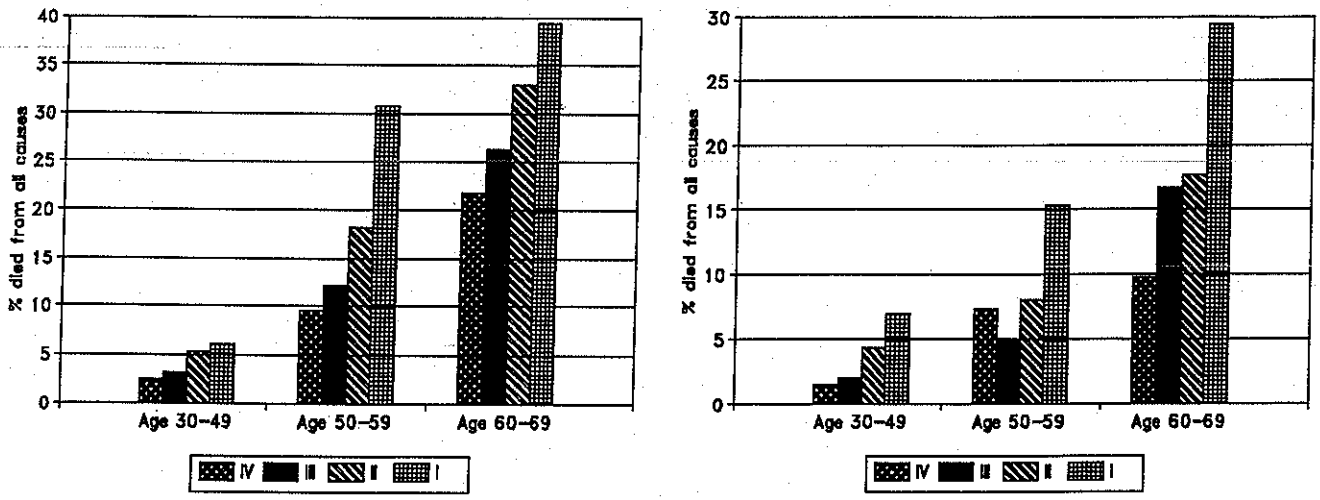
much effort to move became, as Appleyard describes, 'locked in'. They, like others 'locked in' for various reasons, experienced severe discomfort and breakdown of social support networks.

Health impact

The breakdown of social support networks, especially in Heavy street, has important health consequences. Epidemiological studies have shown that low levels of social support networks are linked to increased mortality rates from all causes. From Berkman and Syme's study, *Social networks, host resistance and mortality,* a causal link can be drawn between the negative effects of traffic on communities and mortality rates[13]. Their study involved a nine-year follow-up of Alameda County residents.

Unlike earlier studies Berkman and Syme directly measured social contacts in a large sample of a general population. Four sources of social relationship were examined: marriage, contacts with close friends and relatives, church membership, and informal and formal group associations. Their findings are important in that, in each instance, people with social ties and relationships had lower mortality rates than people without such ties. All four sources were 'found to predict mortality independently of the other three' while marriage and intimate ties were stronger predictors than were the other two. This was found to be independent of self-reported physical health status and health practices.

Berkman and Syme created a Social Network Index in order to assess the cumulative effects of these ties and relationships (Fig 3). The age-adjusted relative risks for those most isolated when compared to those with the most social contacts were 2.3 for men and 2.8 for women. 'For every age group



Berkman and Syme's Social Network Index showing age and sex-specific mortality rates from all causes per 100 men (Fig 3a, left) and per 100 women (Fig 3b, right). Human Population Study of Alameda County, 1965-1974[13]. IV = most connections, I = least connections.

examined, and for both sexes, people with many social contacts had the lowest mortality rates and people with the fewest contacts had the highest rates.' Other epidemiological research has corroborated this (Cassel[14], Welin *et al*[15], Fox[16]) and also suggested that good social support networks are most important for health vulnerable groups, such as the elderly.

The effects of traffic on community life have a serious impact on health. Road accidents can be seen as the tip of a morbidity 'iceberg' which extends far beyond both reported and unreported accidents (Fig 4). Yet such links with epidemiological research appear scarce, largely undiscovered or acknowledged by those working in the fields of road safety and accident casualty reduction.

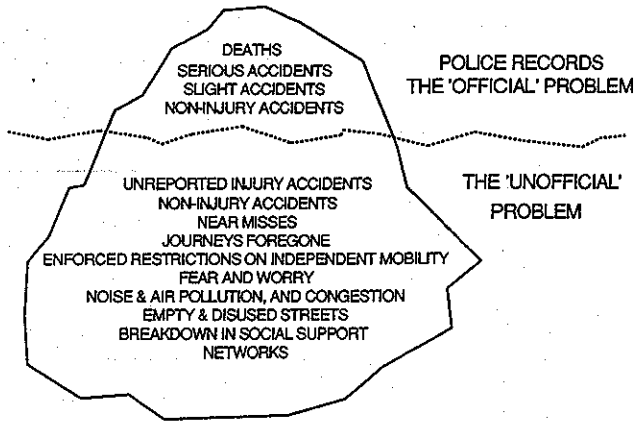


Fig 4. The Morbidity 'Iceberg'. Road accidents are the most easily understood effect of road traffic on health.

A case for environment capacity limits

The negative impacts of traffic on residential amenity have largely been ignored because they are too difficult to quantify and because road (un)safety has historically taken centre stage. The *Manual of Environmental Appraisal (MEA)* is the only widely-used appraisal mechanism for the evaluation of community severance. Issued by the Department of Transport it pertains only to Trunk Roads[17]. The *MEA* does provide a definition of community severance, which is '. . . the separation of residents from facilities and services they use within their community, from friends and relations and, perhaps, from place of work as a result of changes in road patterns and traffic levels'.

A recent review of community severance for the then Transport and Road Research Laboratory (TRRL) highlighted the *MEA*'s contribution in providing 'the methodologies to assess the impact of a new road and the changes in forecasted traffic flow upon the environment. In all there are 11 impacts ranging from traffic noise through to driver stress and community severance'[18]. The review highlighted two key flaws in the *MEA*'s definition of severance: firstly, that geographical areas are not inherently socially cohesive; and secondly, that severance is not necessarily just a product of change, but may already exist. The review team suggested a less restrictive revised definition of community severance as 'the sum of the divisive effects a road has on those in the locality'. However, the *MEA* only provides a coarse mechanism of slight, moderate or substantial severance.

Importantly, the review concluded that a severance index would be required in order to reflect the impact of various traffic volumes. The index would be 'derived on the assumption that severance is proportional to traffic density and to the mitigation factors' such as presence and acceptability of crossing facilities. The proposal for a severance index for the *MEA* highlights the need to provide a framework by which to evaluate accurately potential severance effects of traffic. For non-trunk roads where relatively low volumes of traffic can impact heavily on the fabric of community life a severance index would require detailed street level indicators such as those used by Appleyard and Lintell for accurate evaluation.

Two other indicators of severance mentioned in the *MEA* are noise levels and pedestrian delay in crossing roads. They have formed the basis for much of the published work in this field[19]. For pedestrian delay the gap acceptance theory has been used (giving a 50 to 60 per cent delay for different types of user). Gap acceptance theory based on pedestrian delay has, however, proved to be problematic. Most importantly, increasing levels of traffic can result in pedestrian delay being so great or risk from traffic being perceived to be so high that attempts to cross at such sections may be curtailed.

Gilbert's work on environmental capacity is one of the most important attempts to develop a more sophisticated model[20]. He sought to introduce 'ceilings' along links of existing roads rather than looking at the effects of new road links. In his studies of Bath and London three types of criteria were used: noise, pedestrian's environment and visual intrusion. For each of these three levels of criteria were adopted, resulting in nine separate statements of the acceptable amount of traffic on each link of the existing central-area network. Having thus established 'acceptable' environmental capacity ceilings he was then able to compare them with existing traffic flows to establish the traffic overload on each link. From this 'the overall restraint in vehicle usage required by each set of criteria was then calculated'.

For each set of criterion levels the limiting environmental capacity for each street was calculated. That is, minimum levels for noise, pedestrian's environment and visual intrusion. As in reality these three types of environmental factors are not necessarily of equal importance the criterion levels were varied. In Table I the effects of varying them

for environmental capacity for the Bath study is summarised.

Gilbert's studies suggested that the use of the environmental capacity approach 'demonstrated its utility for the generation of urban network and traffic management schemes'. By combining Gilbert's three criteria with Appleyard and Lintell's more sensitive environmental indicators one may be able to interpret with some accuracy the livability of streets whose primary function is residential. This could provide the basis for a severance index by which environmental performance standards and traffic capacity limits might be established (Fig 5).

In their 1970s research Appleyard and Lintell proposed traffic calming measures for residential streets to protect community activities. In the U.K. it is unlikely, given current rates of implementation, that area-wide traffic calming schemes will achieve a level of street coverage found in some other European cities, although the Minister for Roads and Traffic has stated that 80 per cent of the urban road network is potentially eligible for 20 mile/h status[21]. Funding and staff-time are still major obstacles. For example, Hamburg has over 600 30 km/h speed limit zones installed, giving traffic calming almost city-wide coverage. Driving across the city over a quarter of the distance to and from a residential suburb may be travelled on 'Tempo 30' and other traffic-calmed roads. In Buxtehude, one of the national traffic calming demonstration projects, the proportion of travel on such streets may be over three-quarters[22]. In contrast, drivers in the U.K. travelling in an increasingly congested primary road network may well be prepared to accept localised areas of traffic calming, i.e. a few streets of road humps, just to be 'on the move'.

Given that traffic levels are projected to rise by between 72 and 121 per cent by 2025 residential amenity is likely to come under increasing pressure[23]. Urban street life, the livability of streets, will be increasingly marginalised. Establishing and setting environmental capacity ceilings could act to accelerate efforts to introduce area-wide traffic calming. This will be essential if the impact of traffic on communities is to be contained and ameliorated.

Finally it is worth citing here the following clauses from the 1988 European Charter of Pedestrians' Rights drawn up on behalf of the European Parliament's Committee on the Environment, Public Health and Consumer Protection[24]. Its recommendations are highly relevant to the issues of livable streets and perceived accident risk:

(1) The pedestrian has the right to live in a healthy environment and freely to enjoy the amenities offered by public areas under conditions that adequately safeguard his physical and psychological well-being.

(2) The pedestrian has the right to live in urban or village centres tailored to the needs of human beings and not the needs of the motor car and to have amenities within walking or cycling distance.

(3) Children, the elderly and the disabled have the right to expect towns to be places of easy social contact and not places that aggravate their inherent weakness.

(4) The pedestrian has the right to urban areas which are intended exclusively for his use, and are as extensive as possible and are not mere 'pedestrian precincts' but in harmony with the overall organisation of the town.

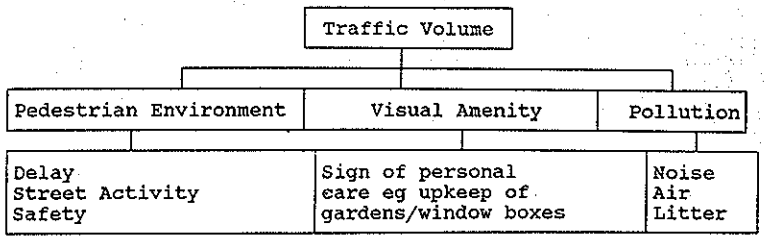


Fig 5. Environmental indicators of community severance drawn from Gilbert[20] and from Appleyard and Lintell[1].

Table I. Proportions (%) of network length in Bath whose environmental capacities would be limited by three different criteria

	Type of criterion			
Criterion level	**Noise**	**Pedestrian**	**Visual**	**Total**
Most restrictive	28	5	67	100
Middle criterion	48	30	22	100
Least restrictive	25	53	32	100

Conclusions

Road accidents form the tip of a morbidity 'iceberg' which includes a far wider range of impacts on the health of the population than is generally acknowledged. There is a chain reaction to the threat posed by traffic. As this paper has attempted to show, perceived accident risk is a response to traffic and a trigger mechanism which influences many street-level activities such as social-support, children's play and community identity. Perceived accident risk also impacts far more severely on vulnerable road-user behaviour than has been acknowledged. It can result in reductions and curtailment of activities if the risk is assessed to be too great. Restrictions increasingly placed on children's independent mobility are key indicators of the degree of this perceived risk. Moreover, traffic also severs communities and diminishes social support networks, imposing substantial health costs. Epidemiological research has shown that such diminution can lead to higher mortality levels from all causes. This may be especially so for the elderly and other health-vulnerable groups.

As a result of their research Appleyard and Lintell suggested that environmental indicators should be used to formulate predictive models of response to various conditions. With such models, 'indices could be established to predict subjective responses to environmental phenomena'. Incorporated into Gilbert's model their sensitive environmental indicators provide the framework for a community severance index by which residential amenity is given greater weighting *vis-à-vis* the perceived 'needs' of traffic. Research to develop such a severance index is required.

Research into the establishment of environmental capacity ceilings began over 20 years ago and was stimulated by concern over rising traffic levels in U.S. residential streets. Projected U.K. traffic increases would strongly suggest that such ceilings are now needed here. Environmental capacity limits could be used to target an expanded area-wide traffic calming programme. Such a programme would play an important rôle in combating the substantial health disbenefits accruing from traffic. Children could be given greater independence as a result of improved road safety and reduced perceived and objective levels of risk. Lastly, it would provide greater opportunities for communities to rebuild damaged social support networks, promoting health in its broadest sense.

This is a revised version of the paper presented in September 1991 at the University of Salford's 5th Biennial Symposium on 'Recent Developments in Research and Road Safety'.

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